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Optimization of Logistics Operations Through the Implementation of New Technologies of Industry 4.0: Case of Products with Dynamic Demand within a Moroccan company.

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ABSTRACT

As technology permeates the world day after day, its influence affects all fields including manufacturing companies, especially the logistical aspect, given its extreme importance and direct impact on the company's development and the success of its transactions.

Nowadays, the implementation of new technologies in the logistics sector is no longer seen as a decision for companies to make or not, but as a commitment that they must make in order to keep up with the competitive level of the market and, as a result, achieve their goals by improving their management methods.

Although the integration of new technologies has been applied for years within many multinational companies, it still poses an issue for several local companies in developing countries that are also trying hard to provide what is needed to introduce the required technology into their operations.

The delay of a large number of local companies in integration new technologies is either due to the lack of competition in the market, or the lack of qualified competencies, or attributable to weak customer requirements, as well as the high costs of introducing technology.

We tried through this paper to address an empirical study of the impact of new technologies on logistics performance of manufacturing companies, through a local Moroccan industrial company, which knows a dynamic demand, and not much time has passed since they started integrating modern technology in their operations.

KEYWORDS: Supply Chain, Transparency, Executing times, Logistics costs.

1 INTRODUCTION

The importance of logistics has grown in the last decade due to the major changes that have occurred in the way companies used to perform regarding the logistics aspect, including the increasing requirements of customers in terms of time, quality, and transparency. Furthermore, what explains this importance is that the field of logistics is not limited to simple or limited tasks, but rather because it extends to include various complex operations within the company. Regarding research in the area of logistics 4.0, we found that most of studies dealing with this subject are conceptual and theoretical. This shows in a clear way that logistics 4.0 works are very insufficient, especially when it comes to the impact of the integration of new technologies on logistics performance of manufacturing companies.

To give a contribution to the previously identified problem, this article presents a case study of the impact of the integration of new technologies on logistics operations within a Moroccan company, with a high dynamic demand of its products. This company is a market leader in its activity specialized in producing and commercializing of a Moroccan unique product, known as Moroccan Zellij, and has an important market share. We aim through this paper to answer the following hypotheses:

H1: we assume that there is a significant relationship between the implementation of new technologies and reducing logistics costs.

H2: we assume that there is a significant relationship between the implementation of new technologies and reducing executing times.

H3: we assume that there is a significant relationship between the implementation of new technologies and logistics transparency.

Our study is a part of a PhD work, and a summary of an empirical study we have conducted in the Moroccan market, which has known over the last decade a real emergence in the industry 4.0, in order to measure the impact of new technologies on logistics performance. To do so, we had to choose a Moroccan company with a large transaction volume. The reason behind our choice was because we already knew that this Moroccan company has not yet integrated any of the new advanced technologies to perform its operations, except a basic tool that was developed inside the company, which unifies logistics operations in a very traditional way. The second reason was that this company produces a local and unique product has “the Moroccan Zellij”; so, beside the fact that we want to study how new technologies affect any company’s logistics performance in a broad way, we wanted to give a special attention to the Moroccan context,

and this unique Moroccan product, that almost all types of buildings in Morocco use it, and so the product knows a very high demand, which directly affects the whole supply chain and the way it works. The third reason behind our choice was that we have found that the company is still following traditional managerial methods, so we had the chance to take part of the implementation of new projects; this has allowed us to study very clearly the real impact of this transition we attended.

In addition of these previous reasons, our main goal is to measure how the progression of technological innovations has led to the creation of systems able to increase communication, to permit to all components to communicate in a fluid way to share as fast as possible the necessary information (Ingo et al, 2015).

Concerning the organization of the study, this paper will be divided as follows: in the next section, we present a brief literature, where we shortly develop what has been evolved by many authors in their works regarding logistics field and the integration of new technologies, then we discuss in the third section the practical side of the paper, where we compare the traditional methods to the new ones within the company that is the subject of the study through many aspects especially related to executing times, costs, and transparency, in order to measure the impact of the integration of new technologies. Then we present the most important results reached after complementing the study and making a comparison between what was previously used by the company, as well as the impact of introducing modern methods and new technologies on its tasks and performance. Eventually, we find out whether the hypotheses we mentioned above have been confirmed or not, before getting into a conclusion in which we summarize the most prominent things we have discussed through this work.

2 LITERATURE

Logistics plays a very crucial role within a company because of its direct contribution in the operations smoothness, as it is responsible for providing to the right customer the right product in the right condition at the right time with the right quantity in the right condition. (Trebuna et al., 2019)

During the last decade, and due to the set of several technological changes that have been used in many areas, logistics' field considered as one of the principle key success factors of manufacturing companies has completely changed, in order to face the increasing challenges, such as reducing executing times, facilitating information sharing, and so on… (Malindzak et al., 2005) (Antoniuk et al., 2021).

Therefore, it is recognizable that logistics costs reach in many cases 20% of the entire costs, what makes companies in front of one of their big challenges, which is to set up a strong and well determined process that guarantees at the same time high profitability, best quality with the minimum cost. (Sasik., 2014)

Moreover, companies are invited to take into consideration the customers' requirements that are increasing day after day in terms of timing, quality, and pricing, whether it comes to business-to-business BtoB or business to customer BtoC, especially with the high use of internet and social media, where people have illimited access to a wide world in which they can compare between different companies, goods or services… Those requirements cannot be taken without a clearly defined flaw of operations established through efficient internal logistics. (Mikusova et al., 2020)

In order to respond effectively to the precited requirements, logistics 4.0 comes to adopt innovative methods that include intelligent mobility, interaction, smoothness of industrial operations, with a very clear objective, which is to make logistics processes more effective through the improvement of intercommunication in an intelligent way. (Nasser., 2014) (Gilchrist,2016; Baur et al., 2015; Koch et al., 2014)

Logistics 4.0 forces companies to center their efforts on improving human-machine interaction through information and communication technology ICT, together with the use of new sensors, so that production processes are optimized, executing times are decreased, and costs are reduced. (Doh et al., 2016) (Barreto et al., 2017)

Accordingly, logistics processes optimization can be achieved only through correct coordination of different components of the supply chain and through establishing a high level of transparency and visibility. (McKinsey, 2015)

To conduct our study, we had to do an internship within this company for a period of time (Three months), and we were lucky because we arrived just a short time before the new technologies were set up. This company is used to manage all their logistics operations in a traditional way, starting from receiving raw materials, through production, storage, all the way to transportation and distribution.

Before we get into the transition from the traditional methods to the modern ones, we have to describe first the traditional operations of logistics' processes, so we can understand how this company used to work, and be able to realize the real impact of the transition to new technologies on logistics performance actually.

We discussed in the introduction the importance of logistics within a company, then we gave a brief presentation of the company and its activity. In the second section, we present the contextualization of this work, and describe with more details the traditional operations that the company used to perform. Then we discuss the industry 4.0 new projects in which the company has invested to improve their efficacity and performance in all logistics' processes.

3 BEFORE AND AFTER IMPLEMENTING NEW TECHNOLOGIES

3.1 TRADITIONAL MANUFACTURING PROCESS

As we have already mentioned before, the company used to manage their logistics operations - starting from receiving raw materials, production processes, storage operations, and transportation - through several traditional methods, we describe first the whole company's process, then we take a look at the way the company used to perform those operations, before getting into the comparison between what the company used to do, and what is actually doing. The traditional manufacturing process is presented as follows:

The factory starts the process by receiving raw materials, necessary for production, then it stores them into raw materials' warehouses. We have to mention that the company offers two sizes (35cm*35cm and 41cm*41cm), with three different quality degrees; first choice or commercial which has the best quality the company produces, economic choice in the middle, then the third choice which represents the lowest quality. The factory conducts mass production to mix raw materials in order to prepare a slurry-like mixture, sent to pressing machines in order to form the square shape. When the form is set up, squares pass to the decoration step to assign a design. We have to indicate that the company has two types of designs; its own design, and personalized design, with a huge number of references in both types. After this phase, the products are packed at the sorting center, before getting sent to the finished products warehouse. All those previous operations were handled in a traditional way, then elaborated in a basic system information in order to ensure the minimum level of traceability. The company realized that traditional managerial methods have negatively affected the smooth running of operations, as well as the whole company's performance, through many aspects:

-*Time wasting*: as all operations are carried out at a very slow pace, company aims to reduce the executing time, in order to increase the productivity, and at the same time decreasing costs. Organizations are nowadays very interested in finding new technology initiatives with no time

wasting, low operating costs in order to offer innovative services and thus gain a competitive advantage. (Qin, 2013).

-*Lack of traceability:* the non-digitalization of the operations does not permit to achieve a high level of traceability at every step of the process, while adding new technologies to the processes' transparency, will give logistics the ability of being capable to answer effectively to the changes of the market that are increasing day by day. (Zrakova, 2019)

-*High error potential*: when clear traceability is not present, there is a big risk that may occur, related to the high potential of committing errors. Hence the necessity of setting up a monitoring system as new logistics is taking place within companies. (Hoeye, 2018)

When the company noticed that traditional managerial methods come with the previous aspects that directly affect in a non-appropriate way the company's performance, it has been decided that the company will follow a new managerial paradigm, based on technologies related to the industry 4.0 concept.

3.2 ACTUAL MANAGERIAL PROCESS

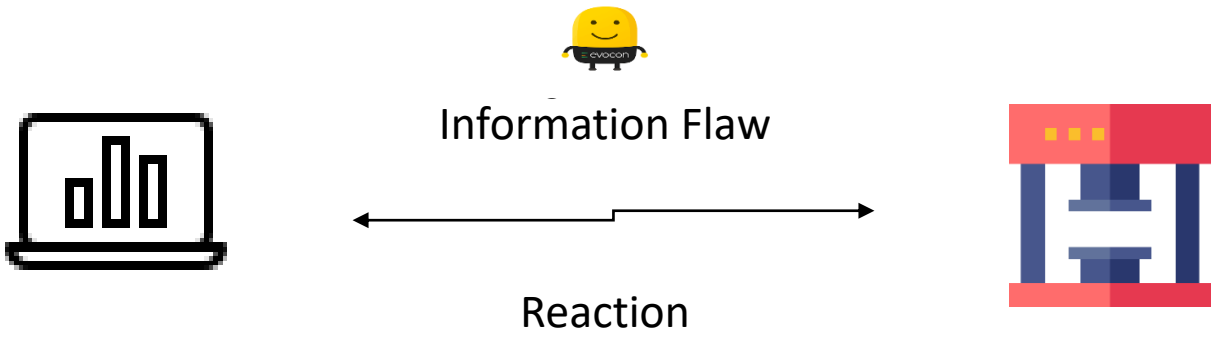
The company has recently integrated two industry 4.0 projects to avoid the aspects we mentioned above; the first one concerns the internal production phase, as the second one concerns the logistics process that comes after.

We start by identifying the first one called "Evocon", and studying its impact on production, then we present the second one called "traceability project", and its impact on logistics performance.

To better understand these two projects, we had the opportunity to meet the supply chain manager, so he gave us all the documentation and information we needed for our empirical study, as well as a full explanation of the impact

Evocon

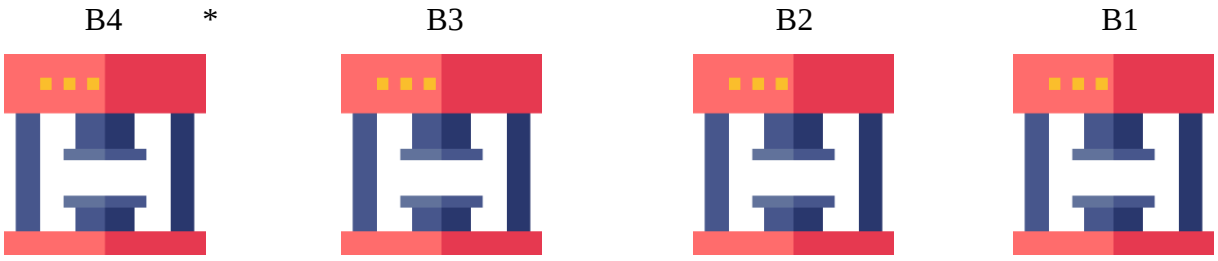
Evocon is a sensor that has one main mission, which is to detect any unplanned stops, then transfer the information alert to the concerned service for intervention. This sensor can also detect the reference change and any unnoticed need.



Source: Super Cérame Kenitra

Evocon sensor is linked to three types of machines: pressing machines, injection molding machines, and entrance ovens.

Pressing machines

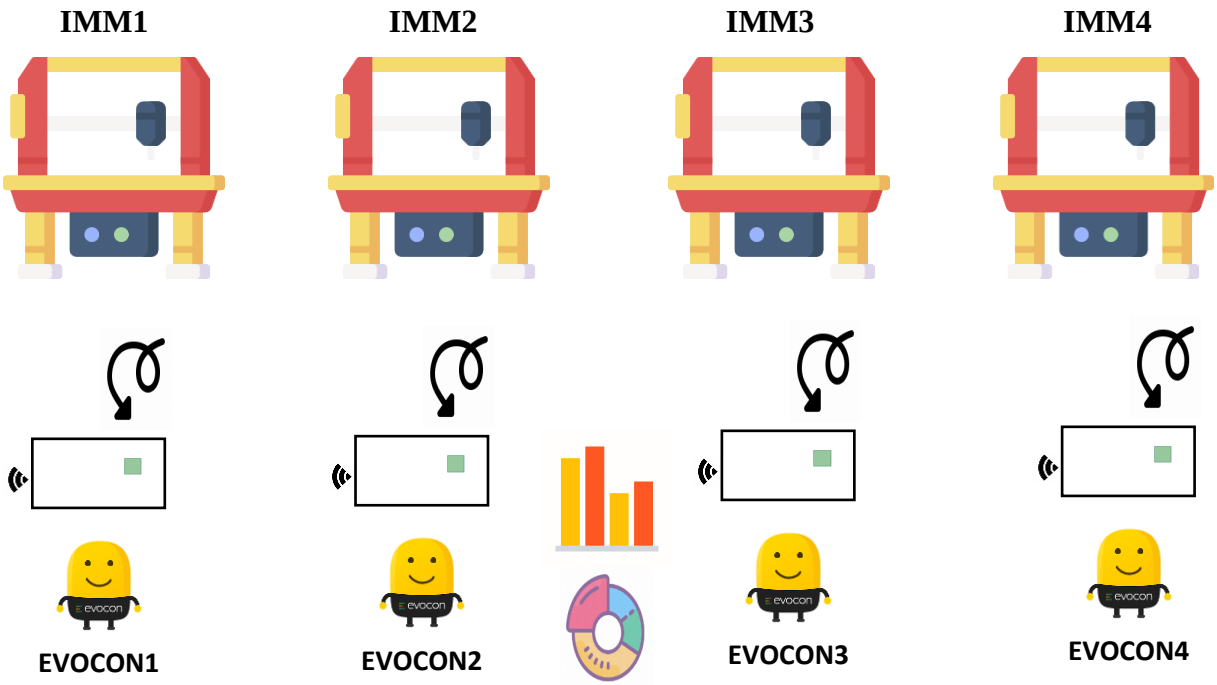


*Pressing machine

**Evocon sensor

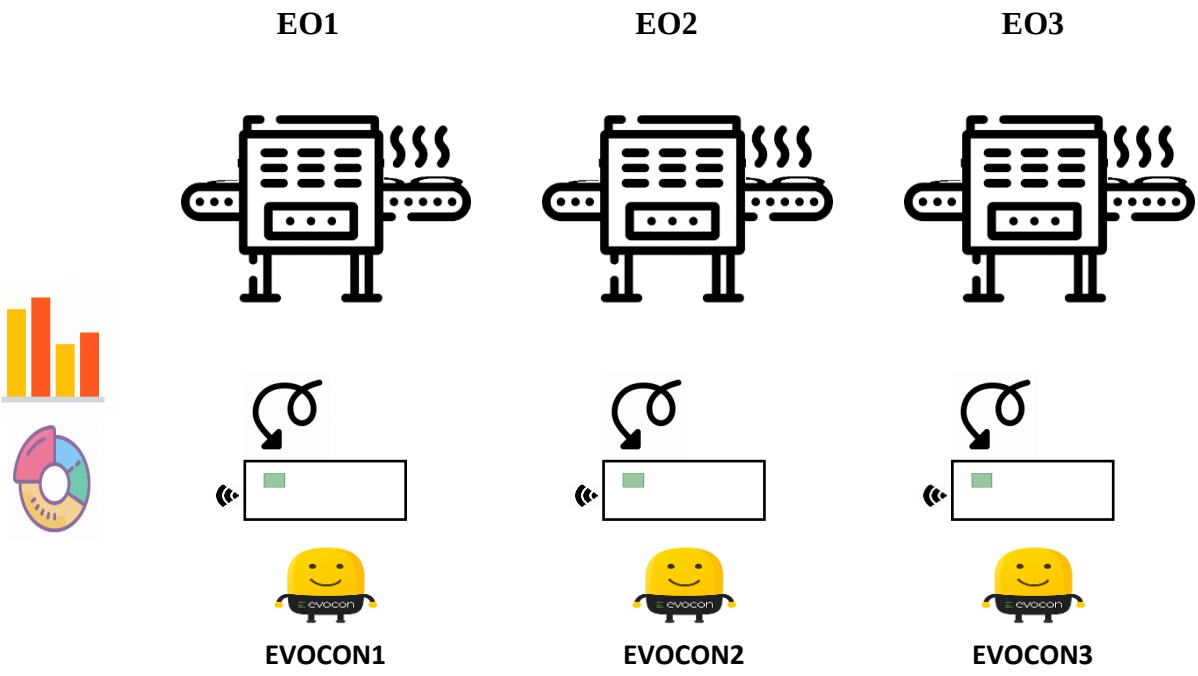
Source: Super Cérame Kenitra

Injection molding machines IMM



Source: Super Cérame Kenitra

Entrance Ovens EO



Source: Super Cérame Kenitra

4 RESULTS

As for the company, this project aims to achieve many objectives, such as integrating all employees in its application, having polyvalence between them, ensuring a global performance, and contributing in the change of managerial paradigms.

Evocon sensors, as we have just presented before, are involved when a problem appears at any level of the machine, then sends an information flaw, to ensure a speed intervention by the employees, to try as fast as they can to solve the problem, reduce the waiting time, and decrease costs engendered by the unplanned shutdowns, and establish a well determined and designed logistics system that works permanently. (Cunnane, 2017)

Regarding the results of this implementation, we present two examples to highlight how the company will gain a huge lack of time and costs. As for the first example, lack of boxes detected by Evocon sensors has permitted a gain of 7 hours and 25 minutes, losses totaling 1852 m^2 of production, and costs that exceed 120.000 Moroccan dirham MAD (12000$). The second example concerns the change of reference, as Evocon sensors detect the change, the company gains a total of 6 hours and 6 minutes, losses totaling 1525 m^2 of production, and costs that exceed 99.125 MAD (9900$). We present a summary of these results in the following table below:

Shutdowns causes	**Time**	**Losses in m^2**	**Losses in MAD/$**
Lack of boxes	7 hours and 25 minutes	1852 m^2	120.000 MAD (12000$)
Change of reference	6 hours and 6 minutes	1525 m^2	99.125 MAD (9900$)

Source: made by ourselves

Traceability project

Logistical challenges may require: High need for transparency, visibility of supply his chain. supply chain integrity management (right product, right time, right place, right quantity, right condition, right cost). (Macaulay et al., 2015) This was the main objective of the inauguration of this project, the company aims to ensure total visibility of the entire supply chain, and to avoid as much as possible the use of traditional management methods. This project is a platform that monitors in real time all operations related to warehouse entries, storage, orders' preparation, and shipping, and gives the possibility not only to the company to monitor all of these operations, but also to the various partners, such as customers and suppliers, to ensure complete visibility.

The traceability project aims to ensure three principal pillars; the precision at the service of the supply chain, the reactivity in the service of production, and the reliability in the service of asset management.

The process starts from sorting phase, where the barcode is put on the pallet and declared on the system, and sent to the control center, to validate or not the conformity of products, before moving to the warehouse entrance area, so that the pallet is scanned and sent to storage.

As we have already mentioned, the customer can himself use the platform to track his order, from the launch phase, and once this order is received, he can declare receipt via the same platform, that gives him as well the possibility of sending reports, complaints, comments, and so on…

The third module offered by this platform is the complete digitalization of the shipment, starting with the receipt of the order to load and its assignment, the loading of the truck, as well as the control of conformity of the purchase order with the order itself.

5 DISCUSSION

In terms of measuring logistics performance, researchers suggest combining economic indicators based on time, cost, and flexibility to capture the different impacts of Logistics 4.0 related indicators on performance outcomes. (Anand, 2006; Power et al, 2010)

We tried through this paper to first make a comparison between the traditional managerial methods and the actual ones based on new technologies, then we described in a detailed way the whole process after the integration of new technologies.

Concerning the hypotheses H1, H2 and H3, we note that all of them have been validated.

H1 supposes that there is a significant relationship between the implementation of new technologies and reducing logistics costs, which has been proven by the results of Evocon project, which has permitted a gain of losses totaling 1852 m^2 of production, and costs that exceed 120.000 Moroccan dirham MAD (12000$) due to the lack of boxes, and costs that exceed 99.125 MAD (9900$) due to the change of references.

As for H2, we assumed that there is a significant relationship between the implementation of new technologies and reducing executing times; through the Evocon sensor, we have showed that with the integration of this digital project, the company has gained a lot in terms of executing times, the sensor has permitted a gain of 7 hours and 25 minutes when it comes to the problems that are caused by the lack of boxes, and a gain of 6 hours and 6 minutes when it comes to the change of references.

We supposed in the hypothesis H3 that there is a significant relationship between the implementation of new technologies and logistics transparency, which has been validated by the traceability project, which has enabled the company to ensure total visibility and high transparency throughout the whole supply chain.

By setting up all previous elements; flexibility, efficiency, and transparency will be reached, as all components will be able to communicate with each other and share all the necessary information. (Ingo et al., 2015)

6 CONCLUSION

In this paper, we tried to investigate the impact of new technologies of the industry 4.0 on logistics performance. Therefore, it has been determined through our study that new technologies have a relative impact on logistics performance on many aspects.

Nowadays, new technologies can only permit for companies an optimization in their costs and executing times, as well as a high precision of the traceability. In addition, our study has showed that the integration of new technologies allowed for companies a permanent quality control of products, better performance of operations and operators, accurate and rapid identification of anomalies, complete visibility of your supply chain, and helped them increase their productivity and profitability.

In conclusion, companies cannot deny the importance of new technologies on their logistics performance. The integration of new technologies in logistics will not only allow companies to follow new trends, but also to gain in several aspects, namely:

Cost savings: thanks to the new technologies, companies can optimize their logistics costs that often raise to 20% as mentioned before.

Time savings: logistics projects that are part of the industry 4.0 paradigm allow to reduce the time of realization of tasks, as well as the elimination of the dead times.

Better transparency of the supply chain: new technologies have enabled full traceability of all logistics operations.

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