

Lean Management and Industry 4.0 Impact in COVID19 Pandemic Era

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Abstract

Covid19 is spreading across the globe. This pandemic affects almost all sectors of activities. It has created disruptions in production chains around the world, which have gone as far as stopping production in certain domains and double capacities in the others. Covid19 created a surge demand of health care equipment that oblige flexible companies to switch their ordinary production lines to produce items related to this pandemic. The aim of our work is to study how technologies offered by the fourth industrial revolution (Industry 4.0) could help to overcome this crisis. Also, to analyze the impact of adopting lean management principles, more specifically the just in time (JIT) principle. For this objective, we conducted a rapid review on the existing publications in literature using the key words covid19, lean management and industry 4.0. Results show that emerging technologies have a big potential to help on combatting this epidemic. Moreover, companies have to minimize the risk of shortage of stock by overusing the JIT lean principle.

Keywords

Lean Management, Industry 4.0, Covid19, Companies.

1. Introduction

Covid-19 is an emerging infectious disease caused by the last coronavirus that was discovered. The disease appeared in late 2019 in Hubei province and more precisely in the city of Wuhan (Zu et al, 2020). It was not unknown before (WHO, 2020). On March 11, 2020, the World Health Organization (WHO) declared Covid 19 as a pandemic, since almost countries of the world have been affected by this outbreak (WHO, 2020). Despite all countermeasures taken by governments, covid19 has not been stopped because it spreads easily. WHO explain that ‘the disease is mainly spread from person to person through respiratory droplets expelled from the nose or mouth when a sick person coughs, sneezes, or talks’ (WHO, 2020).

Within the first countermeasures taken is to close borders. China was the first to close its borders, before other countries did the same. As a result, products and materials movement is blocked. Then it became a challenge to continue supply chain operations properly because part of this chain was interrupted (Paul and Chowdhury, 2020). This decision has a direct impact on companies. The impact on companies depends on their sector of activity. For example, companies that produce medical items, masks, sanitizer, food goes up expressively, contrary to other industries like automotive and sport item (Paul and Chowdhury, 2020).

In this context, our work tries to analyze the impact of continuous improvement approaches (lean) and facilitators (industry 4.0) on ensuring business continuity in this crisis.

The reminder of the paper is as follow. Section 2 represent briefly the methodology used for this work. Section 3 aim at tracing a global idea on the impact of this epidemic. While section 4 explain how industry 4.0 is able to present solutions in crisis. Before conclusion, section 5 study the impact of lean on companies.

2. Method

To understand the impact of the two well-known approaches, lean and Industry 4.0 in the crisis that the world suffers from (covid19), we conducted a rapid review on the existing publications in this field. We used the following key words for the research:

First axis: (Industry 4.0 or Technologies) AND (covid19 or coronavirus or pandemic)

Second axis: (Lean) AND (covid19 or coronavirus or pandemic)

Considering the criticality of the subject, since the beginning of 2020, the number of scientific publications has been increased in relation to covid19. We conducted a selective research to analyze the impact of Lean and industry 4.0 in this crisis period. Figure 1 presents the used methodology to address the study.

After defining the objective of this study that is analyze the impact of Industry 4.0 and lean in the current crisis, we search for recent publications in this field in well known databases (Science direct, Taylor and Francis...), we also include the blogs. We selected papers, which treat directly the axis basing in the first time on titles and abstracts before reading all the papers. We finally analyzed and discussed the results in the following sections.

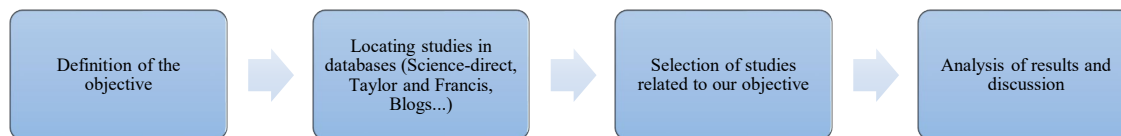


Figure 1: Research Method

3. Global impact of covid19

The exponential propagation of the Covid-19 pandemic all over the globe pushed the countries to make a sudden stop of the economic activity, consequently, at the national level the stop of the factories of production, the services, the tourism and local shopping, internationally, stopping the economic exchange between countries by closing the borders. Figure 2 depicts the number of covid19 cases all over the world until 28/07/2020.

It is a total paralism, the only vital activities that remain in motion to ensure the continuity of the human species is health and food industry.

The countries have dedicated special budgets to finance the fight against this global pandemic, this sum of money is not an extract of the Gross Domestic Product but rather extracted heavily from it. Something that will force the economies to seek the best means at the end to make production efficient in order to recover this budget shortfall during and after the period of pandemic crisis.

3.1. Moroccan and covid19 overview

Morocco is also among countries affected by covid19. The first case was recorded on March 02, 2020. Rapidly, the number of cases increased. As of 07/07/2020, there are 14771 cases affected by the virus (coronavirus-statistiques, 2020). Figure 3 depicts the number of cases in Morocco until 28/07/2020 from the first appearance of the virus. In order to fully contain this epidemic, Morocco have adopted measures earlier on three priority areas: health, economy and social order:

1. Health level: increased supply of health infrastructure + help from hotels to welcome infected people due to lack of space in hospitals + credibility in terms of dissemination of the disease progress report...
2. Economy level: creation of the social fund for the management of the pandemic + facilitate access to finance for companies in difficult situations...
3. Social level: targeted social assistance + adaptability of education to technological developments (e-learning platforms)...

Other measures have been also used. Thanks to communication technologies, the health ministry is strengthening the "wiqaytna" contact tracking system. It is a mobile application that warns the user in the presence of a registered person carrying the virus in the last 21 days.

Flexible companies have changed their activity in covid19 period to produce masks, disinfection systems, respirators, and other medical tools.

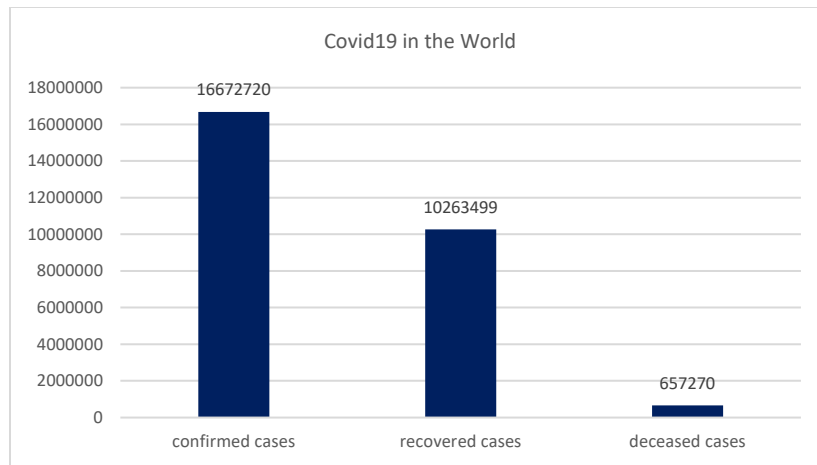


Figure 2: Number of covid19 cases in the world until 28/07/2020
Source : <https://maroc-diplomatique.net/corona-stats/>

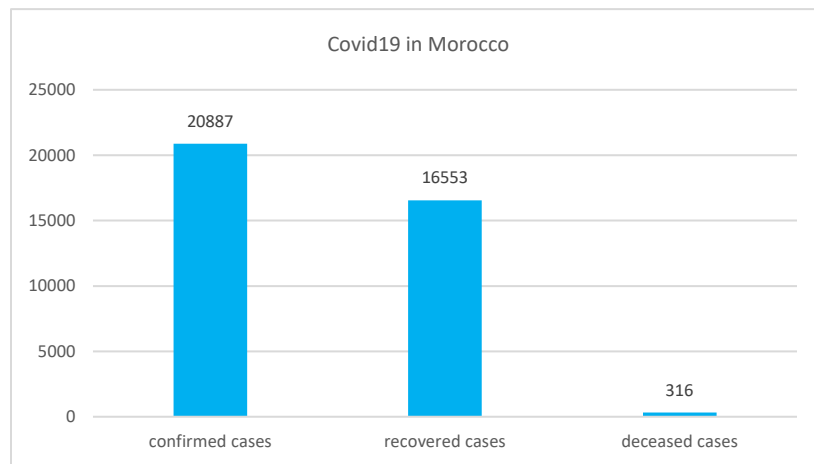


Figure 3: Number of covid19 cases in Morocco until 28/07/2020
Source : <https://maroc-diplomatique.net/corona-stats/>

4. Industry 4.0 impact on covid19 era

The fourth industrial revolution known by industry 4.0 has demonstrated an important role in the outbreak of covid19. Industry 4.0 objective is to convert the work to a highly automated level and augmented operational productivity and efficiency by connecting the physical to the virtual world (Alcácer and Machado, 2019). This will not be possible without adopting a set of new technologies like (Internet of things IoT, Augmented reality, Cyber Physical System CPS, Artificial intelligence AI, Cloud Computing, Big Data...).

During the recent covid19 pandemic, the best health care models have shown their limits; they were not able to provide even the simple personal protective suits (Vaishya et al 2020). The appearance of covid19 pandemic were such a surprise for the world and companies more specifically.

To fight covid19, it is necessary to mobilize many human resources and technologies. Which normally require prior preparation. As time is too limited because of the high speed of virus propagation, this will be a real challenge for countries. In this context, it is strongly recommended to introduce as much technologies as possible to solve the problems related to the virus while minimizing human intervention to avoid contact. (Javaid et al, 2020) listed in his research the most benefits of adopting I4.0 technologies:

- Manufacturing of customized precautionary item related to this virus
- Provide medical part in time despite disruptions on supply chains
- Augmented flexibility working environment
- Facilitate daily life work during the lockdown

- Provides innovative solutions

In the following paragraph, we will analyze how some technologies of Industry 4.0 have contributed to the fight against the virus.

1. Cognitive Internet of Medical things:

IoT, as one of the pillars of industry 4.0, can be very beneficial to combat covid19 pandemic.

The novel application of cognitive radio (CR) based IoT specific for medical domain gives birth to a combination called Cognitive Internet of Medical Things (CIoMT). It is highly suitable for this epidemic since every person will be connected and remote monitored through massive network (Swayamsiddha and Mohanty, 2020). Swayamsiddha and Mohanty affirm that CIoMT help limiting virus from spreading by the fact that is based on rapid diagnosis, dynamic monitoring and tracking, and better treatment.

2. 3D Printing of Personal Protective Equipment (PPE)

Considering the high importance of wearing personal protective equipment in covid19 pandemic, the world faced a serious shortage of them. Vordosa et al 2020, highlight the role of combination 3D printing technology and social network to provide solutions in field of medicine during this crisis. He explain that the coordination between individuals and universities, using social networks as a platform for exchanging and gathering information, gave birth to 150 3D printable designs of PPE.

3. Artificial Intelligence:

Based on epidemic models and evidence based medical tools, AI can do much to help controlling the spread of the virus propagation. Vaishya et al 2020, explain that AI can highly help on monitoring the situations of individuals and provide treatment of the affected ones by developing a neural network able to update day per day information for patient and identify visual features of corona virus disease. Therefore, Artificial Intelligence can; anticipate the spread of the virus within individuals, anticipate changes in the health situation, follow up in real time, and allow reorganization as quickly as possible.

4. Robots:

Robots can be also used to contain the spread of covid19 since they can perform activities like human being. They can be beneficial in medical domain as in manufacturers companies. Companies that already use robots are more advantaged than the others. Because their activities do not depend on employees who are currently confined due to covid19 crisis.

On the other hand, with the spread of covid19 pandemic, many companies have been forced to work remotely. In this case, communication technologies have played an important role to success the fact of switching from face to face work to telework in order to maintain the continuity of work. Table 1 discusses the contribution of the main Industry 4.0 technologies in covid19 pandemic.

Table 1: Contribution of Industry 4.0 technologies in covid19 pandemic

N°	Technology	How it can help in covid19 pandemic	Sources
1	Artificial intelligence	Optimize trials for drugs and vaccines. Help on manufacturing equipment for healthcare system. Detecting symptoms of the virus. Collecting and analyzing data to predict the future area where the virus will be affect. Correct and remove the wrong information about COVID19 in social platforms.	(Vaishya et al, 2020), (Javaid et al, 2020) (Vaishya and Javaid et al, 2020) (Bullock et al, 2020)
2	Cloud computing	Provide the availability of information for an enormous amount of computing power given to the users. Real time decisions making for disease modeling. Stored information at a computing platform enable people to continue their activities basing on several applications (zoom video, google cloud...).	(Vaishya et al, 2020), (Javaid et al, 2020)
3	Big data	Analyze and forecast the reach and impact of the virus on people. Provide data in real time to interested person (scientists, doctors, policymakers...). High capacity of data analysis and storage related to progression of the disease that help on taking better decisions for prevention of Covid19 transmission, health monitoring ...	(Vaishya et al, 2020), (Javaid et al, 2020)
4	Internet of Things	IoT connect all devices in the hospital and strategic locations to the internet. It can be used by different positions: patient, physician, surgeon and hospital management system. IoT can enhanced diagnosis by identifying symptoms and provides better treatment rapidly to the infected patient. It help the medical staff by informing and alerting in case of errors.	(Vaishya et al, 2020), (Javaid et al, 2020) (Singh et al, 2020)
5	Additive Manufacturing	Support companies and individuals to produce needed items to fight covid19 especially with the shortage of medical supplies. Manufacture customized items by using 3D printing.	(Vaishya et al, 2020), (Javaid et al, 2020) (Larraneta et al, 2020)
6	Autonomous Robots	Control the people if they are following the orders of lockdown. Help the medical staff for doing their jobs and enhance their performance. Perform repetitive jobs in hazardous environment of infectious disease. Take smart decisions basing on data analysis through AI.	(Vaishya et al, 2020), (Javaid et al, 2020)

5. Lean Management impact in covid19 era

Lean management is a well-known approach and widely spread around the world. It can be applicable in both service and manufacturers domain. LM concept is to trigger the value flow at the customer's request (just in time JIT) with the focus on wastes eliminating in all process steps that the customer is not ready to pay (Gupta and Jain, 2013). Waste can take the form of Transport, Inventory, Motion, Waiting, Over-processing, Overproduction, and Defects (Gupta and Jain, 2013).

In the context of the corona virus, one of the pillars of lean management is put under question. The highly dependence on just in time delivery systems has demonstrated its weaknesses (Sarki et al, 2020). Despite being used to improve efficiency and production flexibility, JIT is vulnerable to high operational stress caused by such crisis (Bryce et al, 2020).

The authors (Sarki et al, 2020 and Bryce et al 2020) claim that JIT did not really help either production or logistics in this epidemic time.

However, in the context of supply chain disturbances, JIT can be seen from two perspectives:

1. Supplier perspective: the fact of adopting the JIT principle in such a situation (covid19) help to reduce costs of stocks to a minimum and to avoid degradation of the goods in final product warehouse. On the other hand, when a sudden crisis happened there will be no goods to deliver. Therefore, large losses will be recorded.
2. Customer perspective: Customer will no longer have raw material to start his production lines. As result, stock out costs will be automatically generated.

In such a situation, the overproduction and the stock will no longer be considered as types of waste, on the contrary it will be preferably to work in stock well dimensioned to compensate the market fluctuations.

Table 2 shows the waste that can be considered as benefits in case of such pandemic.

Covid19 pandemic has revealed an important subject related to the way companies manage their stock either for raw material or for final product. Actually, companies have to rethink about a hybrid system that will not rely 100% on just in time principle, but it take into consideration reducing risk of rupture and then augment the reliability of the supply chain.

Table 2: Benefit of reverse situation of some lean wastes

	Normal situation	covid -19 situation	Comment
Lean wastes	+ /-	+ /-	
Transport	-	-	
Inventory	-	+	To overcome the logistical disruption that will cause delivery delays
Motion	-	-	
Waiting	-	-	
Over-processing	-	-	
Over-production	-	+	The overproduction in the pandemic situation makes it possible not to have a fatal and instantaneous rupture of the product, on the contrary this over production will secure a duration which will allow time to react quickly.
Defect	-	-	

Moreover, JIT lead to increase the number of deliveries to customer with small but continuous quantities. Such way of work increase automatically the use of transport engines, which causes pollution that influence negatively environment. However, the current lockdown caused the air quality in many big cities across the globe (New York, China...) to improve and drop in water pollutions in some parts of the world (Saadat et al, 2020).

6. Conclusion

This paper examined the impact of industry 4.0 by its emerging technologies to limited the spread of covid19 pandemic. In addition, it highlight the impact of lean management principle (JIT) on the continuity of companies' activity. With the covid19 outbreak, the implementation of I4.0 will be accelerated because of its strong capability to offer innovative asnd efficient solutions. Regarding Lean Management philosophy, companies have to rethink to find a hybrid model that will not rely 100% on just in time principle, but to find a compromise between lean principles and the general context of the market to preserve the reliability of the supply chain.

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