

The Adoption of Industry 4.0 in Moroccan Industrial Companies to Overcome the Crisis Covid-19

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Abstract

With the current rapid technological evolution, most countries are facing a major challenge to keep up with the pace. In this context, the industrial sector, which is an essential pillar of any country, also needs to adapt and accelerate the process of digitization of Industry 4.0 to ensure continuous and resilient production in the face of pandemics such as Covid-19. However, the Covid-19 crisis has had a significant impact on the industrial sector, with the temporary closure of many factories to protect the health of workers, leading to a severe economic crisis.

This document focuses on the importance of the rapid adaptation of the industry to digitization, particularly Industry 4.0, to maintain production in the face of pandemics such as Covid-19. The article examines the advantages and disadvantages of Industry 4.0, as well as relevant technologies. It also presents research on the impact of the Covid-19 crisis on industrial businesses and the use of Industry 4.0 to manage this crisis. An investigation was carried out on 45 Moroccan companies from different regions, and the results showed that more than 50% of these companies maintained or increased their turnover thanks to the implementation of Industry 4.0.

Keywords

Covid-19, Industry 4.0, industrial revolution, digitalization.

1. Introduction

Digitization is a phenomenon that is spreading rapidly around the world, generating increased competition between companies. To remain competitive, they must adapt by using advanced Industry 4.0 technologies. Technologies such as artificial intelligence, the Internet of Things and additive manufacturing are being implemented to improve productivity, production customization and information management.

However, the Covid-19 pandemic has disrupted businesses around the world, with significant economic impact. To cope with this situation, many companies have sought alternative solutions to survive, including relying on the digital technologies of Industry 4.0. In Morocco, companies have also adopted this strategy to resist the pandemic.

The application of digital technologies allowed companies to adapt quickly to the new situation and continue to operate despite the restrictions imposed. Remote communication tools allowed teams to work together despite physical distance, while document management tools enabled instant access to information and real-time collaboration. Remote support tools were also used to manage computers and machines remotely, allowing companies to maintain production.

2. Evolution of Industry 4.0

The industry has undergone a major revolution; it has gone from the first production system that is based on agriculture essentially (Industry 1.0) to an intelligent industrial system (Industry 4.0).

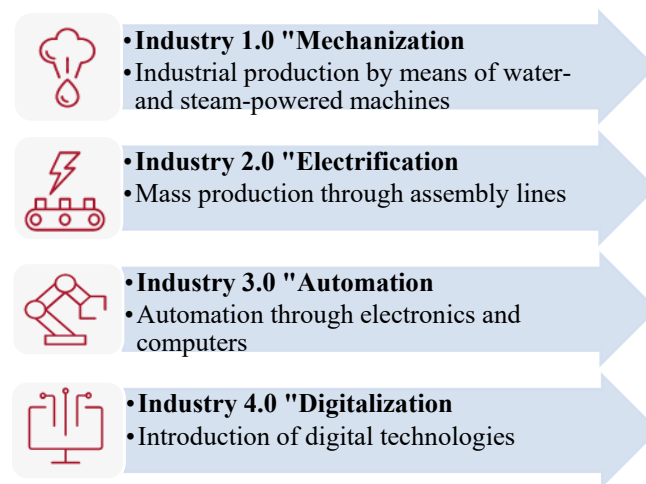


Figure 1. The evolution of the industry over time

2.1 Industry 1.0 “Mechanization

Between 1680 and 1720, there was an agricultural and demographic revolution which imposed an industrial revolution. Indeed, in 1765 James WATT exploited the coal and invented the steam engine in order to radically transform the general organization of the production. This production is essentially agricultural. This increased the production capacity, and forced the market to accommodate a production with different outlets. (Samadi & Achelhi 2021).

This revolution allowed the creation of factories that used the steam engine to power their equipment, which increased the rate of production and led to greater manufacturing.

But, with the appearance of these factories the society begins to be interested in the environmental problems. (Shin et al. 2019).

2.2 Industry 2.0 “Electrification

The second industrial revolution began at the beginning of the 20th century with the discovery of electricity, motors and the invention of assembly line work. The primary objective of this revolution was to introduce mass production and innovations in chemistry and related fields. (Javaid & Haleem 2019).

Henry Ford (1863-1947) came up with the idea of mass production in a Chicago slaughterhouse and invented the assembly line for mass production of vehicles, which makes the designed machines more mobile. Thanks to technology, vehicles, means of transportation and some devices built into machines or even machines consume oil, so paying attention to the environment becomes an obstacle. (Keller 1970).

2.3 Industry 3.0 “Automation

It was not until the second half of the 20th century that the computer appeared. Since 1970, electronic devices have been invented and used in industrial environments. Vacuum tubes were replaced by transistors and then electronic circuits immigrated in integrated circuit chips. (Samadi & Achelhi 2021).

At that time, production was further advanced by the automation of mechanical machines, computers, programmable logic controllers and telecommunications.

Since the introduction of these technologies, it was now possible to record more and more data but with a time lag or after the fact.

Faced with this revolution, the problem of pollution caused by these machines and the non-treatment of industrial waste became a very big undesirable effect. (Tantawi & al. 2019).

2.4 Industry 4.0 “Digitalization

Industry 4.0 is the next step in the industry development process. The term Industry 4.0 was first introduced at the Hannover Messe event in Germany in 2011. (Grieco & al. 2017).

This latest revolution is also called the Industrial Internet of Things or the factory of the future. This revolution aims to implement smart factories capable of producing productions using more ecological and efficient processes.

Industry 4.0 is characterized by highly developed automation and digitalization processes and the use of electronics and information technology (IT) in manufacturing and services. (Lu 2017).

One of the main goals of Industry 4.0 is to connect the physical and virtual worlds, combining assembly-line and custom manufacturing.

The benefits of this technology include increased productivity, reduced errors and rework, and the execution of high-risk tasks. (Samadi & Achelhi 2021).

3. Benefits and drawbacks of Industry 4.0

Industry 4.0 drives automation and connectivity at the product level. It allows for faster and real-time information.

The implementation of new technologies leads to comparisons if it is practical or not, it is in this sense that a review of the advantages and disadvantages of this production system should be made.

3.1 Benefits of Industry 4.0

The benefits of Industry 4.0 can be classified along three key dimensions:

- Technical dimensions: analyzing the following articles, (Grieco et al . 2017); (Lu 2017); (Mortyl et al. 2017); (Leyh & al. 2017); (Peruzzini et al. 2017); (Weyer et al. 2015); (Koch et al. 2014); (Mckinsey & Company 2015); technical benefits include: increased productivity and operational efficiency, ease of interconnection and information from traditional industry, communication between machines and humans via IoT, speed of data collection, analysis, and processing, and reduced overproduction.
- Logical Dimensions: According to (Yasanur 2018): Industry 4.0 can decrease logistics costs (transportation, warehousing), optimize turnaround times, deliver orders quickly, and improve logistics service quality.
- Ecological and human dimensions: after analyzing the following articles, (Dalenogare et al. 2018); (Karre & al. 2017); (Pereira & Romero 2017); (Waibel & al. 2017); this industry can reduce production waste, energy consumption, errors, worker complaints, and it can facilitate the execution of high risk tasks.

3.2 Obstacles to the implementation of Industry 4.0

Following the analysis of the following articles (Mckinsey & Company 2015); (Raj et al. 2020); (Alcacer & Cruz-Machado 2018); (Kiel et al. 2017); (Mamad 2018); we can synthesize the set of barriers into:

- High cost;
- Limited corporate structure;
- Hacking through cyber-attacks;
- Spirit of staff and adapting to new changes;
- Lack of skilled manpower.

4. Technologies associated with industry 4.0

The technologies associated with Industry 4.0 bridge the physical and digital worlds and make intelligent and autonomous systems possible. They are diverse and their list tends to grow as time goes by. For the application of these, we distinguish nine technological pillars (see figure 2).

In general, companies use most of these technologies, but the effectiveness of Industry 4.0 comes to life when these technologies are used together.

According to (Pfeiffer 2018) and (Kahmann 2021), four dimensions of technologies exist in industrial applications and their implications, however, are distinct in terms of human-machine interaction, qualification, work organization, and employee representation:

- Mobile and internet-based communication;
- Intensified networking of production;

- New robotic and production technologies;
- Wearable computing objects.

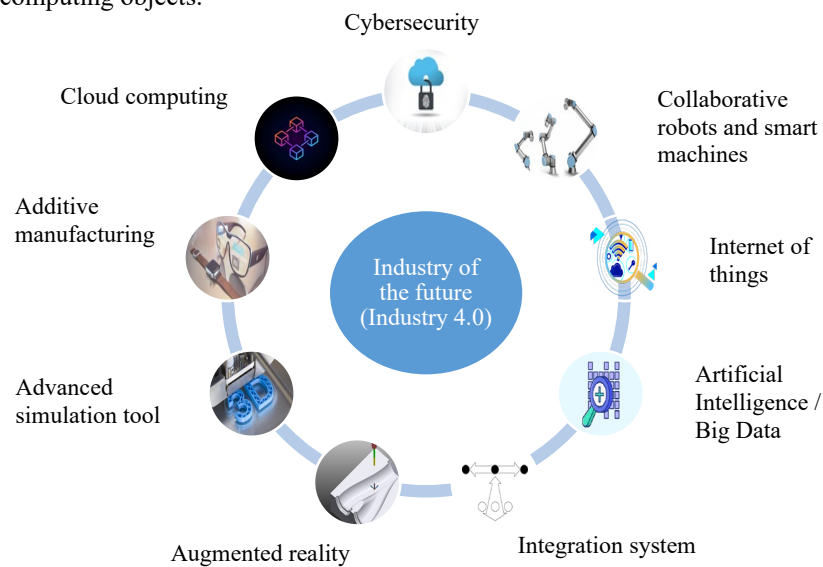


Figure 2. The nine technological pillars of Industry 4.0 inspired by the work of the Digital Region (Auvergne-Rhône-Alpes region)

5. Impact of the Covid-19 crisis on industrial companies

The Covid-19 pandemic that hit the world in 2020 was a real shock for all the world's economies, bringing them to a standstill or even to a halt, following successive periods of containment/decontainment and the sanitary measures that were put in place over time. This pandemic has had a very marked impact on the financial situation of companies: they have experienced a sudden drop in their turnover, unprecedented in some sectors, and have had to reduce their expenses and borrow to meet their deadlines.

Despite government rescue programs, a wave of bankruptcies is expected in several sectors and the number of registered unemployed has increased during the year 2020. According to the World Bank, a quarter of companies have seen their turnover fall by 50% and 11% of companies have had to lay off their staff.

Morocco, like all the countries in the world, could not escape the Covid-19 crisis and suffered very heavy economic and health consequences. Faced with this situation, the Moroccan government has made enormous efforts to ensure that the effects of this crisis are not very serious. It has formed an economic watch committee on March 11, 2020, to anticipate and monitor the direct and indirect repercussions of the Covid-19 pandemic on the national economy and also to identify support to the most impacted sectors. (El Amine & Bouayad Amine 2020).

The current health crisis (Covid-19) has dealt a heavy blow to the Moroccan economic situation and will have very strong consequences that will be felt for several years.

The High Commission conducted a survey at the end of April 2020 on the effects of Covid-19, among 4,000 Moroccan companies and found that 57% of them had stopped their activities temporarily or permanently.

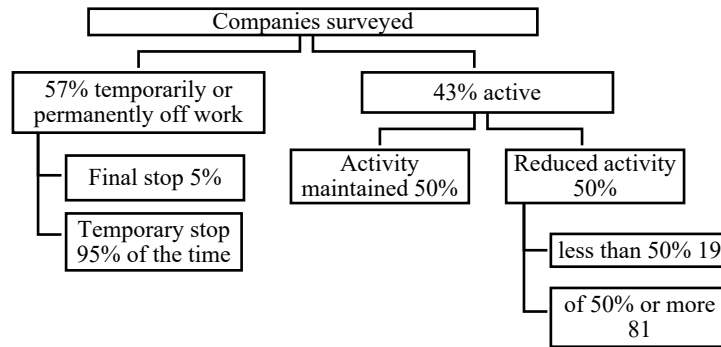


Figure 3. Impact of covid-19: level of activity (from HCP survey)

They are divided into four main sectors (from HCP survey):

- Service sector 34%;
- Industry sector 27%;
- Construction sector 23%;
- Trade sector 16%.

6. Use of industry 4.0 in crisis management Covid-19

In order to continue and overcome the challenges, companies have been forced to use innovative technology solutions. This is a direct consequence of the Covid-19 pandemic that has changed the way companies work internationally.

Many employees have resorted to working remotely or telecommuting due to the confinement. This has proven to be an adequate solution as companies have been able to continue their production in full or in part. Online work has allowed employees to perform their daily tasks such as:

- Instantaneous remote communication between teams;
- Remote meetings;
- Remote computer and machine management;
- Organization and management of projects;
- Document management with access at any time (data sharing).

Industry 4.0 has played, on its part, a very important role against the lock-in and social distancing that has caused a restriction in accessibility of the staff.

Indeed, Industry 4.0 through its technologies has been able to ensure this continuity. The connectivity between men and machines and connected objects based on the Internet of Things (IoT) have improved the automation of production sites and greatly reduced human intervention. A study by Gartner reveals that 47% of companies plan to increase their investments in IoT as a result of the confinements, while a McKinsey report exposes that IoT could gain between 10% and 30% productivity depending on the sector. Also, 3D printing or additive manufacturing has allowed companies to create complex parts in hours, which can be critical in the production chain, instead of weeks using traditional methods (the production of breathing aids for example).

To prevent the spread of Covid-19, the World Health Organization has mandated that employees who have been required to work in the premises because of their critical positions follow the following precautions:

- Wear a mask;
- Ventilate for 10 minutes and wash hands every hour;
- Observe physical distancing;
- Perform a covid-19 test if necessary.

Studies have shown that Industry 4.0 has a positive impact on Covid-19 enforcement. For example, IoT is an effective tool for managing personnel who do not wear masks or maintain the necessary physical distance. This was also controlled by computer vision and the use of sensors. Machine learning, in turn, played a role in whether or not to test. (Agrawal & al. 2021).

7. Research Methodology

In this work, we present the purpose of the study, which is to determine whether Moroccan companies have used Industry 4.0 to overcome the Covid-19 crisis. We also hypothesize that more than half of the companies were able to overcome the crisis through the implementation of Industry 4.0. To validate this hypothesis, we conducted exploratory interpretive research by sending a questionnaire to 45 Moroccan companies. The directors and production managers of these companies were asked to answer the questionnaire. The companies concerned are located in industrial zones in different provinces of Morocco. This research methodology will allow us to collect qualitative data on the use of Industry 4.0 by Moroccan companies to face the Covid-19 crisis, and to confirm or not our hypothesis.

This questionnaire consists of two parts:

- The first part aims to identify each company and gathers general information such as name, size, province and number of years in business. This part is important because it will allow us to better understand the situation of each company and to determine if factors such as size or seniority have an influence on the company's ability to overcome the Covid-19 crisis through Industry 4.0.
- The second part of the questionnaire is essential and answers the main question of the study: does the implementation of Industry 4.0 help Moroccan companies to overcome the effects of the Covid-19 crisis? This part will collect qualitative data on the use of Industry 4.0 by companies to cope with the crisis and whether this technology has really contributed to the stability of their turnover. The answers provided by the executives and production managers of the companies involved will help validate or invalidate our hypothesis that more than half of the companies were able to overcome the crisis thanks to the implementation of Industry 4.0. This data will also be able to provide useful information for companies that want to use Industry 4.0 to deal with similar crisis situations in the future.

8. Results and interpretations: impact of industry 4.0 in the management of the Covid-19 crisis

8.1 Profile of responding companies

In this paragraph, we present the characteristics of the companies that responded to the questionnaire. Of the 45 valid companies, 71.1% are large companies, 22.2% are SMEs and 6.7% are SMMEs. This distribution will allow us to better understand the impact of the company's size on its ability to overcome the Covid-19 crisis through the use of Industry 4.0.

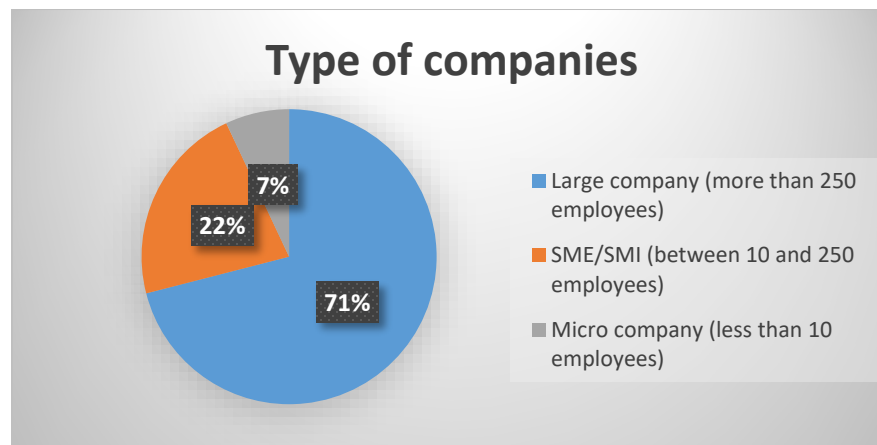


Figure 4. Type of respondent companies (source: Authors).

These companies are also distributed over five main regions, with 53.3% located in the Casablanca-Settat region, 13.3% in the Fez-Meknes region, 8.9% in the Rabat-Salé-Kénitra region, 8.9% in the Tangier-Tetouan-El Houceima region and 15.6% in the rest of Morocco. This geographical distribution will help to understand whether the location of the company has an impact on its ability to overcome the crisis Covid-19 through Industry 4.0.

Finally, we provide information on the age of the companies that responded, with 44% having more than 20 years of existence, 13.8% having less than 5 years of existence, and 42.3% having between 5 and 20 years of existence. This information is important because it will help to understand whether the age of the company has an impact on its ability to overcome the Covid-19 crisis through the use of Industry 4.0. Overall, this information will provide a better understanding of the characteristics of the companies that participated in the study and whether these characteristics have an impact on their ability to overcome the Covid-19 crisis through the use of Industry 4.0.

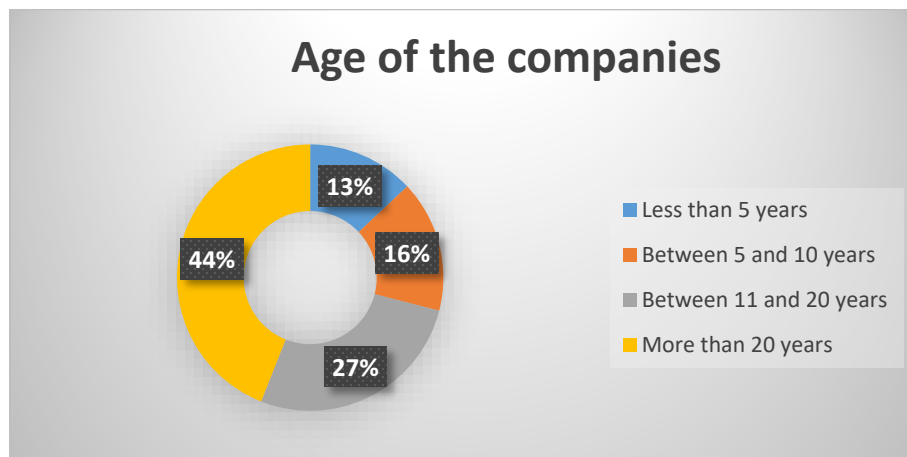


Figure 5. Age of respondent companies (source: Authors).

8.2 Results and interpretations

To test the validity of the proposed hypothesis, we conducted a survey of fifty Moroccan companies. The questionnaire sent included about ten questions aimed at analyzing the impact of the implementation of Industry 4.0 in the management of the Covid-19 crisis.

The main results of the survey show that 81.8% of the companies surveyed know that Industry 4.0 is an industrial revolution, which is encouraging because it indicates that most companies are aware of the importance of this technological innovation. However, 18.2% of the companies surveyed have never heard of Industry 4.0, which may be an indicator of the lack of information and awareness around this innovation.

These results show the importance of increasing companies' awareness of Industry 4.0 and providing them with the information they need to understand its impact on their business, especially during times of crisis like Covid-19. Companies that have a better understanding of Industry 4.0 are more likely to adopt it and reap its benefits to overcome the crisis.

After defining Industry 4.0 to the respondents, the survey showed that the majority of the questioned companies (77.8%) have partially implemented the digital technologies of Industry 4.0, while only 11.1% have fully implemented these digital technologies. On the other hand, 11.1% of companies have not implemented any Industry 4.0 measures. This study also shows that more than 75% of the companies that have implemented Industry 4.0 are large companies that have existed for more than 20 years in the automotive, aerospace, food and chemical sectors. These sectors require new technologies in their production based on robots and automated machines, which makes it easy to implement Industry 4.0.

These results show that although most of the companies surveyed are aware of Industry 4.0, not all of them have implemented these technologies in their business. However, for those companies that have implemented Industry 4.0, they are mostly large companies in sectors requiring advanced technologies.

In addition, when analyzing the survey results, it was found that the most common technologies used by the surveyed companies were IOT, used by 42.85% of the companies, machine learning (41.45%), MES production control software

(37.15%), cloud computing (32.85%), advanced simulation (15.7%) and additive manufacturing (2.85%). Companies using a combination of these technologies can benefit from greater efficiency in their Industry 4.0 implementation.

The survey also looked at the potential impact of the implementation of Industry 4.0 on the organization of work within the companies surveyed. The results show that more than half of the companies that have partially or fully implemented the digital technologies of Industry 4.0 (i.e. 58.5%) expect their work organization to be impacted.

Of these companies, 18.5% expect some jobs to disappear in the coming years. This can be explained by the fact that Industry 4.0 often involves the automation of certain tasks, which may lead to a reduction in the workforce. However, it is important to note that 30% of the companies surveyed believe that nothing will change in their work organization by applying the digital technologies of Industry 4.0.

These results show that while companies expect changes in their work organization by implementing Industry 4.0, they are not necessarily pessimistic about the future of their workforce.

Implementing Industry 4.0 has different challenges depending on whether companies have already applied digital technologies or not. For companies that have not yet applied digital technologies, the major challenges are related to manpower. Indeed, 50% of companies consider the lack of skilled labor as the main cause, while the remaining companies consider resistance to change among employees as the main obstacle. This may be due to a fear of losing their job or a reluctance to learn new skills.

In contrast, for companies that have already implemented digital technologies, the challenges are grouped into four main categories. First, human challenges, which include workforce qualification, resistance to change, the need to support employees in the transition, etc. Second, financial challenges, which may be related to funding needs, excessive cost, uncertain return on Industry 4.0 investment, etc. Technical challenges are also important, especially with regard to the implementation of the latest technologies. Finally, security is also a major challenge for companies adopting Industry 4.0, especially in terms of cyber security.

These results indicate that for half of the companies that have applied Industry 4.0 digital technologies, their revenue has been stable or increased in the first six months of 2020, compared to the same period in previous years. This suggests that the implementation of these technologies can have a positive impact on companies' financial results. However, for 18.5% of companies, revenue decreased, highlighting that the implementation of Industry 4.0 does not necessarily guarantee positive financial results for all companies. It is important to note that the turnover of the remaining companies was not revealed, so it is not possible to draw any conclusions about their financial situation.

Interestingly, despite the Covid-19 global health crisis, most companies that implemented Industry 4.0 were able to maintain their business moderately or without major impact. In fact, 78.5% of companies reported a moderate or no impact on their business. This is largely due to the stability of their activities (60% of companies) or a partial shutdown (37.2%).

Companies have successfully adapted to the situation by using digital tools such as remote team communication tools, telecommuting tools for meetings, remote support tools for telecommuting, and document management tools with anytime access. For example, 55.5% of companies used remote team communication tools and 78.5% used telecommuting tools for meetings.

These tools allowed employees to work remotely and securely and to continue their activity despite the restrictions imposed by the health crisis. Importantly, Industry 4.0 has played a crucial role in companies' ability to adapt to the situation by using innovative digital technologies.

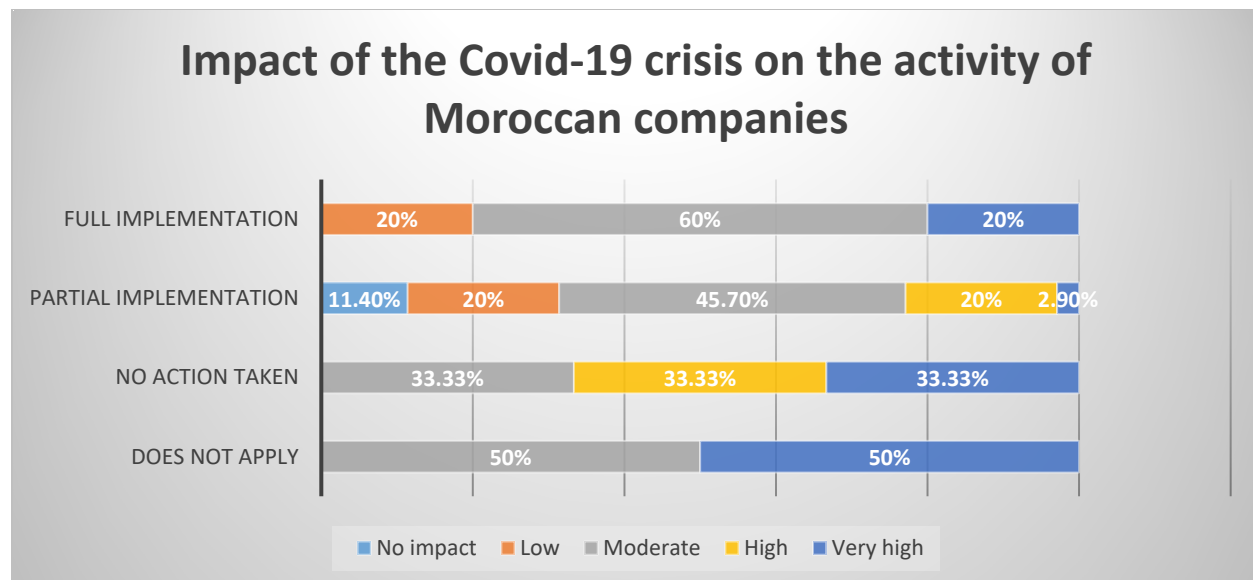


Figure 6. Impact of the Covid-19 crisis on the activity of Moroccan companies (source: Authors).

9. Conclusion

Indeed, the application of Industry 4.0 digital technologies has enabled companies to better withstand the Covid-19 crisis. By using the different pillars of Industry 4.0, companies have been able to adopt new, more flexible and efficient ways of working, allowing them to maintain their production and activity despite health and economic constraints.

The survey of Moroccan companies showed that the use of Industry 4.0 technologies was particularly helpful during the lockdown period. Remote communication tools, such as chat and video conferencing, allowed employees to work remotely and stay in touch with colleagues and customers. Remote support tools also helped keep machines and computers running smoothly, even without on-site staff.

In addition, analysis of the survey results shows that the implementation of Industry 4.0 has also had a positive impact on company productivity and innovation. The new technologies have helped to optimize production processes and reduce costs, while improving product quality and enabling new business models.

Finally, the application of digital technologies of Industry 4.0 is a crucial issue for companies, especially in times of crisis. It allows them to better withstand economic and health shocks by offering them innovative and efficient solutions to maintain their activity and improve their competitiveness, something that validates our main hypothesis.

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Biography

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