

Implications of The Industry 4.0 in Logistics Operations

Omar ANBOURI, (PhD Student)

*Laboratory of Research in Management and Organizational Sciences - LARSGO
National School of Business and Management - ENCG
Ibn Tofail University, Kenitra, Morocco*

Abdelhay BENABDELHADI, (PhD. Professor)

*Laboratory of Research in Management and Organizational Sciences - LARSGO
National School of Business and Management - ENCG
Ibn Tofail University, Kenitra, Morocco*

Correspondence address :	National school of Business and Management of Kenitra Ibn Tofail University Morocco - Kenitra Postal Code, 14020
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Abstract:

In a world characterized by a fierce competition, where markets are changing rapidly, the rivalry is increasing, the product life cycle is decreasing, the emergence of Industry 4.0 technologies has led to a large number of changes in the functioning of manufacturing companies, that are racing against time day by day to be more powerful, responsive, and able to face new challenges. With the advent of digital technologies, new challenges have been promoted, companies are called more than ever before to follow technological changes in order to respond effectively to customers' requirements, in terms of quality, cost, time, and so on... Nowadays, one of the most important challenges facing companies are the commitments related to the field of logistics, due to the many problems associated with it, such as improving quality, reducing costs, and optimizing shipping and delivery services, in order to reach its most prominent goals, which is to ensure a high level of customer experience improvement. By taking into consideration the direct and significant impact of logistics on the company's productivity, it has become necessary to take seriously the implementation of modern technology in this field, which mainly lies in the development of an advanced system that includes resource planning, warehouse management, transportation system, in a way that makes sharing information at real time, and reducing cost, a top priority.

Regarding the type of literature used, the article is a systematic review, which aimed to collect as many relevant studies as possible, and give a critical evaluation and synthesis of existing knowledge that address the impact of the new technologies on logistics performance in manufacturing companies.

This article highlights the importance of the Industry 4.0 in logistics operations, its pillars and implications, the key factors that will be required to meet the new conditions of the Industry 4.0 concept in logistics' field, as well as the risks that may occur.

Keywords: Industry 4.0; Logistics; Supply Chain; Internet of Things.

JEL Classification: L60, O32

Paper type: Theoretical Research

Résumé :

Dans un monde caractérisé par une concurrence féroce, où les marchés évoluent rapidement, l'émergence des technologies de l'Industrie 4.0 a entraîné un grand nombre de changements dans le fonctionnement des entreprises industrielles, pour qu'elles soient plus puissantes, réactives, mais surtout capables de faire face à de nouveaux défis. Les entreprises sont aujourd'hui plus que jamais incitées à s'impliquer pleinement dans le processus d'intégration de nouvelles technologies dans différents départements, afin de suivre correctement les évolutions technologiques, et répondre parfaitement aux exigences des clients, notamment en termes de qualité, de coûts, de délai, etc... qui sont des aspects fondamentalement liés à la logistique. De nos jours, l'un des défis les plus importants auxquels sont confrontées les entreprises sont les engagements liés au domaine de la logistique, en raison des nombreux problèmes qui y sont associés, tels que l'amélioration de la qualité, la réduction des coûts et l'optimisation des services d'expédition et de livraison, afin que les entreprises puissent garantir une bonne expérience client. Les entreprises qui sont donc bien conscientes de l'impact de la logistique sur leur rentabilité assurent qu'il est devenu nécessaire de faire intégrer les nouvelles technologies de l'industrie 4.0 dans toute la chaîne logistique, notamment l'implémentation de ces technologies dans la gestion d'entrepôt, la planification de production et à travers l'insertion des progiciels de gestion intégrés.

Concernant le type de littérature utilisée, l'article s'agit d'une revue systématique, qui avait comme objectif le rassemblement du plus grand nombre possible des études pertinentes, l'évaluation critique et de synthèse des connaissances existantes qui traitent l'importance et surtout l'impact de l'intégration des nouvelles technologies sur l'effort logistique global au sein des entreprises industrielles.

Cet article met en évidence l'importance de l'Industrie 4.0 dans les opérations logistiques, ses piliers et ses implications, les facteurs clés qui seront nécessaires pour répondre aux nouvelles conditions du concept de l'Industrie 4.0 dans le domaine de la logistique, ainsi que les risques qui peuvent survenir.

Mots-clés : Industrie 4.0 ; Logistique ; Chaîne d'approvisionnement ; Internet des objets.

JEL Classification : L60, O32

Type de l'article : Article théorique.

1. Introduction

This article emphasizes the use of Industry 4.0 in logistics fields, trying to highlight its importance and how this new revolution Industry is affecting the way manufacturing companies are working.

As we have already mentioned above, we proceeded for the writing of this paper to the choice of the systematic review. The main reason behind this choice was to deliver and provide readers with a detailed summary of a large number of available primary research which deal with the subject of industry 4.0, its importance, the changes generated by this new paradigm, as well as its impact on logistics performance. In addition, we also aimed through the systematic review to draw conclusions, as well as to formulate a general synthesis of several works that have been done by different authors in this specific subject.

It is noticeable that the Industry 4.0 has changed and is still changing managerial techniques and practices, engendering the creation of new jobs, and, on the other hand, the disappearance of a lot of positions that will be replaced by new devices and machines. This conversion will greatly affect how companies will be controlled and managed, following the new context incitements.

Despite the fact that some sectors have gone first to meet new Industry requirements, others are also invited to do the same, because those changes are made very rapidly, giving birth to the new industrial revolution, also called the Industry 4.0.

The fourth industrial revolution was the reason behind many changes, not only on the industrial level, but on all levels (economic, social, and so on...), influencing the methods of work, and how it is organized and arranged, and how the interaction between human and machine should be managed. With Industry 4.0, the world is witnessing a big transition to the digital age of production, which will create greater efficiency and cost savings while increasing quality, flexibility and innovation across industries. Industry 4.0 will pave the way for higher levels of productivity and effectiveness by leveraging data-driven insights and analytics to optimize operations in real time as well as predictive maintenance for equipment and machines before it becomes an issue that causes downtime. The main goal of industry 4.0 is to provide automation and digitization by having a high level of machine intelligence, cyber-physical systems, and autonomous processes.

Despite the presence of a large number of positive aspects associated to the integration of the new technologies into the logistics field, it must be noted that the process has many unfavorable points and limits. The main risk that threatens is that many jobs will be missed in the future, as they will be replaced by modern machines, and it will be necessary, on the other hand, to create other job opportunities to follow the rapid technological development. Hacking attacks may be among the dangers arising from the implementation of new technologies, because the transmission of information is based mainly on digitization, which increases the possibility of data leakage and exposure to hack attacks. A financial challenge that requires companies to keep up with these developments, and invest in new technologies in order to ensure competitiveness.

In spite of the previous risks related to the new paradigm of industry 4.0, it has become necessary to introduce the requirements of the fourth industrial revolution, as technology is growing tremendously, and it is only a matter of time before the process is entirely digitalized.

A good understanding of the advantages and disadvantages of the implementation of industry 4.0, will greatly help in gaining a good level of awareness of the importance of what is happening, in addition to the understanding of the changing behaviors of customers towards products and services, and on which criteria customers' decisions are made, and at what level

can be seen and measured, as well as the emergence of certain terms such as social media, social networks, acquisition channels that are related to these changes. In this paper, we aim to orientate the discussion of the key factors that will be required to meet the new conditions of the logistics 4.0 sector.

This paper will be divided as follows: the second section will treat the Industry 4.0 concept, its historical development, its characteristics. The third section will focus on the pillars and the requirements of a coherent logistics 4.0, where technologies are used to execute principal tasks. Finally, we will deliver the conclusions and come out with new lines of research.

To better understand the impact of the industry 4.0 on logistics operations, it is necessary to start with the major logistics theories that we were based on to identify the problem in question. The first one in the theory of constraints (Goldratt, 1984), the main theory we have adopted as a starting point for this paper. According to this theory, the company has at least one factor that negatively impacts the achievement of its objectives, and that the instability of the company is inevitable. The theory of constraints is focused in a precise way on the fact of detecting any system's constraint, in an effort to maximize performances. Based on this theory, all departments and processes are limited in performance by at least one element, which prevents it from reaching the higher level, this element is called the system's constraint. The theory can be established through a well-determined procedure that starts according to the author by identifying the constraint in question, exploit it through the increasing of its efficiency, and then elevate the constraint's performance.

The second theory is the 'logistics pillars theory' (Gaston Ronald NGOOH, n.d). This theory considers that whatever the logistics project is, the work approach is always based on four fundamental pillars of logistics: resources, costs, deadlines, and quality of service.

Regarding resources, the author thinks that logistics management is mainly characterized by an optimized management of resources (human, materials, information system, ...) of the company, in order to satisfy the different needs. Concerning the second pillar, logistics contributes to increasing the company's profit, the reason behind the special attention that companies pay to the optimization process of logistics costs. As to the third pillar, the integration of logistics time standards has become a top priority for the company, as it permits the definition of ranges of operations and processes, that allow the elimination of any superfluous operation or any type of time wasting. The quality of service, which is the fourth pillar of this theory, is of great importance for the company on two levels: internal and external quality; this pillar revolves mainly around identifying any type of waste, respecting delivery times, taking into consideration the importance of anticipating any activity that may negatively affect customer's satisfaction.

The theories above will allow us to find a direct relationship between them and logistics field, as the first one helps us to understand that logistics, considered as one of the most important departments within a company is facing a huge number of constraints and limits, and the second one gives us a clear vision about the fundamental pillars of logistics.

2. Industry 4.0: An overview

Industry 4.0 consists in the integration of new technologies into industry, after the use of information and communication technologies ICT has become inevitable, especially since it became essential for the productivity improvement and for company's competitiveness, by increasing automation and digitalization of processes. (Woschank and Dallasegam, 2021)

The aim of industry 4.0 is to bring new perspective for the company, where the last one comes up with a new smart networking design of human, products and processes throughout the whole

value chain, to make itself more efficient and well organized, in a way that allows companies to provide products and services that matched exactly with customers' requirements. (Reiner, 2014; Barteveyan, 2015)

Before getting into the implications of Industry 4.0 in the logistic domain, let us take a short look into the historical development of the industrial revolution concept. (Barreto, Amaral, & Pereira, 2017) The first industrial revolution started for the first time in Britain in the 18th century, and was characterized by the use of the steam engine, and the emergence of heavy machines in order to mechanize production. The second industrial revolution began in the 19th century, where electricity was expanded, as a part of the industrial power, which helped companies increasing their mass production. The third industrial revolution appeared in the 20th century, and was developed in parallel with the invention of the internet, and came up with factory automation, digital systems... that allowed companies to communicate and share information.

Those were the previous industrial revolutions that have led to the fourth industrial revolution, also known as Industry 4.0. The fourth industrial revolution Industry 4.0 came after the lean revolution, outsourcing revolution, and automation. (Roland Berger, 2014)

Industry 4.0 brought a noticeable transformation to the whole manufacturing system, through new trends such as artificial intelligence (AI), Internet of Things (IoT), autonomous vehicles... (Stock and Seliger, 2016) All those trends have made factories completely smart, the thing that helped raise their effectiveness and productivity, based on the integration of human effort with the effort of modern technologies. (Kolberg and Zuhlke, 2015). This integration allows a fluidity and flexibility, as all elements will communicate with each other in order exchange and share needed information (Ingo and Lorig, 2015). The creation of the Industry 4.0 frame was a response to the lack of production that was caused by the transfer of production power to the countries with cheap labor. (Holubcik, Koman, & Soviar, 2020)

Looking at advanced requests of customers and their requirements, that are increasing day by day, on their orders for products and services, companies strive to offer a new model based on a custom production. To answer the right way, the orientation should be towards Industry 4.0. (Lendel et al., 2013; Jankalova and Jankal, 2018) Relying on advanced machines, smart devices, that will authorize to companies to meet customers' requirements, Industry 4.0 has all the basics needed to face challenges as it should (Xu et al., 2018). The essential principle of the industry 4.0 is to allow people, machines, and products to be interconnected, in a way that permits information to be shared smoothly. (Holubcik et al., 2020)

When we think industry 4.0, we should not focus on one thing, but rather a group of things that form the mainstay of the concept. The most important pillars of the industry 4.0 are the following (Hermann et al., 2016) Internet of Things (IoT): when information and data are shared by all elements that are involved in manufacturing process, such as robots, devices, and so on. Industries across the world are turning their attention to the internet of things IoT. The idea is that all physical objects that are embedded with sensors, and could be connected to the internet, which would allow them to be controlled remotely and send data back. Artificial Intelligence (AI): consists of the developing of systems (robots, computers, ...) that can be used in multiple that are able to perform tasks that usually need human intelligence, it includes techniques that provide computers with capabilities such as learning, problem-solving, planning, and self-correction. Big Data: used to store information and data coming from various departments due to its large capacity. Companies need to make sure they have an easy way of storing the data they own, so that they can use them easily in the future when they need them. In addition, decision-making is often based on the insights generated by stored data. Therefore, big data's tasks are not only limited in storing data, but also in analyzing and

suggesting recommendations. Autonomous Automation: based on artificial intelligence performances, advanced robots and computers will be able to compensate for the absence of humans, and take their places in all production activities.

Mundane tasks will therefore be performed by smart devices. People will intervene only when machines force them to do so. The purpose is to ensure continuity, efficiency, and especially flexibility, which is considered as a key success factor. Workers' involvement field is limited in the intervention called by machines. (Dubovec et al., 2016)

Thanks to the intelligence of the tracking system, the processes' transparency, logistics will be able to answer effectively to the changes of the market that are increasing day by day. The implementation of smart processes will therefore increase the effectiveness of people, machines, and materials, and help in saving resources, reducing time and costs. (Zrakova, 2019) One of the most important goals of the industry 4.0 is to establish a system, in which companies benefit from autonomy and self-sufficiency in terms of human resources, financial capacities, and so on. The main reason behind the emergence of this need of building a new system is the impact of information technologies on customers' requirements of variation, quality, and speed of delivery services. (Lee et al., 2014)

Industry 4.0 is also affecting how logistics elements are performed, on the level of a set of things. (Lee et al., 2014). ERP system, that is usually used by companies to manage day-to-day business tasks, such as supply chain operations. The main purpose behind the use of an ERP system within an organization is to enlarge and expand its efficiency and productivity, by managing powerfully all types of resources utilized by the company, in order to establish an integrated system, that helps keep traceability of the whole supply chain, and all the moving parts of manufacturing and distribution. The second element concerns costs and time, that are also among the main objectives of the logistics optimization process. The new industry 4.0 technologies aim to decrease a company's costs and time to maximize profits, by providing smart processes, able to perform various tasks in the fastest and most optimized way. The third segment is to ensure the information flow between production department, warehouses, ... related to the previous point, the importance of industry 4.0 lies in its ability to give companies the possibility to share data smoothly and effectively, this helps to optimize both costs and time, by providing real-time information sharing, often considered as a crucial process for all departments involved in the supply chain. The fourth segment is reducing the downtime of machines. It is noticeable that downtime is inevitable, given that all companies are nowadays dependent on their equipment. Thanks to industry 4.0, requests for maintenance are made as fast as possible, it also allows understanding equipment issues, to ameliorate the overall quality of preventive maintenance, as well as keeping traceability of equipment's life cycle.

3. Industry 4.0 applications in logistics

As we have seen before, logistics represents one of the important pillars of the company, contributing to performing a large number of functions, related to internal logistics, storage, packaging, transport. Logistics management is the part of the whole supply chain, which refers to the process of planning, coordinating, controlling, and ensuring the efficient flow of resources, materials, equipment, and information, in order to respond effectively to customers' requirements. Companies are used to execute their logistics operations processes in a traditional way, that is often normal, and relies on manual data collection, information sharing, and paper-based communication.

To make those processes smarter, faster, and interconnected, manufacturing companies are adding intelligent technologies, following the main requirements of the fourth industrial

revolution, to which logistics is also attached under the name of logistics 4.0. (Lendelye, 2018)

During the last decade, logistics' field, as well as the other fields, has radically changed, due to the set of several technological transformations that have been used to facilitate sharing information, data, and reducing time. (Antoniuk et al., 2021)

Logistics 4.0 is just a new paradigm of the logistics system, aiming to respond effectively to the customer needs, to improve customer relationship management, and to optimize the production processes, in such a way that the time is decreased and the price is reduced, as part of a very well remarked digital transformation. (Barreto et al., 2017)

In order to achieve an optimal, realistic, and effective implementation of the logistics 4.0 concept, it must be based on the following applications: resource planning, transport management system, warehouse management system, smart traffic system, and information security.

3.1. Resource planning

Following the Industry 4.0 requirements, and the implementation of Cyber Physical System CPS, the process of resource planning aims to maximize the overall productivity, and enhance efficiency, by allocating tasks to people, based on their capacities. Resource planning is the process of defining how all resources are determined, acquired, and managed. (Roseke, 2019) The resource planning process goes through several steps; the first step is to be able to determine what is required to execute the work in terms of labor, materials, equipment, and facilities. Then comes the step of acquiring those resources to be available and ready for use. Once the required resources are available, human resources of the company must be able to manage resources in the most optimized way, and to ensure that they are correctly exploited to reach the maximum level of usefulness and performance. The process optimization is accomplished through the proper alignment and integration between all the supply chain components, and the reach of a high level of transparency and visibility. (McKinsey, 2015)

3.2. Transport Management System

Transportation management system TMS is seen as a part of supply chain management concentrated on transport logistics. TMS allows a remarkable fluidity in the interactions that happen between the order management system and the distribution center, especially in the context of the Internet of Things IoT and the new Industry 4.0 paradigm.

A transportation management system is inevitable for companies, for the reason that it allows using GPS technologies, to locate vehicles, to conduct in real time the shipments from starting point to the arrival point, and facilitate the connection with the smart traffic system.

TMS are offering new experiences, permitting for example to track the existing location of a vehicle, to monitor its movement, and forecast its future location.

The key point of increasing the decision-making quality is to establish a well-determined and designed transportation management system that works permanently with the Internet of Things IoT devices and machines, in order to make the entire supply chain coherent, well planned and ordered. (Cunnane, 2017).

3.3. Warehouse Management System

Warehouses are one of the important components in the entire process of the supply chain, and can be considered as one of the key factors behind the competitiveness of the company, especially when it comes to the logistics field. (Barreto et al., 2017)

The implementation of the new paradigm of the logistics 4.0, with the integration of the new warehouse management system have brought radical changes to how warehouses are working. For example, RFID sensors will be able to divulge what has been delivered and transfer in real time the information to the whole supply chain.

A WMS signal will be transmitted by tags and sensors once the pallets are moved in order to offer a real-time visibility and high transparency, the thing that helps to avoid difficult cases such as out of stock situations, and taking decisions about any adjustments that may be required to increase customer experience. (Schrauf, 2017)

3.4. Smart Traffic System

Smart traffic system STS, also known as intelligent transportation system ITS, represents a new pillar that contributes in many areas related to transportation systems, such as managing transportation, traffic control, infrastructure, and so on. (Barreto et al., 2017)

New technologies are adopted by the smart traffic systems, such as computing hardware, sensor technologies, virtual operations...

The purpose of using digital technologies is to meet global challenges optimally, so that these actions aim to decrease the risks associated with transportation, and to raise the level of safety, it also aims mainly to reduce carbon emissions and pollution, and the number of accidents. The applications related to smart traffic systems are many and varied, we briefly refer to the most prominent of them: Traffic Management Systems TMS, Emergency Vehicle Preemption EVP, Vehicle Data Collection VDC.

A successful smart traffic system can be established by permitting a full synchronization between various transport modes all along the entire logistics process, and can be used for smart truck parking and delivery regions. Companies using real-time information aim to increase their decision-making level, as well as their flexibility and efficiency. (Atzori, 2010)

3.5. Information Security

With the expansion of the Internet of Things, the emergence of the new Industry 4.0 paradigm, cloud-based systems, Big Data, and other trends that are actually changing managerial methods of organizations, the latter are looking for ways to ensure a high level of security. (Antoniuk et al., 2021)

Nowadays, for the organizations that are seeking to establish a successful business within the reliance on new technologies, security represents a mainstay and a real challenge, due to the weaknesses and risks that may appear, especially those related to the security aspect. Companies should not ignore and deal with a kind of leniency with the security part, no matter how much they benefit from the new technologies that could pose a source of threat and danger. In this regard, it is necessary and imperative that companies take practical measures to protect their information and data.

Companies must be aware that the security and protection system is not a simple procedure in itself, but a key factor in competition, by defining exactly the preventive actions and by identifying clearly the information security policy, and applying the early detection of the risks that may occur, which are often very expensive, and negatively affect the normal workflow. (Bishop, 2004)

For the previous reasons, and regarding the increasing requirements from the financial and insurance institution in terms of security, it has been observed by the increasing number of organizations that are looking for obtaining security certification.

4. Discussion

Nowadays, logistics is seen as one of the most important pillars in terms of competitiveness for the manufacturing companies, and it became more important thanks to the introduction of modern technologies, which contributed to reaching effective human-machine communication.

Employees are now able to achieve better results, and avoid mistakes and errors that were previously difficult to avoid, as well as their ability to shorten time and reduce costs.

Considering the big amount of data and information, the new industry 4.0 paradigm helps companies to take optimal decisions, in light of the difficulties associated with making right decisions. Industry 4.0 will help increase both safety and productivity, so that employees will not need any more to perform arduous and not even doing mundane tasks, because machines will be managed by artificial intelligence, and will notify workers with all the updates related to maintenance and repair in case of failure or poor performance of devices. We are present in the table below (Table 1) a summary of what has been said by several authors in their works regarding industry 4.0 concept, where they try to address its significant importance and impact in the way companies are working. Authors attached high priority to the reasons behind the emergence of the fourth industrial revolution; and the main reason, which is one of the most common points between them, was the advanced and rapid change in the customer's requirements.

Table 1. Overview of Industry 4.0

Author (s)	Year	Industry 4.0 overview
Woschank & Dallasegam	2021	Industry 4.0 consists in the integration of new technologies into industry, after the use of information and communication technologies ICT has become inevitable, especially since it became essential for the productivity improvement and for company's competitiveness, by increasing automation and digitalization of processes
Holubcik et al	2020	The creation of the Industry 4.0 frame was a response to the lack of production that was caused by the transfer of production power to the countries with cheap labor
Zrakova	2019	Thanks to Industry 4.0 concept, the processes' transparency, logistics will be capable to answer effectively to the changes of the market that are increasing day by day
Jankalova & Jankal	2018	Looking at advanced requests of customers and their requirements, that are increasing, on their orders for products and services, companies strive to offer a new model based on a custom production. To answer the right way, the orientation should be towards Industry 4.0
Xu et al	2018	Relying on advanced machines, smart devices, that will authorize to companies to meet customers' requirements, Industry 4.0 has all the basics needed to face challenges as it should
Dubovec et al	2016	The purpose of Industry 4.0 is to ensure continuity, efficiency, and especially flexibility, which is considered as a key success factor
Stock & Seliger	2016	Industry 4.0 brought a noticeable transformation to the whole manufacturing system, through new trends such as artificial intelligence (AI), Internet of Things (IoT), autonomous vehicles

Bartevyan	2015	The aim of Industry 4.0 is to bring new perspective for the company, and come up with a new smart networking design of human, products and processes throughout the whole value chain, to make companies more efficient and well organized
Ingo & Lorig	2015	Industry 4.0 integration allows a fluidity and flexibility, as all elements will communicate with each other in order exchange and share needed information
Kolberg & Zuhlke	2015	Industry 4.0 have made factories completely smart, the thing that helped raise their effectiveness and productivity, based on the integration of human effort with the effort of modern technologies
Lee et al	2014	One of the most important goals of Industry 4.0 is to establish a system, in which companies benefit from autonomy and self-sufficiency in terms of human resources, and financial capacities

Source: Authors

The second table (Table 2) represents a comparative table of what has been asserted by authors about the applications of industry 4.0 in logistics field. These applications revolve around five main aspects that we have already mentioned in the second section “Industry 4.0 application”: resource planning, transport management system, warehouse management system, smart traffic system, and information security.

Table 2. Summary of industry 4.0 applications in logistics

Author (s)	Year	Industry 4.0 applications in logistics
Antoniuk et al	2021	Logistics’ field as well as the other fields, has radically changed, due to the set of several technological transformations that have been used to facilitate sharing information, data, and reducing time
		With the expansion of the Internet of Things, the emergence of the new Industry 4.0 paradigm, cloud-based systems, Big Data, and other trends that are actually changing managerial methods of organizations, the latter are looking for ways to ensure a high level of security
Lendelye	2018	To make those processes smarter, faster, and interconnected, manufacturing companies are adding intelligent technologies, following the main requirements of the fourth industrial revolution, to which logistics is also attached under the name of logistics 4.0
Barreto et al	2017	Logistics 4.0 is just a new paradigm of the logistics system, aiming to respond effectively to the customer needs, to improve customer relationship management, and to optimize the production processes, in such a way that the time is decreased and the price is reduced, as part of a very well remarked digital transformation
Cunnane	2017	The key point of increasing the decision-making quality, is to establish a well-determined and designed transportation management system that works permanently with Internet of Things IoT devices and machines

McKinsey	2015	The process optimization is accomplished through the proper alignment and integration between all the supply chain components, and the reach of a high level of transparency and visibility
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Source: Authors

We would like through the tables above to draw attention to the fact that industry 4.0 will undoubtedly transform our society from a traditional industrial society to a digital society, where everything will be interconnected by intelligent systems and networks. It will offer many opportunities for companies such as increasing their productivity, boosting innovation and improving competitiveness. Industry 4.0 will allow companies to optimize their supply chains by using connected devices and artificial intelligence to better monitor their operations and meet customer demands quickly, cheaply and effectively.

5. Conclusion and Future Works

In this paper, we tried to address what is required for an optimal and a proper application of the new logistics 4.0, by taking into consideration the challenges that companies face for a fully accomplishment of the new paradigm. Our conclusion is divided as follows: the first paragraph is a summary of what we have discussed in the first section entitled: “industry 4.0: an overview”, while the second paragraph represents a synthesis of the second section under the title of: “industry 4.0 applications in logistics”. Then, we give a general synthesis of our entire content of our paper, as well as the implications of research. Furthermore, to give a great attention to the managerial level, we tried to address reflections regarding some recommendations that we could suggest for companies to help them better understand the context of the industry 4.0 concept, and provide them with the right information concerning the implementation of new technologies especially in logistics fields within manufacturing companies. At the end, we mention the further works, mainly on the practical level, because this work was more concentrated on theoretical aspects, and we have to be more focused on the empirical level, through studying the relationship that exists between industry 4.0 and logistics performance of industrial companies.

In the first section, we tried to discuss the historical evolution of industrial revolutions and the specificities of each one of them, the importance of the new orientation following the fourth industrial revolution that companies should go through to respond effectively to markets changes. We also discussed the principle of the industry 4.0, summarized in the fact that information can be shared smoothly, as well as the most important pillars on which the correct implementation is based (Internet of Things, Artificial Intelligence, Big Data, and Autonomous Automation).

In the second section, our discussion was more focused on the industry 4.0 applications in logistics. The right implementation of the new industry 4.0 paradigm in logistics fields must be based on five fundamental applications: Resource Planning : through a defined and strategic approach, which consists of identifying, ensuring all resources required are available, and used in the most effective way; Transport Management System TMS : given that the presence of a strong transportation system is inevitable of companies, its importance is characterized by the several possibilities that offer to logistics, as it allows locating vehicles, to conduct in real time the shipments from starting point to the arrival point, and facilitate the connection with the smart traffic system, as well as it permits the increasing of the decision-making quality; Warehouse Management System WMS : the integration of new technologies has brought a significant change in the way warehouses are working, through tags, sensors, ... in order to establish a real-time information sharing, and high

transparency. Smart Traffic System STS: by the contribution in managing transportation, and traffic control, especially through the implementation of new technologies, such as computing hardware and sensors. Information security: due to the weaknesses and risks that may occur when implementing the industry 4.0 concept, the presence of a security system has become more and more important to protect their data and information.

We can effectively say that the logistics 4.0 paradigm can be seen as the integration of the new intelligent systems in the entire logistics process, with the aim of the optimization of both inbound and outbound logistics. This optimization will not be possible without the presence of databases and software, in which intelligent systems are embedded, in a way that allows a smooth mechanism for the information to be shared and exchanged, and to ensure the communication between all the components of the whole supply chain.

In the same vein regarding the supply chain, it is noticeable that the integration of the new devices and machines, will make it smarter, more powerful, and functional, with a great ability to respond effectively to the market requirements and associated challenges.

Industry 4.0 has been largely debated in the last few years, as authors, economists, managers, workers, and industrial experts struggle to know exactly its implications for their fields. As for our theoretical research, studies have determined that the integration of new technologies is affecting managerial levels in all organizations. Industry 4.0 is now affecting all companies and industries, and the impact on managerial level has been inevitable and it has become a serious issue for managers, who must attach a high importance to the implementation of new technologies, to answer the best way to the new market's requirements.

Regarding research limits, most of the papers are broadly theoretical research, and the discussion is more focused on conceptual studies, showing an absence of proof regarding the real impact of industry 4.0 on logistics in manufacturing companies. In addition, most of the works were concentrated in the requirements that are needed to reach a full integration of new technologies (Resource Planning, Transport Management System, Warehouse Management System, Smart Traffic System, and Information security), without giving a high attention to conditions that companies should have to start this implementation, in terms of company size, financial aspect, return on investment, ...

We recommend at the end of this paper that companies train their managers, employees, and staff members on newer technologies and make sure they are aware of the latest trends of industry 4.0 so that they can become competent workforce for their company and they reach a high level of theoretical and practical knowledge. Manufacturing processes are getting more and more sophisticated and require a competent workforce with a high degree of technical knowledge, employees should therefore be able to stay on top of new trends and growth industry demands. Companies have to make sure that staff are trained in the latest technologies that are crucial for competitive manufacturing.

As further developments, we aim to conduct empirical research that will study the impact of logistics 4.0 on performance in manufacturing companies, especially the effect on the human factor, in terms of time, effort... and in particular the productivity that can be reached and obtained by integrating new technologies. Our future works will therefore be more focused on measuring especially the managerial impact caused by the integration of industry 4.0 concept in logistics field, by elaborating a number of hypotheses to validate or not the relationship that may exist between some logistics 4.0 components and logistics performance of manufacturing companies.

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