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Digital Technologies' Risks and Opportunities: Case Study of an RFID System

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Abstract: Smart technologies have been the subject of a growing interest for the past few years due to the growing market demand. They are believed to improve human life, existence, and companies' performance. Considering the recent advances, X.0 concept has proven to be a mindset changing so that companies can now see that they can improve their competitiveness, ensure an innovative, sustainable and resilient environment, and smarten and develop their lean manufacturing tools. Nevertheless, if X.0 adoption is still not at its highest level, it is because of the relevant challenges and difficulties that occur during the implementation process. Within this scope, this paper aims, through a systematic literature review, to identify risks and opportunities of X.0 technologies to constitute a referential to be taken into consideration for a successful implementation. Results are validated by the modelling and simulation of an RFID system applied within the automotive industry, for which we identified risks and opportunities from one side and the system contribution in terms of smart Lean Manufacturing. From one hand, the value added of this paper, on the contrary of previous researches, is mainly regrouping risks and opportunities of most relevant digital technologies to conclude on those of X.0 revolution as a concept as described in following sections. From another hand, we were able to prove, through a real case study, that X.0 concept directly contribute in smartening and improving lean manufacturing principles.

Keywords: innovative; sustainable; resilient; modeling; risk and opportunities; simulation; X.0 technologies; lean manufacturing

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1. Introduction

Considering the growing demand and competition pressure, digital technologies were the most suitable solution for the growing industrial world. Each year, more countries show interest and appear to be involved in adopting the digitalization concept. This paradigm has seen the light in Germany during the Hanover fair held in 2011 [1]. Researchers interested in exploring the different sectors that are involved and open to investing in revolutionary technologies showed that the three main active sectors were the automotive, aerospace and the food industry [2].

As stated in Figure 1, digital technologies were discovered in 1940 and merged their benefits over the years to constitute a whole new revolution: the 4th industrial revolution. This concept gave birth to what we call Industry 4.0 technologies and kept growing by introducing new aspects such as environment, social and economic fields. According to this, Industry 4.0 moved to the next level: 5.0 technologies. X.0 is therefore used in this paper to talk about all aspects of these new revolutions. These technologies were the most crucial factor for company development [3]. Studies have shown that the most used ones are

IoT/IIoT, big data, cloud computing, RFID, 3D printing, simulation, robotics, augmented reality and cyber-security [4,5], the last being directly related to blockchain. The whole constitutes the 10 pillar technologies and companies' leaders to an innovative, sustainable and resilient environment and smart Lean Manufacturing.

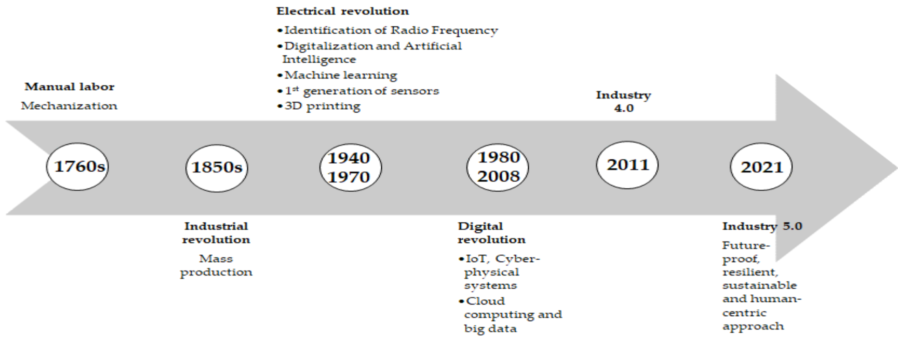

Figure 1. Industrial revolutions through the years.

As mentioned in ISO 31000, "Risk management is an integral part of all organizational activities" [6]. According to this, implementing smart technologies cannot be realized without a previous risk analysis, which constitutes the second aspect of this research. In this paper, the risk was associated with challenges, barriers and difficulties, and they may constitute a risk themselves.

Based on the result of an extensive literature review, this paper begins with an overview of the most relevant advantages. Then it identifies the risks and barriers that should be considered before adopting the digitalization concept. This review is followed by the modelling and simulation of a case study presenting the RFID system adopted by an automotive company to enhance the performance of its feeding process. The choice of this case study goes back to the fact that the RFID system represents a relevant example of smart lean manufacturing application.

2. Contribution and Research Methodology

Several research studies have exposed and detailed technologies of the most recent industrial revolution. Many have discussed their opportunities and challenges, focusing on how this revolution improved the world [7,8]. Each of these studies was focused on a specific field and, therefore, only interested in the technologies that can be useful in the studied area. No overview of the global risks and opportunities was provided, considering all kinds of possible applications of X.0 technologies.

The contribution of this paper is to develop these studies to gather all technologies' opportunities and challenges in the same study, thus enabling the exploration of the different benefits that X.0 technologies can bring to a company.

This paper also highlights the importance of establishing a risk analysis strategy, as many risks and barriers may arise. In this case, preventive actions should be prepared as a countermeasure.

Targeted readers are researchers of all expertise levels and from diverse research backgrounds.

This research was developed following the five phases of a Systematic Literature Review (SLR), starting by defining the problem and formulating the research questions, selecting databases, and then defining the inclusion and exclusion criteria along with the keywords. The next step was searching for relevant papers investigating digital technologies' benefits, challenges, or both. Analysis results and synthesis are reported in this paper along with a discussion, thus being the two last phases of an SLR. Elements of each phase are presented in Figure 2.

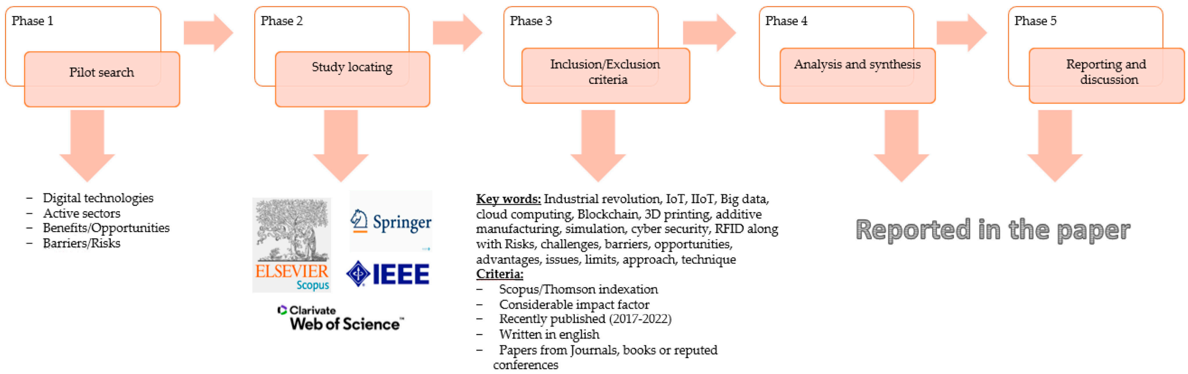

Figure 2. SLR phases.

The problem of this research was basically concerning risks and opportunities of digital technologies and was conducted by gathering papers from the most relevant databases (Elsevier, Springer, IEEE, etc.) using specific keywords such as the combination of "digital technologies" with "Risks", "Barriers", "Benefits", "Opportunities", etc., and focusing on specific criteria (Scopus indexation, English usage, paper type, etc.). This paper reflects the result of analyzing the 101 selected papers.

This review was concretized through the analysis of a model describing the solution adopted by an automotive company to increase the performance of its feeding process. A simulation was also performed to detect the changes that occurs after implementing the new system.

3. X.0 Technologies

Digitalization can be defined as the integration of digital technologies within the production systems to make tasks more autonomous, flexible, efficient and safe since it limits the physical contact between machines and humans. It is a new way of Manufacturing where manual operations are nearly absent, and resources are used in an efficient way. This opening on digital technologies raises new challenges, mainly regarding cybersecurity. This section develops the advantages and challenges of the 10 pillar smart technologies.

3.1. 3D printing/Additive Manufacturing (AM)

Also called additive Manufacturing, printing advanced technologies, being easy to manufacture, are highly used for research matters and to develop new products. Associated with waste reduction, energy efficiency, and decreased resource involvement, it allows more flexibility in product manufacturing and a quick and efficient process [9,10].

AM had a remarkable contribution within the medical field, especially regarding prosthetics (bone and cartilage replacements), dental implants, hearing aids, and other products, as shown in Figure 3 [11–14].

Figure 3. AM contribution within the medical field [15].

One of the most important advantages of AM is its opportunity to create customized products of multiple forms [16]. Shape complexity, scrap generation, accuracy and precision are no longer an issue. However, depending on the process used (Stereolithography, Fused Deposition Modelling, Powder Bed Fusion, Selective Laser Sintering, Binder Jetting, Direct Energy Deposition or Laminated Object Manufacturing), 3D printing presents many risks and complications, such as high cost and slow/Time-consuming process [10]. The first challenge to consider is choosing the right AM process, which includes selecting the suitable material. Indeed, some 3D printers have low dimensional accuracy, low lifespan, poor mechanical properties and powder agglomeration limitation. Therefore, depending on the final usage, a limited material choice can exist. Other barriers to consider are the necessity of staff re-education and the lack of guidelines [15].

3.2. Augmented Reality

Augmented reality (AR) is an emergent technology commonly known for its ability to allow interactive digital information in the real world and in real time, combining virtual and real environments. Therefore, it is a promising technology supporting knowledge-intensive works [17]. AR strength goes back to its variant application domains such as education [18,19], medicine [20], manual assembly and Manufacturing [21,22] and maintenance [22–24]. However, it is growing in wider fields such as healthcare, military operations, marketing, and others [25]. Other popular applications of AR include training [26], remote support [27] and context-sensitive instructions [28], thus enabling users to improve various task performance metrics such as completion time, accuracy, sources of error identification [29] and human error reduction by relieving mental fatigue, [30]. Moreover, when it comes to prototyping, AR is a perfect tool for cost reduction and can be used as decision support through simulation and without any risk to operator safety [31].

Nevertheless, the main roadblock to AR adoption is usually the expensive equipment required [32] and the need for cognitive skills, which is not yet ensured as there's still insufficient awareness of AR staff technologies caused by a lack of information on standardized procedures.

The complexity of its implementation and the high risk of cyber security issues are also considered major risks that may discourage companies from adopting AR [31].

3.3. Robotics

Recently, whether they are industrial or service-oriented, Robots have seen increasing success across the globe. Indeed, the International Federation of Robotics (IFR) mentions that its annual turnover is $50 billion [33], which is far from surprising considering its various features as shown in Figure 4.

Figure 4. Key features of robots [34].

Robots' major asset is that they can be used in many different ways, either for laboratory experiments [35], manufacturing, agriculture, farming and construction, or as a domestic or professional service. They can serve for housekeeping, safety or domestic assistance, surveillance, exploration or education. In the medical field, robots greatly enhance surgical operations and diagnostics and can also be used for nursing.

By replacing human beings with a robot, either completely or partially (depending on the operation to be performed), companies will be able to eliminate redundant workflows and human involvement in unsafe, repetitive and intensive tasks, enhance operational efficiency, get quick access to data and information and reduce workload while being able to handle complex tasks [34,36]. Furthermore, exploiting these advantages reduces assembly time and monotony and improves quality and flexibility [37].

Regardless of the numerous advantages of robots, several threats must be considered, mostly related to security (firmware, communication protocols, data storage, cryptography, control systems), cyber-criminality, actuation and movement accuracy and safety since robots can be unpredictable and potentially dangerous [38]. Furthermore, from an ethical point of view, people tend to express a remarkable resistance motivated by the fear of losing their job or impacting human relationships, especially concerning domestic robots or those dedicated to caring for our elderly and children [35,39]. The lack of knowledge can also explain this since robots require technical expertise and training. Sometimes, working alongside the robots can also be psychologically challenging for a human being [40].

3.4. Cybersecurity

Driven by the development of IoT, cloud computing . . . , data protection became the first concern of companies. Data loss or leakage can highly threaten business, notoriety and trust [41], which results in legal penalties and financial and reputation losses [42] and, in case of identity forgery, may lead to fake data/information and wrong status (sensors) [43].

It is a matter of a few minutes for an attacker to access and take control of the entire system just through one exploitable vulnerability [44]. Accordingly, cyber-security allows the company to protect computers, servers, mobile phones, and electronic systems from malicious attacks, protecting the information on these devices and the identity of people using them [45].

Cyber-security threats are divided into three categories: Cybercrime (Sabotage, Monetize), Cyber-attack (Information gathering) and Cyber-terrorism (System destruction) [46]. Unfortunately, it is impossible to fully detect and eliminate vulnerabilities against these threats [46].

3.5. Blockchain

Since it was first identified by Chaum in his PhD thesis in 1982 [47], blockchain has increasingly evolved over the years and gained in terms of performance. Moreover, this evolution led to the enlargement of its applications to the whole social level [48,49]. Indeed, blockchain was defined as the fifth breaking innovation within the computing paradigm, preceded by the mainframe, personal computer, internet, mobile and social network [50], and Gartner's recently predicted that blockchain technology will contribute $3.1 trillion of new business value by 2030 [51].

Applied in all trustworthy fields with strong certifications, blockchain is the enabler of the digital currency known as Bitcoin [52]. From Blockchain 1.0 (Bitcoin and the like) to Blockchain 2.0 (Ethereum and SCs), to Blockchain 3.0 (IOTA, Cardano, Tezos, etc.), and the ongoing Blockchain 4.0 (use of A.I., Blockchain as a Service, etc.), This technology has many advantages [53,54]:

- distribution: a resilient and secured system through storage of information on multiple computers;
- traceability: all transactions are traceable;
- anonymity: addresses' owners' name is only used to prove the ownership of a private key. Transactions can be done anonymously;

- decentralization: transactions are managed without a central authority;
- immutability: once accepted, it is not possible to modify data;
- cost friendly: open-source software with low maintenance costs;
- autonomy: data exchange, record, and update are performed in a trustworthy environment using consensus-based specifications and protocols. Therefore, it ensures the authenticity of the recorded transaction on the blockchain without human intervention.

Despite the promising features of blockchain, the technology is still not highly adopted [55] due to its several drawbacks. Indeed, blockchain still has performance and scalability issues, their energy consumption is high, their cost is not predictable and there is no control of written and read information, especially regarding public blockchains [53]. In addition to that, security is still a huge concern for this technology. On 22 May 2018, hackers attacked the blockchain Verge, stealing nearly 35 million anonymous coins [56]. On 5 January 2019, hackers caused a loss of $1.1 million US dollars by attacking the blockchain Ethereum Classic (ETC) [54,57].

Another constraint to consider is that successful blockchain implementation goes with integrating several technologies, such as big data and cloud computing, making the process much more difficult [57]. Finally, from an organizational aspect, barriers to be expected are a lack of skills, tools (hardware and software) and standards/business models for both implementation and maintenance [55].

3.6. IoT/IIoT

Internet of Things (IoT) is the technology that connects physical objects to each other, making them able to communicate using the internet, actuators and sensing tools that gather data to generate actions using devices [58–60], thus enhancing communication possibilities between virtual and physical worlds [61].

It is commonly used in domestic equipment (Smart home), medical and healthcare field and within societies (Smart city, connected vehicle). However, it is also strongly used in the industrial field such as industrial automation, smart grid, maintenance forecast and transportation. This specific side of this concept gave birth to the Industrial Internet of Things (IIoT). IIoT can promote various industrial applications related to logistics, Manufacturing, food production and services, enhancing business competence and manufacture, decreasing downtime, and improving product excellence [60].

Nevertheless, resources, battery energy, storage space and processing resources were limited, making IoT very challenging to Implement [62]. Indeed, most IoT nodes are designed to be of small volume and weight, not leaving enough space for a larger battery [60]. Moreover, regarding safety and confidentiality risks, IoT nodes usually gather sensitive and confidential data but do not protect them with the necessary processing powers [63,64]. In addition to that, IoT systems, being heterogenous and decentralized, presents poor interoperability [60].

3.7. Big Data

Since its first appearance, big data has been proven to be a life-changing technology both personally and professionally from different aspects [65]. Nowadays, it is highly relied on for decision-making (data-driven decisions), especially in a highly dynamic business environment [66,67]. Moreover, thanks to its capacity to store and analyse complex, voluminous and heterogenous data [68], the overall goal of big data is to create an understandable structure based on extracted information from a huge data set [69].

It is an enabling technology for cost reduction, faster and better decision making, new products and services created for customers, a very powerful strategy for online businesses and fraud Detection [69]. However, it presents many risks, such as poor data quality, lack of trust in data, lack of sufficient resources, lack of security and privacy and lack of financial support [70]. In addition, it is a time-consuming technology comprising various phases of development, testing, and adoption, which commits the top management a mandatory condition for its implementation and may therefore take one year to one and a half years. In case of failure, the company may face a loss of confidence to recover the investment made (return on investment (ROI) issues) [71]. Even with its enormous evolution, lack of skills, experts, and data scalability are also to be counted as the biggest risks that occur while adopting big data [72].

3.8. Cloud Computing

The United States Institute of Standards (NIST) defines Cloud computing as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources such as networks, servers, storage, applications, and services". Cloud computing has five essential characteristics that distinguish it from other computing paradigms and counts four deployment models that are represented in Figure 5 [73].

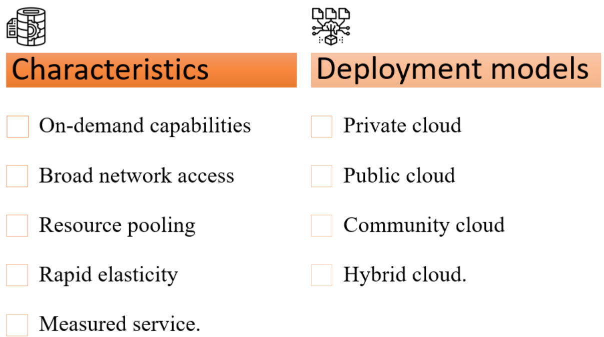

Figure 5. Cloud computing characteristics and models.

Cloud computing is known for its cost efficiency, scalability, elasticity, almost unlimited storage capacity and continuous availability as it offers easy access to information in different time zones and geographic locations. Moreover, it is one of the few technologies that present the advantage of being fast to deploy and easy to integrate, all along with having a robust architecture that ensures its resiliency and redundancy [69].

This innovative concept also delivers services that were not possible before, such as mobile interactive applications (location, humidity, stress sensors, worldwide weather data, etc.), can lower IT barriers to innovation [74], provides data backup services, disaster recovery and automatic software updates [75].

Nevertheless, free access to cloud storage servers is limited and, therefore, not enough to reliably save and maintain data, pushing users to purchase extra cloud storage services. It also presents huge security risks due to vulnerabilities of central auditing servers [76], which require a vast and complex hardware infrastructure and new skill sets. Finally, from a political point of view, it represents several issues related to where the physical data resides, where processing takes place, and where the data is accessed.

The full potential of cloud computing is constrained by the availability of high-speed access to all users [74].

3.9. Radio-Frequency Identification (RFID)

Radio Frequency IDentification (RFID) is a wireless communication technology that, using tags (fully or partially passive or active), antennas and a host computer or middleware, captures data and links it to different attributes such as serial number, position, colour, date of purchase and other information about the entity carrying the Tag, through a data collection process based on electromagnetic waves exchange between RFID tags and RFID readers.

Communication performances, interaction with other supply chain information systems and level of standardization of this new concept have known an increasing success during the last few years [77–79]. Indeed, it became omnipresent in our daily life routines such as ticketing, payment, passports, car keys, etc. RFID systems vary one from another depending on the involved frequencies: micro-waves, Ultra High Frequencies (UHF), High Frequencies (HF), Low Frequencies (LF), which define the read ranges [80]. In the industrial field, it offers better visibility and tractability in logistical and Manufacturing processes [77], unitary identification and low-cost tags [80], with real-time data collection and sharing [81]. Furthermore, RFID technology, by redesigning the inter and intraorganizational business processes that, could lead to the emergence of the so-called "smart processes", which are processes that can initiate business transactions without any human interventions and, therefore, ease the integration of inter- and intraorganizational information systems [78,79].

Regardless of the remarkable evolution of this technology, many risks are still threatening its implementation success, such as data security and privacy that can be easily hacked or captured by hidden readers as data transmission is ensured through air interface [77]. In addition to that, RFID requires extravagant equipment, which ends up with a high cost that may not be covered by some companies [82], especially since it is constraint by a limited channel bandwidth [83] and by material to use since communication cannot be ensured efficiently through metals or liquids [84]. This includes a lack of technical and financial support and a lack of skilled experts [85].

3.10. Simulation

Simulation is the virtual scientific approach designed to experiment on a model representing a real phenomenon or a given system or product. One can study and observe characteristics and behavior under different configurations. It highly serves the decision-making process through real-time testing, considering real production constraints, which allows better control of work results without the cost and time consumed using the old way based on prototypes [86–88].

Nevertheless, without a clear understanding of the process and its parameters, and a proper understanding of the problem, companies risk getting the wrong conception and, therefore, not achieving the expected results [89,90]. This can also be related to the lack of skills and knowledge in terms of simulation and the diversity and complexity of the dedicated software or application with poor access to guidelines [91].

3.11. Analysis and Discussion

Following the performed literature review results, Tables 1 and 2 summarize the most relevant risks and opportunities of digital technologies. The process was to first identify keywords representing risks and opportunities for each technology independently, then identify the common ones to evaluate the criticality and occurrence of each risk and the importance of each opportunity. The tables regroup the most relevant ones but don't present an exhaustive list, as the target is to understand mostly the roadblocks or the key elements that don't encourage companies to adopt the digitalization concept and to study the potential motivations behind companies' interest towards digitalization. The keywords were chosen in a way to be precise and explanative at the same time. For instance, "flexibility" was used to identify the technologies that offer the possibility to improve companies' processes and make them flexible either when it comes to precision, diversity of products or accuracy of data when interactivity describes the technologies that allow interaction between virtual and real words. When it comes to risks, the keyword Complexity was used to identify the technologies in which implementation is difficult and is mostly linked to a lack of skills and guidelines.

Accordingly, we can conclude that most smart technologies present the advantage of bringing effectiveness and flexibility to the processes among companies, making them more performant. Some of them also allow interaction between reality and virtual worlds, such as Augmented reality, IoT/IIoT and RFID systems, while others can be used as decision-making support, such as Augmented reality, big data and simulation.

Table 1. Opportunities for digital technologies.

Opportunities	Easy/Quick Process	Efficiency	Flexibility	Precision	Interactivity	Decision Support	Data Protetction	Traceability
3D printing /Additive manufacturing (AM)	[9,10]	[9,10]	[15]	[15]				
Augmented reality		[29]			[17]	[29]		
Robotics		[34,36]	[35,37]					
Cyber security							[45]	
Blockchain							[53,54]	[53,54]
IoT/IIoT		[60]			[61]			
Big data		[68]	[66,67]			[66,67]		
Cloud computing	[69]	[69]	[69]					
Radio-Frequency Identification (RFID)		[78,79]			[77–79]			[77]
Simulation		[86,89]	[86,89]			[86–88]		

Table 2. Risks of digital technologies.

Risks	Expensive /Time-Consuming Process	Poor Properties	Limited Choice	Lack of Skills /Guidelines	Data Accuracy	Safety/Cyber Security	Complexity	Resistance to Change
3D printing/Additive manufacturing (AM)	[10]	[16]	[10]	[16]				
Augmented reality	[32]			[31]		[31]	[31]	
Robotics				[36]		[38]		[35,39]
Cyber security						[46]		
Blockchain	[53]			[55]		[54,56,57]	[57]	
IoT/IIoT			[63,64]			[63,64]	[60,62]	
Big data	[68]			[72]		[70]	[68]	
Cloud computing	[76]			[74]		[76]	[74]	
Radio-Frequency Identification (RFID)	[82]	[84]	[83]	[85]	[77]	[77]		
Simulation					[90]		[90]	

By getting closer to X.0 technologies through this review, it is clear that smart practices, flexibility, reliability and responsiveness played an important role in resilience development. A survey answered by various sectors proved that smart practices ensured by X.0 technologies led to an innovative reconfiguration of Manufacturing processes and products (volume/diversity) [92]. More than that, Industry X.0 highly contributes to industrial innovation, sustainability, and efficiency (environmental, social, and economic). For example, Artificial intelligence and Machine learning can be used to identify solutions for environmental issues such as waste control, resource optimization, carbon neutrality, etc. [93,94]. The substitution of paperwork by digital electronic devices, smart grids, green energy management, reducing energy consumption through IoT technology, usage of modelling software to optimize buildings, material saving and waste reduction through 3D printing and adoption of a photovoltaic system are some of the numerous sustainable aspects of X.0 technologies [95]. Finally, digitalization made people change their way of thinking and managing their factories, which brings to light the innovative aspect of Industry X.0. In fact, it provides opportunities to create new and more individualized products [96], new ways of interaction, a better understanding of customers' needs, smart goods and services, etc. [97].

Nevertheless, digital technologies are subject to several risks, the most critical one being data security. Implementing their means, therefore, implementing a solid cyber-security system. On the other hand, the low digital maturity of companies can be justified by the high investment required and the complexity of the implementation process which itself can't be supported by companies due to the lack of skills and guidelines.

4. Case study Simulation: Risks and Opportunities of an RFID System

To better understand the literature review results, a case study was conducted on an industrial company operating within the automotive field. This company aims to improve its components' feeding flow and control by implementing an RFID system.

The first step was to observe the existing flow and identify the weaknesses of the actual system using check sheets, daily follow-up, time measurement and operations classification. These parameters were then affected to the simulation model presented in Figure 6 as inputs. The "0" reflected in the simulation model are related to fact that at it represents the model in its initial status (Simulation not yet launched), which means that there's 0 entity at each process. The goal of this simulation is to analyze the behavior of the current system and identify the bottleneck processes and wastes (MUDAs) to be eliminated for a better performance. To define probability lows to be used for each process, we used Input analyzer tool within ARENA software.

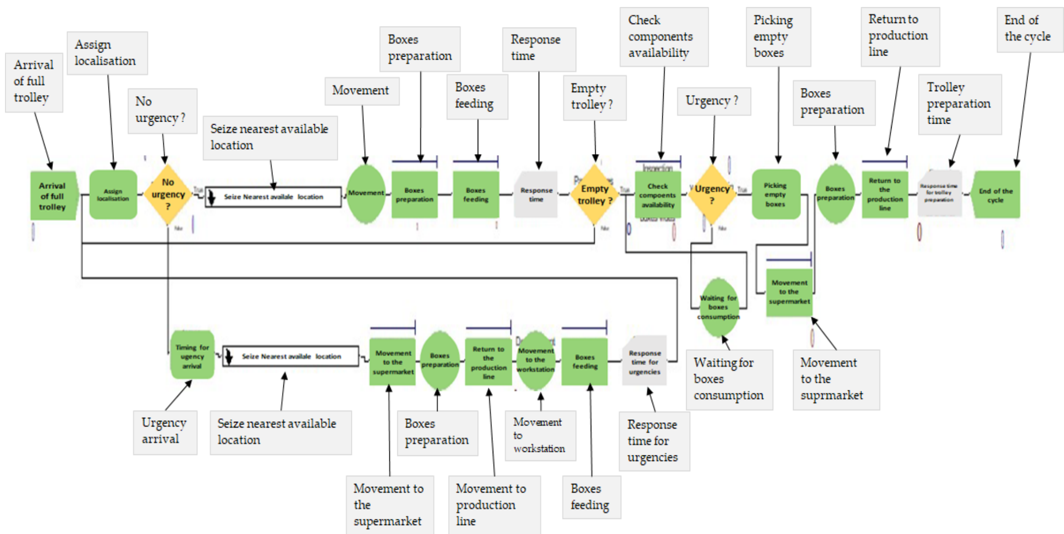

Figure 6. Simulation model of the current system.

Results showed that the actual system is impacted by waiting time, overstock, non-added value operations, absence of a control system, absence of a work instruction, no visibility on actual consumption, and no traceability (Consumption vs. available). Once these issues are detected and analyzed, the next step is to identify the most suitable technology. By consulting experts and holding meetings for experience sharing and benchmarking, the company concluded that RFID is the golden ticket to achieving the expected results.

Using SAP software, actors of this system will manage to check the needed components and set a feeding list that will be validated once feeding trolley capacity is achieved. This responsibility is given to the warehouse distributor, who can access previously validated lists if needed or print them to make the feeding process easier. In addition, to avoid useless movements back and forth to the warehouse, an in-line distributor can have access to the trolley preparation status so that he only goes to the warehouse once the trolley is completed.

Meanwhile, he is responsible for scanning empty boxes by putting them in the RFID structure. These actions are represented by the use case diagram in Figure 7, a diagram that represents the structure of major functionalities needed by each user of a given system [98].

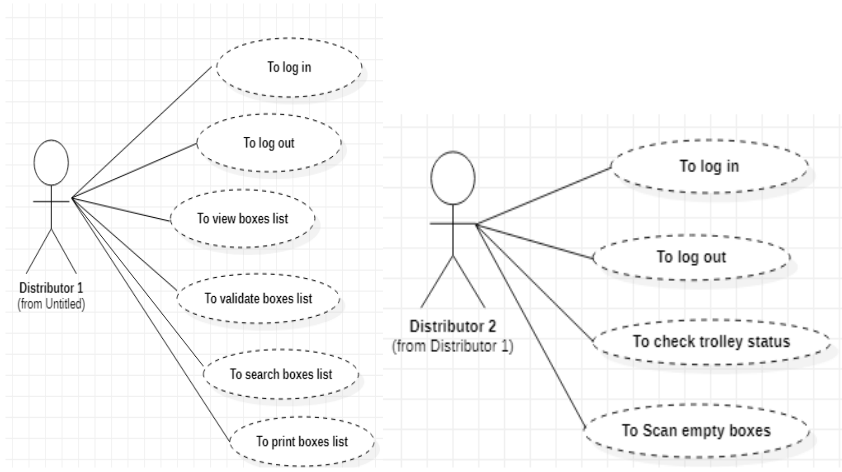

Figure 7. Use a case diagram of the RFID system.

When it comes to the sequencing of these actions, they are presented in the sequence diagram in Figure 8, reflecting the temporal succession of the process and the interaction between the object of the system [98,99].

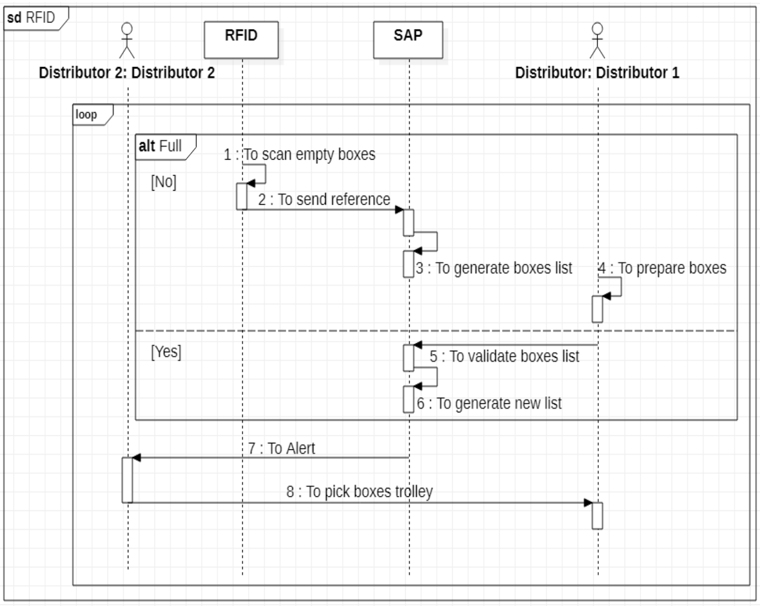

Figure 8. Sequence diagram of the RFID system.

Along with line production, the in-line distributor collects the empty boxes and puts them in the RFID structure in order to be scanned, then takes them to the empty boxes trolley. Once the RFID reader scans the label printed in the box, the respective reference is automatically sent to the SAP system as a signal that the concerned component needs to be refilled. A new picking list is created with details of the component's information (Concerned production line, component name and type, quantity needed, number of boxes needed, etc.). The warehouse operator grabs the components and puts them in the feeding trolley, and the SAP system updates the inventory accordingly. This sequence is repeated until the feeding trolley is full, then the actual picking list is validated and a new one is created. A signal is then sent to the in-line distributor that moves the empty boxes trolley to the warehouse, grabs the full boxes trolley and starts the feeding process inside production lines. This cycle is then repeated until the end of the shift. It can also be interrupted in case of urgent need.

To better observe the behavior of the RFID system, the simulation model presented in Figure 9 was performed using different parameters to verify the system's reaction to different situations and in different conditions. Similarly to the first simulation, we used timings taken after system implementation and listed the new operations performed by the feeding operator to be used as input for the simulation model, and relied on Input analyzer to define probability laws of each process. The "0" reflected in the simulation model are related to fact that at it represents the model in its initial status (Simulation not yet launched), which means that there's 0 entity at each process.

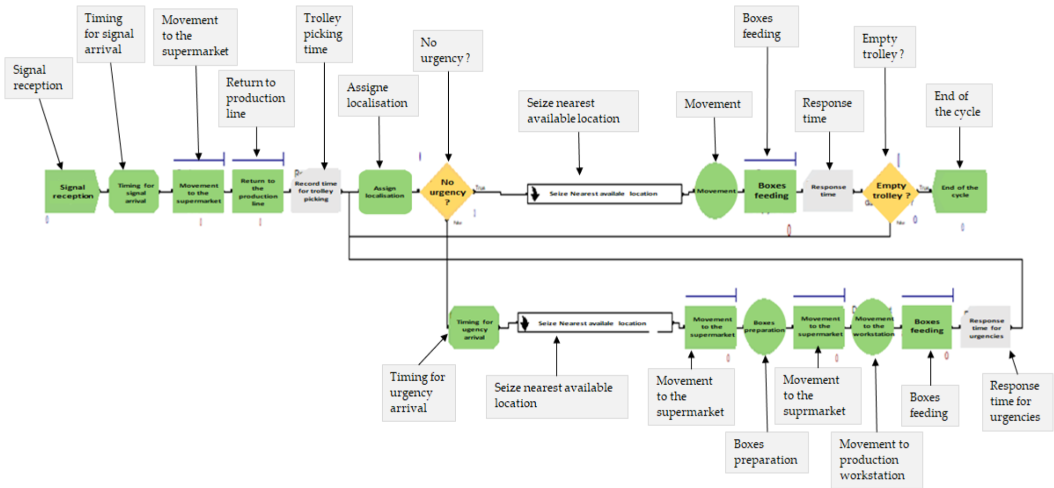

Figure 9. Simulation model of the RFID system.

Results showed that after implementing the RFID system, several MUDAs were eliminated such as waiting time as the operator, once he gets to the supermarket, the trolley will be already ready to pick which reduce the waiting time to zero. In addition to that, the operator no longer needs to keep checking boxes consumption status as empty boxes will be scanned using the RFID structure, which allows to dedicate other responsibilities to the feeding operator and also reduce their number.

A risk analysis was also established to identify risks and roadblocks that may be faced during or after the implementation of the RFID system in order to establish countermeasures accordingly, thus using the SWOT matrix, a technique commonly used since the 1960s–1970s to identify the internal strengths and weaknesses and the external opportunities and threats of a system [100,101]. Results are summarized in Figure 10.

As already stated, Industry X.0 technologies are also used to support the smartening of lean manufacturing tools and principles [14]. They are two complementary concepts: Lean principles eliminate MUDA and ensure standardization for a smooth implementation of X.0 technologies when Industry X.0 allows the smartening and development of lean manufacturing tools without bringing any change to its principles [92]. Indeed, the implementation of the RFID system contributed to waste elimination by replacing paper with digital tools, better control of inventory which eliminated the risk of overstock, and no more waiting time.

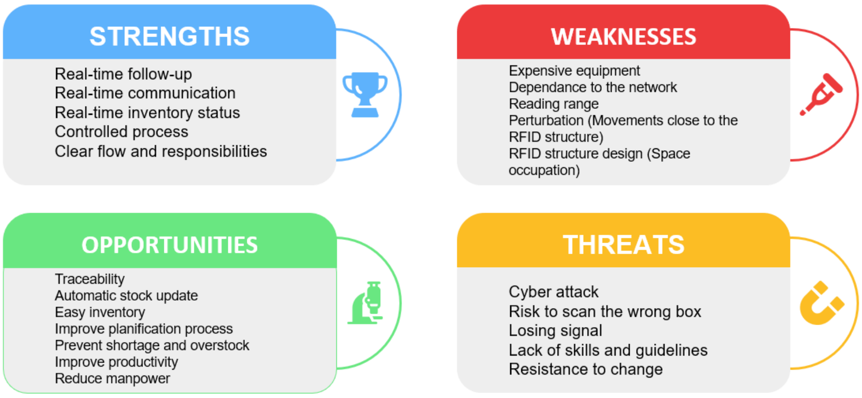

Figure 10. SWOT analysis of the RFID system.

To put SWOT into action, it is a good opportunity to match up the Strengths with Opportunities and the Threats with Weaknesses following TOWS analysis, and therefore identify the relationship between the internal and external factors. This analysis allowed us to define strategies and actions by taking advantage of the positive aspects of the RFID system. Results are represented in Figure 11.

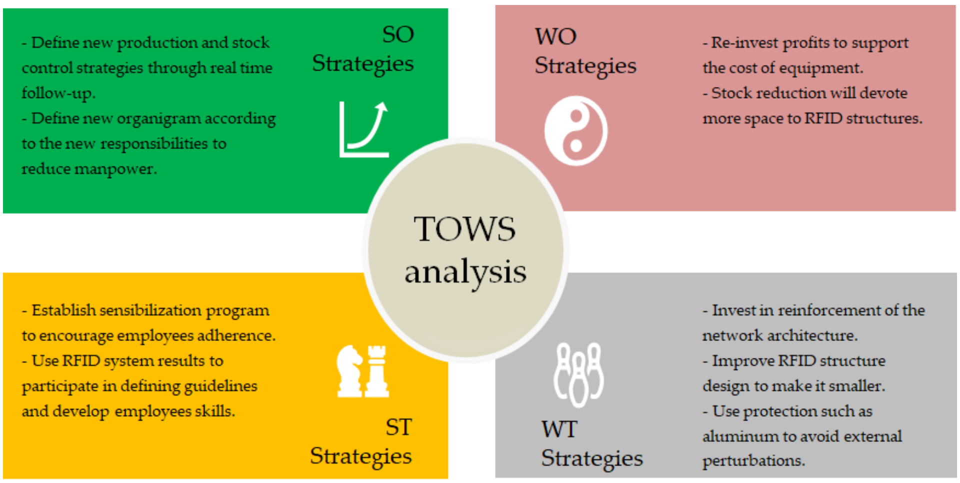

Figure 11. TOWS analysis of the RFID system.

When it comes to the study, many difficulties and barriers were faced and made the process more complicated, but at the same time, simulation offered several opportunities that supported the decision-making. In other words, the pros and cons of following the strategy and using tools are represented in Figure 12.

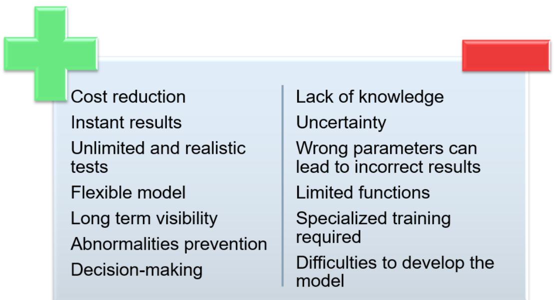

Figure 12. Pros and cons of the conducted study.

5. Conclusions and Perspectives

Digitalization is a paradigm that is strongly present in many applications of our everyday life and continues to develop and renew itself through the fact that more and more companies have become ambitious to ensure not only an innovative, sustainable and resilient environment but also the smartening and development of their lean manufacturing tools. A conducted literature review has proven that each one of the smart technologies has many opportunities but presents many risks. These risks and opportunities can be either common or related to a specific technology, but either way, the establishment of a risk analysis strategy is a mandatory step during the digitalization process. For new companies intending to adopt this concept, this paper will provide a referential to what they will encounter.

This research was concretized by the modelling and simulation of the case study of an automotive company, based on which we were able to validate the risks and opportunities identified during our research on RFID technology, as well as the importance and benefit of using simulation. Indeed, results showed that the RFID system would bring many improvement opportunities by eliminating MUDAs and facilitating communication when simulation supported the decision-making process that was completed by a preventive action plan to overcome detected risks and weaknesses.

In terms of perspectives, we aim to reinforce this research with a statistical study based on a survey, from which we can come up with lessons learned from smart factories, but also reflect risk and barriers occurrence during the implementation of revolutionary technologies. In addition to that, since the articles studied didn't rely on a specific risk analysis system or tool, it is interesting to define which risk assessment strategy/tool is suitable for each technology.

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