Study and Analysis of the Use of Internet of Things for the Greek Enterprises

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I hereby declare that the work submitted is mine and that where I have made use of another's work, I have attributed the source(s) according to the Regulations set in the Student's Handbook.

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Abstract

This dissertation was written as a part of the M.Sc. in e-Business and Digital Marketing at the International Hellenic University. The study is divided into three main chapters. Firstly, a literature review that realizes an assessment of how the Internet of Things is affecting many areas of our daily and professional lives, concluding specifically with how it has penetrated the business sector and in which ways. The second chapter is dedicated to the analysis of the use of the Internet of Things in twelve business sectors, which were selected based on whether Greece is active in them. For this chapter, related research articles were studied which, at a theoretical level, apply the IoT in each individual business sector, in combination with the research of real companies that have already introduced the IoT in their internal functions or the products and services they offer to their customers. In the third chapter, data on the use of IoT in business sectors of Greece are presented, as well as reports regarding the digital maturity of the country in general. The goal of this research was to offer a complete image of the future trends in technology for the business sector and explain the impact on customers and businesses experience, by gathering as many sources as possible. Therefore, the research questions that emerged were: “How do businesses worldwide are already using Internet of Things” and “At which stage is Greece regarding digital maturity?”.

Throughout my M.Sc. thesis I had an efficient collaboration with my supervisor, Prof. Periklis Chatzimisios. I would like to express my gratitude as his help and guidance was crucial for the accomplishment of this project. Finally, I would like to thank my parents for the full support in all possible ways, which made the completion of this postgraduate program possible. Without them, I would not have succeeded and the least I could do is dedicate this work to them.

Keywords: Internet of Things, Greek Enterprises, 4th Industrial Revolution, Industry 4.0

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1 Introduction

The trends of technology during the recent decades have mostly to do with data and information that can help organizations and enterprises to understand the character and needs of the end customer. As it is characteristically mentioned in (Mubarok & Arriaga, 2020) "markets have changed from mass production to mass customization". Knowing your audience gives you great power, which can be translated as the personalized service of the customers, or even cases where the public is served before the demand even appears, that is, the prediction of their needs before they even think about them.

The integration of most recent technological development has been made possible through the use of Internet of Things (IoT) technology. The main principle of IoT is that it enables everyone to be connected to at any time, a fact that is not limited only to people, but also to actual devices and things. This is a new era, in which a "network of networks" has been launched. The peculiarity of this network of networks is that it bypasses the need for human handling, in order for data to be transmitted to the cloud. It actually enables us to create an automated world, where all devices, from household appliances to those devices that we operate daily in our workplace, operate independently. Many also describe this era as Virtual Reality, where machines, objects and people are all connected in a network (Szozda, 2020). However, in addition to serving our needs, the devices have the ability to self-maintain, making our lives easier and saving us time from maintenance. This is a fact that can be proven to be extremely useful, not only in the parameter of our personal life, but also at the level of companies and the development of their internal operations. This, however, will be discussed further in the following chapters.

The question that arises is how does this technology work? To understand the operation of IoT devices, it is firstly important to understand the use of Radio Frequency Identification (RFID) technology. RFID systems help devices to identify objects and record metadata via radio frequencies (Jia et al., 2012). Typically, RFID systems consist of tags, which are microchips with an antenna attached to objects to be located. Beyond that, there is the RFID reader, which after communicating with the RFID tag, converts the

radio waves into messages. Thus, since the era of the creation of RFID technology in 1945 as a war and espionage tool, we have come to use it in Information Technology, as a means of "reading" the data emitted by any kind of object, as long as it has a built-in antenna. This technology leads to the concept of the IoT, as it is a prerequisite for the connectivity of devices in the cloud.

In IoT technology, the "thing" can have many meanings: it can be a living being (human or animal), having sensors built into a part of its body that record its vital signals or it can be a refrigerator which records the food we store in it and notifies us of deficiencies (Wikipedia Contributors, 2020). In essence, anything that has an Internet Protocol (IP) address and can transmit data over a network (TechTarget Contributors, 2020).

The reasons that make the use of the IoT network so attractive in our time, is that it opens a wide field of possibilities in many sectors, both at a personal level and a business level. Figure 1 displays all the possible ways that the IoT are connecting the world. It is easy, according to (Mattern & Floerkermeier, 2010), to think of a steady future for smart devices connected to the internet, due to the evolution of technology that allows us to reduce the size of various electronic components, as well as for them to become more affordable and therefore significantly more accessible for the masses. This can affect manufacturing and production companies deeply.

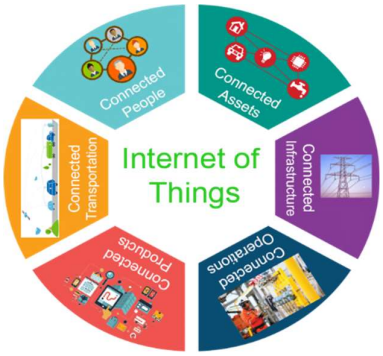

Figure 1. Internet of Things: What are the uses?[1]

[1] https://www.varistor.in/blog/internet-of-things-what-are-the-uses/

2 Literature Review

The present research has been carried out entirely by studying previous works that deal with the issues of the use of IoT, in a more general context, i.e. issues related to the technology around them and their creation, but also their application in the field of business and their direct connection to Industry 4.0. Initially, articles were researched with the phrase “IoT” and then this research became more specific, by investigating the combination of the “IoT” and “business” terms, always keeping in mind that the papers and articles should be within 5 years or 10 years at most. Then, reports were studied which have been taken from data that emerged from the application of new technologies in real companies, foreign and Greek. In these cases, an analysis of the reports of both origins was made, with an attempt to assess how the examples from abroad could be applied to Greek companies.

Various kinds of categorizations have been made regarding the use of IoT and by which way their integration could improve various aspects of our lives. The present study will focus on a specific category, based on the categorization created by Sundmaeker et al. (2010), in which the use of IoT is found in three main areas:

- Industry
- Environment
- Society

The environmental and the social domain deal with the use of IoT in cases such as the protection and management of natural resources and the development of societies and cities, respectively. The industrial domain is the one that this research deals with, as it carries out "economic and commercial activities between companies, organizations and other entities". This includes companies in the construction sector, banking and finance sector, government agencies, the service sector and in general, any type of organization. We will first see how we have come to this point of technological advancement.

It is without saying that the evolution of this sector, which has reached the level we are in today, has to do with the automation of everything and digitalization. What these terms mean in practice, has to do with the ability of each thing to connect to the cloud, as mentioned above, but also the re-examination of these aspects in a digital

environment. It is a new form of communication between things, which defines a new era in which the function and usefulness of things extend beyond their original use and reason of creation (Schroeder et al., 2019). Following this logical continuation, it is natural for the stakeholders associated with each product to change. This scalability and the expanded uses of the products have attracted the interest of companies, either as a way to elevate their development and internal operations, or as an opportunity for different business moves and opportunities. Thus, we have reached the so-called "Industry 4.0", a term that characterizes the practices that businesses can incorporate to reach digitalization, the use of technologies to make business digital.

What is actually Industry 4.0? As shown in Figure 2, number 4 refers to the fourth event in a row that influenced the history of industry, with the first change to have occurred in the 18th century; it had to do with the transition from manual labor to mass production by the contribution of machines. The second one was a change that was succeeded due to electricity and steam in mass production in the 19th century. The third one included the use of computers, at a level that allowed people to access them at a large scale, as well as the introduction of alternative energy and automation of work processes (Rath et al., 2019; TechTarget Contributors, 2020). The 4th consecutive revolution in the field of industry is a product of the 21st century and, specifically, it was firstly introduced in 2011 in Germany, after the government urged the promotion of use of computers in the construction process. It is historically proven that every introduction of new technology that affected the Industry, positively affected productivity (Muller & Voigt, 2018).

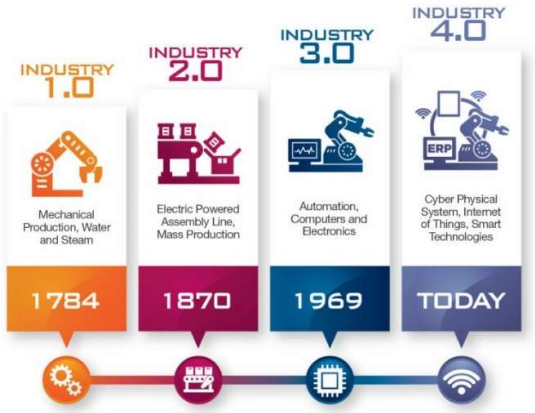

Figure 2. The 4 Industrial Revolutions[2]

According to Rath et al. (2019), there are four important aspects that allow digitization in a business and therefore, the realization of I4 as can be seen below:

- Data, computational power and connectivity
- Analytics and intelligence
- Human-machine interaction
- Digital-to-physical conversation.

In the first category we find IoT, Big / Open Data and cloud technologies, in the second, digitization and automation of knowledge work (artificial intelligence and machine learning) and advanced analytics, in the third one we talk about next-level Graphical User Interfaces (GUIs), as well as virtual and augmented reality and in the last one, additive manufacturing (e.g., 3D printing), advanced robotics and energy storage and harvesting are included.

What is the added value of utilizing IoT to the above? Some argue that, in combination with the use of Big Data and Cloud technology, companies are led to a significant reduction of their costs, since the combination of these technologies can lead to the prediction of buying habits of the customers. In other words, we could say that it prevents companies from making unnecessary and costly moves. The reasons for their integration into business, however, are not limited to this.

[2] https://evodiokaltenecker.com/when-technology-meets-strategy-impacts-of-industry-4-0/

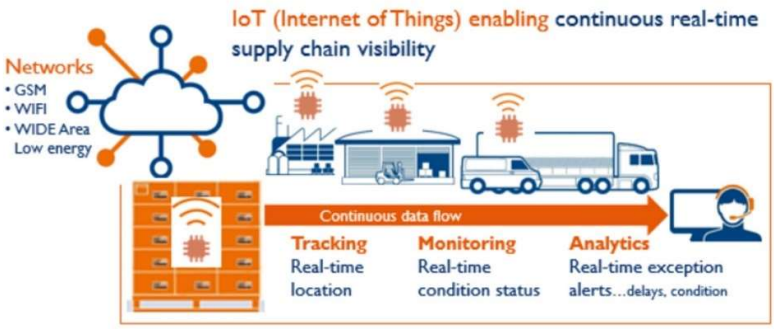

Figure 3. IoT enabling continuous real-time supply chain visibility[3]

The idea of generating and monitoring data in the "here and now" with the help of IoT is particularly appealing, especially in the case of commercial businesses, as they make it possible to track customers' buying habits and how they interact with their products (Horwitz, 2016). In commercial enterprises, the use of IoT occurs mainly in Supply Chain Management, which clearly affects the operation of the enterprise as a whole, but also in Asset Management (Ruan & Shi, 2016) with their use in combination with mobile, RFID and NFC (Near Field Communications) technologies. An example of how IoT affect Supply Chain Management, can be seen in Figure 3, describing a reality where there is continuous data flow and real time supply chain visibility.

According to (Chandra, 2019), one of the ultimate goals in the Supply Chain Management (SCM) is End to End Visibility (E2E), which in short means the ability for a company to be aware of all its internal processes. Visibility makes traceability possible, i.e., the possibility of knowing the history of resources in the production process (Mantravadi & Møller, 2019). When every process is digitized and therefore transparent, then the weaknesses are easier to identify. Although in literature, this change, which comes from I4, focuses on the technological infrastructure, the real picture is that it affects organizations from the ground up. While changes affect every sector of the business in the value chain, the perspective of customers and their needs, as well as competition, cannot be unaffected (Grabowska, 2020). The use of new technologies can save time and

[3] https://www.zetes.com/en/technologies-consumables/iot-in-supply-chain

effort in businesses, but prerequisite for that is a strong infrastructure that allows the interaction between humans and Cyber-Physical Systems (Radanliev et al., 2020).

However, growth through digitalization relates not only to the opportunities given to businesses by large-scale data collection, but also to the ability of those directly involved, in order to make the right decisions and choose the most appropriate information given, to eventually take the right steps (Nagy et al., 2018).

According to Sundmaeker et al. (2010), IoT can affect the product lifecycle management, from “head to toe”. It all starts by connecting objects to Information Technology, something that requires an intelligent infrastructure that supports data retrieval from objects. This technology must be present in every moment of the life cycle of the object, from its production to its disposal to the user. The goal is the transparency, the complete, that is, provision of information of every aspect of the object, so that they serve as data for the organization of a company, its production process, its accounting processes, etc.

Although there is no widely accepted definition of what I4 means, it is widely associated in the literature with the construction industry. There are surveys and reports that investigate the profit that construction companies can make, using the practices of I4, which aim at cloud manufacturing, intelligent manufacturing, C2B manufacturing etc. (Weking et al., 2020).

Pech & Vrchota (2020), characterize IoT as a “modern form of Information and Communication (ICT) technologies”, a term that assumes that all the parameters that characterize a business (devices, applications, systems, etc.), make it possible for people and organizations to connect to the digital world (TechTarget Contributors, 2019). In simpler terms, ICT refers to the telecommunications and the access they provide to information (ICT Definition, 2010). According to (Pech & Vrchota, 2020), ICT is directly related to the proper functioning of a Supply Chain Management of a company, as it involves the integration of the human factor and especially of customers and suppliers, in order to improve the latter. The demands are mainly two: the connection of the two worlds, the physical and the digital and the collection of data for the purpose of its subsequent analysis. This is what Cyber-Physical Systems do, which are defined as "integration of computation" and consist of "computation units, control units, network communications, sensors, and actuators" (Wang et al., 2012). Their purpose is to integrate networking

into physical objects so that they can be connected to the internet (National Science Foundation, n.d.) and that is why today we can talk about "smart" devices.

The idea of the Smart Factory: The concept of Smart Factory is essentially a consequence of the concept of I4, which “increases digitization and automation of the manufacturing environment, as well as the creation of digital value chains to enable communication between products, their environment and business partners” (Grabowska, 2020) and which is mainly concerned with the operation of factories and manufacturing businesses. The Smart Factory is the factory of the future, where everything is automated and researched to perform perfectly anytime. How? With the power of data and knowledge. Figure 4 displays the ways that characterize the functions of the Smart Factory.

The purpose of smart factories is the particularly large production volume, by exploiting fully automated and digitized processes. I4 allows processes to be performed and managed in a virtual space (Szozda, 2017). The large volume of production, however, does not necessarily mean that the integration of IoT technology in production is addressed only to large companies. According to (Pech & Vrchota, 2020), small and medium enterprises have the opportunity, with the use of new technologies, to increase their competitiveness in the field. This fact is something very important for the companies themselves, but also for the economy of the countries. Naturally, the technologies that enabled the emergence of Industry 4.0 were initially only available to large enterprises, due to capital needs that small and medium-sized enterprises could not afford. However, according to (Gilchrist, 2016), the Industrial Internet of Things (IIoT) or Enterprise Internet of Things, includes every size of businesses.

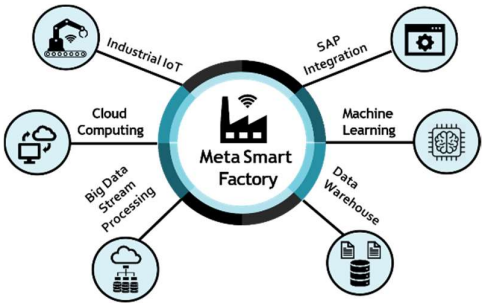

Figure 4. Functions of Smart Factory[4]

Through the dynamic integration of IoT technology in the industrial space, the concept of Industrial Internet of Things emerged. The term IIoT for many is synonymous with the term I4. According to General Electric, which introduced the term in 2012, IoT integrates machines, advanced analytics and employees into a workplace (Digital G.E., n.d.), creating a strong and impenetrable basis for companies to promote efficiency in the internal operations of the company and in its productivity. It is a way for businesses to have a clear view of the full range of their internal operations. It has also been defined as the driving force that allows close connection and communication between all objects within an industrial space (Sun et al., 2020).

It is important to note that the involvement of competent people and staff is essential for the smooth operation of a smart factory. Starting from the beginning of a Digital Transformation process in a company, competent people and scientists in the fields of data, process, and electromechanical engineering are needed (Gilchrist, 2016). However, apart from the scientists, any member who is part of the staff, since all the functions of the company have entered the process of becoming digital, should have the appropriate friction with the new technologies, in order to carry out the daily needs of a smart industrial environment (Mubarok & Arriaga, 2020). It is, however, important, not only from the point of view of the handling of digital processes, but also from the point of view of complementing human knowledge on the possibilities of digitized processes and vice versa, since for some, the digitization and automation in industrial environments, secures the workers, for them not to be replaced, but to supplement their abilities and to help them achieve the best results possible (Sun et al., 2020).

[4] https://metasmartfactory.com/products-manufacturing-execution-and-operation-software/

2.1 Supply Chain Management changes

A supply chain is "a network between a company and its suppliers to produce and distribute a specific product to the final buyer. This network includes different activities, people, entities, information and resources" (Investopedia, 2020). In short, a supply chain is every activity that takes place in a company, from the initial idea and design of a product until the selling to the customer, a process that includes many stakeholders, such as employees in each department (logistics, marketing, sales etc), manufacturers, suppliers etc. So, how can IoT technology can contribute to the whole supply chain management? A little above, the factor of end-to-end visibility was mentioned, a term that in short indicated the transparency, which facilitates every stakeholder to acquire knowledge for each phase in the product life cycle.

Thus, the term that connects the change that I4 brings to supply chain management, is Supply Chain 4.0. Following the developments in the technological field but also assisted by them, companies are able to integrate them in the way they design, produce and distribute their products and services. The trend of our time, in terms of the consumer public, is individualization and customization, a fact that companies must take seriously, since there is now such a large volume of information for the benefit of the public, something that makes the competition grow. Thus, it is vital to have a supply chain management that is fast, flexible, clustered, more precise and more efficient (McKinsey & Company, 2020b).

Supply Chain 4.0 is a term that is a consequence of the Industry 4.0 and a part of the "Smart manufacturing" process. It is smart because it integrates digital technologies at every stage of the supply chain management. The most important points of this development are the introduction of new concepts in the field of production, such as autonomy in the production elements, digitized production and the connection and exchange of data between elements of the production process (Caiado et al., 2021).

Although there is no term that accurately describes the meaning of I4, we can say that it offers horizontal, vertical and end-to-end integration and transforms businesses through knowledge management (Caiado et al., 2021). In the literature, however, it is common for IoT, Big Data, cloud Services and 3D printing to appear as the technologies needed by businesses to achieve the digitalization which is crucial to integrate an I4

mentality into their internal operations. These functions can be applied to a variety of businesses, from agriculture to transportation and energy systems, to make them more sustainable (Esmaeilian et al., 2020), a term that seems to prevail in society at large as a demand.

In the case of increasing the speed of supply chain operations, the concept of forecasting is important, something that has begun to take its first steps in the field of business. Predicting customers' needs and their next buying desire is something that is made possible through IoT and Big Data analysis and is a force for companies that are able to operate in this way, giving them a competitive advantage. However, there will be an extensive report on this trend in the next chapter.

In some cases, traditional production methods have floated to the brim and no longer meet market needs. Proper timing and interaction with the public are the demands of the market today (McKinsey & Company, 2020a). The power of information is what drives the internal change of companies, but the way they manage it to increase their productivity and profits, is what matters most.

2.2 Complementary technologies

It is important that a reference is made to technologies that, in addition to IoT technology, are used by companies or is deemed appropriate to be used, in order to achieve the change that is so desirable for work environments, in terms of improving their internal operations, but also to accomplish growth in their productivity. For some, this reference could be considered necessary, as the demand for business is change and it can only be achieved by implementing a combination of new technologies, which always include IoT.

- *Big Data analytics:* There is no specific term that defines the concept of Big Data, however the term Big Data analytics describes the field that collects, researches and analyzes the huge amount of data sets that are too large or complex, which is due to the fact that, through IoT, all objects can be smart and have the ability to produce data. As shown in Figure 5, big data are characterized by "volume, velocity and variety" (SAS, n.d.-b) and it is impossible to store and analyze them using traditional methods.

- *Cloud computing:* Cloud computing creates a new way of handling applications on the Internet and enables their design and development, as well as their control and handling (Zhou et al., 2013). It can provide many advantages for businesses, like extra storage and applications [Figure 6] and with its existence, it is possible for things to have their physical form and at the same time, their "digital twin", with a presence on the internet.
- *Artificial Intelligence:* Artificial intelligence plays a major role in the development of IoT capabilities and in fact, the two technologies have been combined in the business sector in the recent years, since with the contribution of AI technology, patterns and anomalies are recognized in those data generated by devices through IoT technology (Devinney, 2018).
- *Cyber-Physical Systems:* In an intelligent business environment, cyber-physical systems play a critical role in connecting physical objects to computers (Mantravadi & Møller, 2019). Figure 8 displays the factors that interact and at the same time connect with Cyber-Physical systems.
- *5G technology:* 5G communications enhance smart business environments, offering accelerated and improved quality of communication between IoT devices, but also improves their lifespan, offering reduced power consumption and therefore greater autonomy, without the need for human help (Singh & Sood, 2020). In Figure 9, the ways in which 5G and IoT interact are shown.
- *Blockchain technology:* In some cases in the literature, there is also the use of Blockchain technology (Bahga & Madisetti, 2016), which essentially functions as a means for the user to take advantage of a service remotely (as shown in Figure 7), but at the same time providing the element of security and trust, something that many researchers pose as a concern in the study of IoT in general.
- *Internet of Services*: It is worth noting that the contribution of the Internet of Services (IoS) to the evolution of I4 is crucial. In addition to the functions of IoT technology, which clearly focuses on things - machines and equipment used in an industrial environment - IoS tackles Service Oriented Architecture (SOA), which aims to leverage functionality within a business and reuse them for proper time management, reducing the effort from reprogramming them (Reis & Gonçalves, 2018).

Figure 5. Big Data characteristics[5]

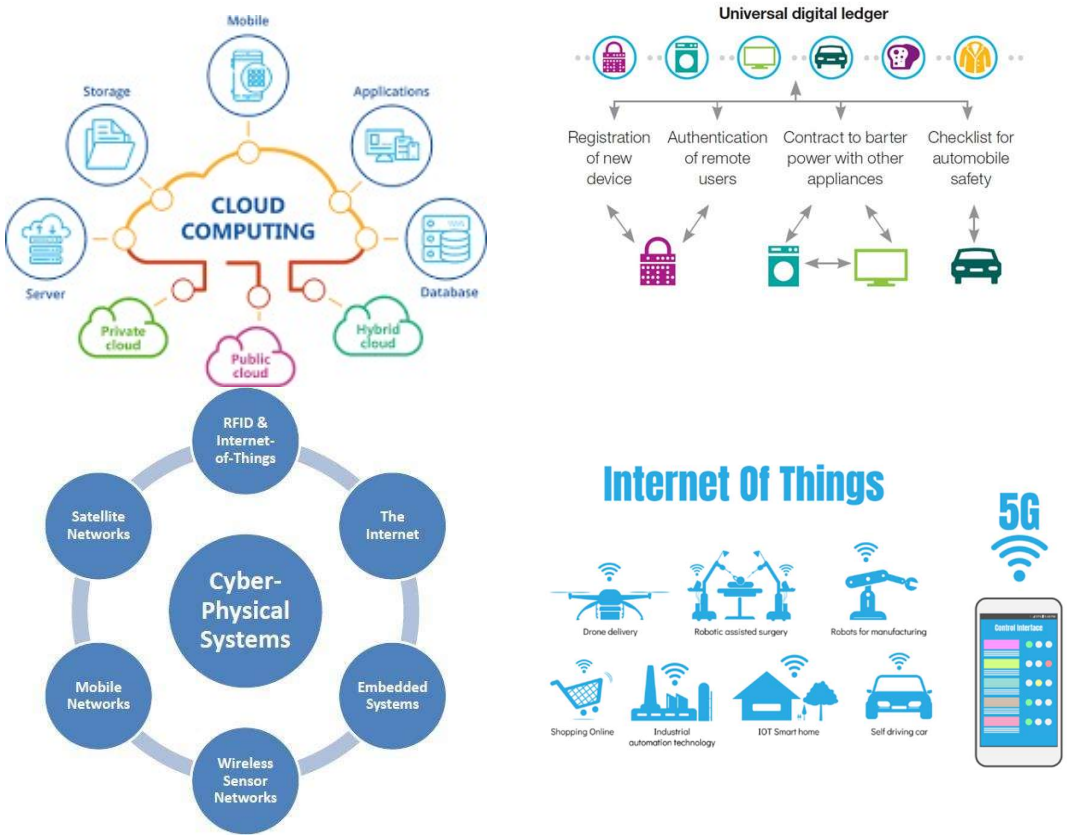

Figure 6. Cloud computing in Business[6]

Figure 7. IoT-enabled applications that emerge from Blockchain technologies[7]

Figure 8. Cyber-physical systems components[8]

Figure 9. 5G and the IoT[9]

[5] https://www.tcgdigital.com/big-data-advanced-analytics/
[6] https://medium.com/@outrightsystems/cloud-computing-in-business-ab19f308221d
[7] https://www.rs-online.com/designspark/when-the-blockchain-technology-meets-the-internet-of-things
[8] https://www.researchgate.net/figure/Large-Scale-Cyber-Physical-Systems-Components_fig1_300125823
[9] https://www.linkedin.com/pulse/5g-iot-what-do-things-really-mean-us-monique-morrow/

2.3 IoT Usage Worldwide

In the field of business, it is widely accepted that the “one size fits all” concept does not correspond to reality. A rural business, for example, cannot have the same business model as an electronics e-shop, so both of these companies could not integrate the same mode of IoT technology in their internal operation. For some, the integration of IoT involves an even deeper understanding of business goals, helping them get there easier and faster, but also redefining them (Larison, 2020). How can this be done? As mentioned in the introduction, the power of information is the main point we need to focus on. Data, and in particular, big data, are the ones that now determine the trends and provide useful information for the market, something that proves to be extremely useful for the business plan and can determine a business strategy.

More specifically and given the circumstances, with the rise of Covid-19 having changed the data in everyday life and the way millions of people work, IoT can make working from home easier, giving employees the opportunity to have access to equipment and files located in corporate facilities and offices, which in combination with the comfort of home, is able to greatly increase productivity. On the other side, in the case of working in traditional ways, in an office, and especially for the largest companies in human capital, with IoT practices it is easier for employees to be in touch and communicate more easily in a vast environment. Companies, that is, have the ability to operate more widely.

It makes sense for small and medium-sized companies to have many questions about the particular ways they can use this technology to improve intra-corporate communication. Luckily, there are notable companies that provide their IoT services to the SMEs that need them. Ringcentral, for example, is a company that distributes an IoT and cloud-based communication tool, which facilitates communication between employees in companies, while enhancing work from home. This has been described as a sample of "Smart workplace solutions" and is part of an overall effort to modernize the traditional workplace. The "smart offices" are based on a combination of various technologies and, in addition to improving internal organization, they aim to better communicate with employees, in order to achieve a positive climate that enhances productivity (Erler & Francino, 2019).

Personalization and customization is the demand of buyers in our era and the thing that makes them loyal customers in a company, as it creates this feeling of trust and intimacy, when the company shows that their needs are understood, studying the profile and their preferences and how their necessities are of real importance. The power of information, through the data provided by IoT devices, enables companies to be aware and to understand the behavior of buyers at every stage. This starts from the market research that the customers do to find the product they will choose, until the moment that they take it in their hands and use it. This process can diversify and strengthen the way a company markets its products, and even the way it designs and produces them.

According to Elizalde (2020), an IoT product should necessarily perform some key tasks to be considered valuable and those are: to use sensors to obtain data, to analyze this data, through connection with the cloud, to transfer the data, as well as to store it there, to create insights through the analysis of this data, which it then uses to make the "things" execute orders, as well as to present these insights to users. All this must be done safely at every stage of the process.

Therefore, according to these characteristics, an IoT platform must provide the specifications for these tasks to be fulfilled. IoT platforms are systems that make it easier for businesses to bring their items to the Internet, the way technology makes it possible to automate items (Software Testing, 2020).

The need to integrate IoT services has become so urgent for businesses, that large "players" in the business sector have reached the point of having developed their own platforms, which provide services to smaller companies, with ready-made solutions for the application of IoT technology. This may be related to the forecasts for the big growth in the IoT market, which estimated that by 2020, it would reach $ 1.29 trillion (Baranwal et al., 2019), something that is expected to be found in subsequent research on whether it was held. The services they offer, have to do mainly with the connectivity and the management of the networks and the devices that exist within them, as well as of course with the whole management of the data, from their acquisition to the analysis. In essence, these platforms provide the infrastructure for businesses to develop the way that is most convenient for them, to develop an integrated system that meets their operating needs, an intermediary that connects physicality with the application layer (Caiado et

al., 2021). There are four types of IoT platforms that businesses can adopt and those are:

- End-to-end
- Connectivity
- Cloud
- Data

Figure 10. *2020 Magic Quadrant for cloud Infrastructure & Platform Services*. (2020). [Graph]. Amazon Web Services (AWS).[10]

[10] https://pages.awscloud.com/GLOBAL-multi-DL-gartner-mq-cips-2020-learn.html

Some of the most well-known platforms are described below:

Amazon Web Services: AWS was named a leader by Gartner regarding cloud Infrastructure and Platform Services for 2020. In the Gartner report, the cloud Infrastructure and Platform Services are critiqued based on their ability to execute and their completeness of vision, as shown in Figure 10. Then, the services are divided into the "Niche players" and "Visionaries", the "Challengers" and the "Leaders", based on the two axes. Based on this "quadrant", AWS wins the top place. Amazon's platform offers a range of services - in addition to services such as analytics and developer tools, which most platforms have - and other products, such as Gametech, Quantum technologies and satellite services. Its IoT Core service allows you to connect billions of devices to the cloud and to each other, even if they use different protocols [Figure 11].

Microsoft Azure: The Microsoft platform offers cloud solutions that include a comprehensive package of services, including unlimited analytics service, serverless computing, security in IoT hardware and software and more, offering a total of over 200 products in the fields of IoT, Artificial Intelligence and Machine Learning, Analytics, Blockchain services, Computing, Containerized applications, Databases, Developer tools, DevOps, Management, Media, Mixed Reality, Mobile, Networking, Storage and more. It offers training on cost and workload management, while on its website it claims that AWS is 5 times more expensive for Windows Server and SQL Server. The IoT services it provides are varied, including solutions in architecture and infrastructure that will support the large number of devices, always having security as a major concern. Figure 12 shows the creation of safe buildings using IoT, with the help of Azure.

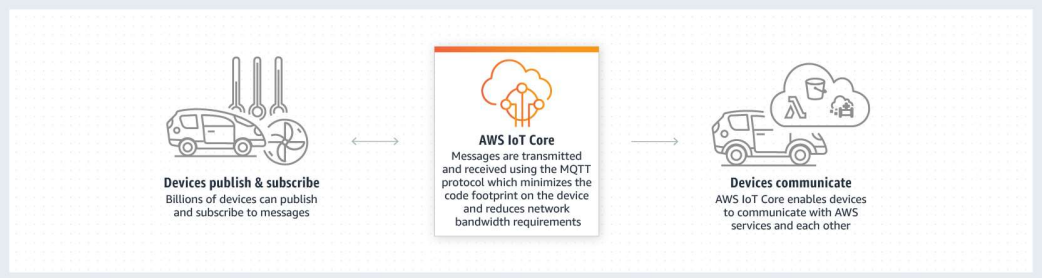

Figure 11. *The Message Broker*. (n.d.). [Illustration]. Amazon Web Services (AWS).[11]

[11] https://aws.amazon.com/iot-core/

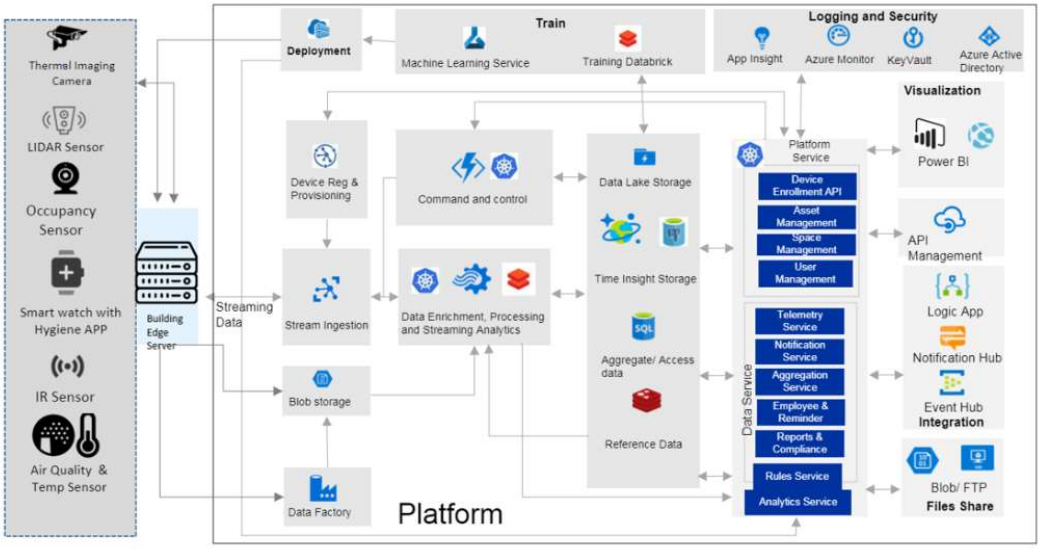

Figure 12. *Cognizant Safe Buildings with IoT and Azure*. (n.d.). [Illustration]. Microsoft.[12]

Google Cloud: The platform proposed by Google, offers a layered infrastructure, as illustrated in Figure 13, as well as intelligent monitoring and control and puts a lot of emphasis on privacy and transparency. In addition, it emphasizes the speed and reliability of its services, as well as the capabilities it offers to the user to maintain their data in a hybrid and multi-cloud environment, which creates a sense of flexibility for the user. It also offers important IoT solutions, enabling the user to collect data from any connected device and providing the user with a range of tools so that he can achieve and manage data collection and analysis in the real and the online world.

[12] https://docs.microsoft.com/en-in/azure/architecture/solution-ideas/articles/safe-buildings

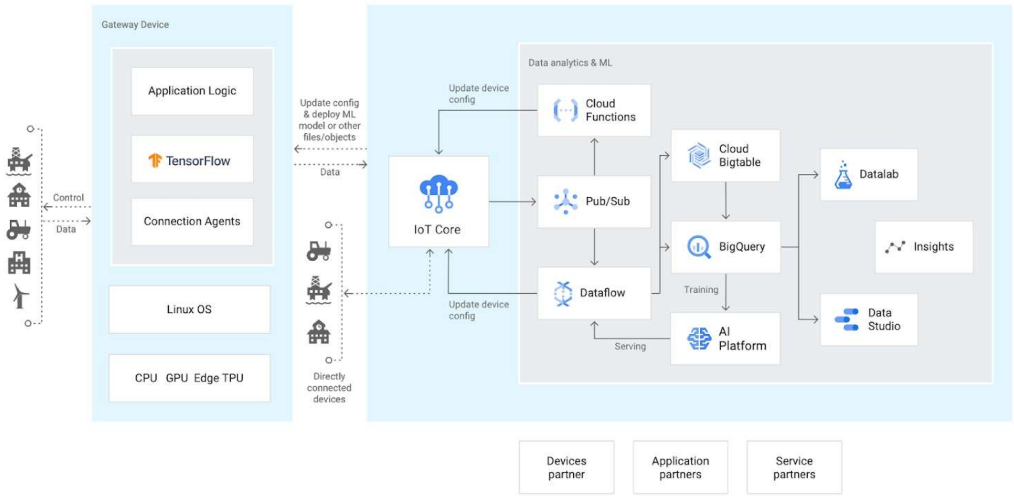

Figure 13. *Google IoT Platform*. (2019). [Illustration].[13]

Cisco: The Cisco website, narrates very interesting case studies from real cases of uses of the IoT platform offered by the company. Among them, the case of the port of Rotterdam, where the large number of serviced companies and employees, makes the storage of large volumes of information necessary on the Internet. Cisco's "Connected Factory" technology and PROFINET network architecture enable faster internet in the business environment. As shown in Figure 14, they assure the extraction of data from disparate sources and they transform them into intelligent data, with security always in mind.

[13] https://habr.com/en/post/442710

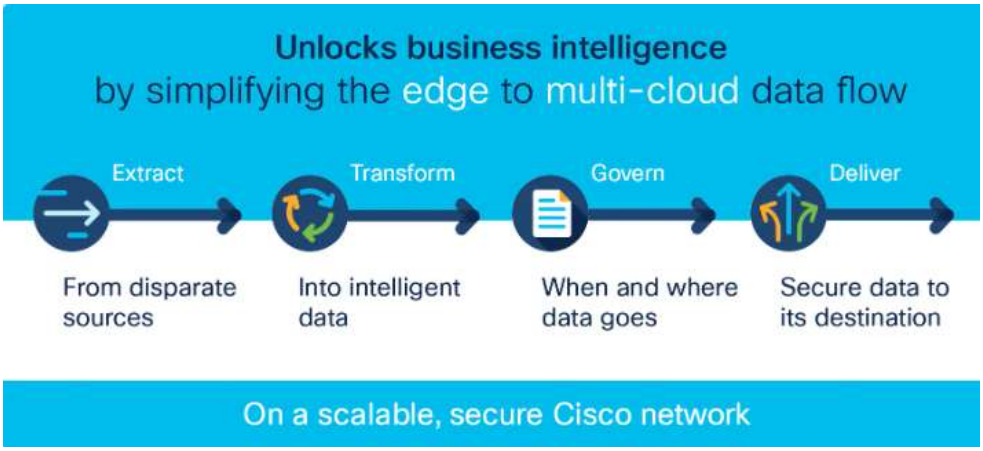

Figure 14. Cisco® Edge Intelligence. (2020). [Illustration]. Cisco.[14]

There are several studies devoted to comparing IoT platforms. Muhammed & Ucuz (2020) make a very interesting and extensive comparison in the individual points between the first of the above three IoT trading platforms, which are characterized as the "big three". The comparison focuses on points such as: ease of connectivity, communication between devices, emphasis on analytics, data visualization and security, among others. In that comparison, the "winner" was Amazon Web Services, as it is considered by users to offer a more complete package of services, while maintaining a high level of security for them.

It seems that, despite the impressive services and variety offered by some of the "big players", users seem to prefer and trust those platforms that provide them with the greatest security. An IoT architecture can provide many opportunities for a business, but it can also be fatal if the right measures are not taken. It could be posing even more risks to a company in terms of the privacy issues it is called upon to manage. Advanced technologies and digital systems favor attackers, who can easily extract information about how a company operates or its financial data, especially if they specialize in it (Zakoldaev et al., 2020). This is something that can favor the competition, or simply cause the collapse of a company, with significant economic and social impact for all its employees. The concept of security can cover many areas, so not all challenges are addressed in the same way.

[14] https://www.cisco.com/c/en/us/solutions/collateral/internet-of-things/at-a-glance-c45-743263.html

2.4 Security in IoT

In the literature, the issue of security in the field of IoT has begun to be extensively analyzed in recent years and covers all areas, from that of personal use and ordinary consumers, to the level of business and the most complex way of dealing with this issue. As the conditions for the integration of IoT into a wider range are constantly increasing, so are security concerns. The main issues related to security in an IoT environment are *privacy, authorization, access control, verification, information storage, system configuration* and *management*. These specific issues have been divided into four main categories by Alaba et al. (2017), which are, as shown in Figure 15:

- Application
- Architecture
- Communication
- Data

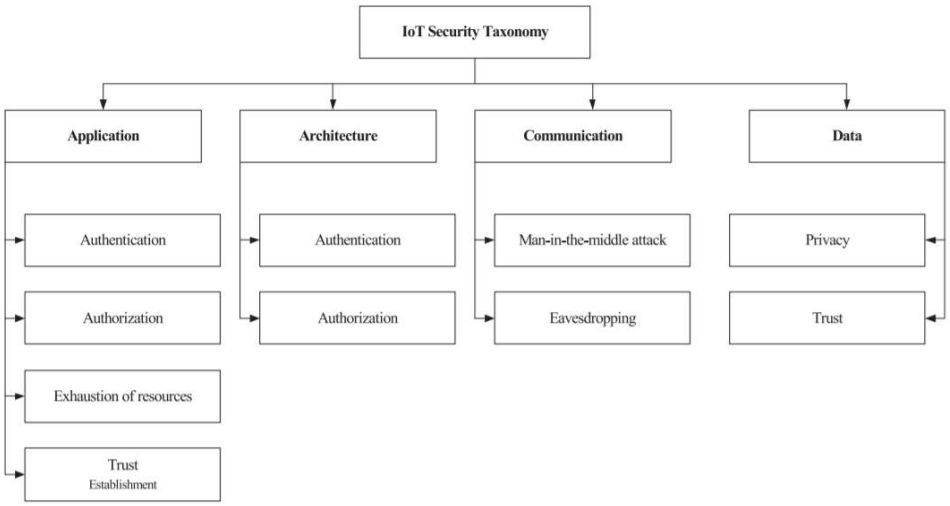

Figure 15. IoT Classification. (2017). [Graph]. [15]

[15] https://www.sciencedirect.com/science/article/abs/pii/S1084804517301455

We now provide information about the main security issues that we can encounter:

- *Authentication* in an IoT application, is the factor responsible for integrating IoT devices into an intelligent environment and includes checking the reliability of the devices before exchanging information. In IoT architecture, authentication presupposes the integration of systems that ensure trust and identity management.
- *Authorization* in an IoT application means that the data should only be available to users who are authorized to view them. In the IoT architecture, authorization is possible through the exchange of recognized data between connected devices / sensors.
- Constantly receiving information and exchanging it, makes it is easy to create overload and leaks in an IoT application. So when certain resources are overconsumed or misused or wasted, an *exhaustion of resources* is about to happen. An alternative way of depleting resources is in the case of an attack, where the continuous transmission of a large volume of packets occurs.
- *Trust establishment* is crucial for keeping users' personal information within the application server and during data exchange between devices.
- In *Man-in-the-Middle attacks*, an attacker alters the communication that takes place directly between two devices and has the ability to obtain sensitive information related to the user or business. It is therefore vital that this threat is eliminated, in order to ensure the integrity of the information.
- *Eavesdropping* "occurs on the network layer of IoT" and is performed using cryptography, by decrypting what is heard or read during information exchange between two parties.
- Keeping user *data* protected is one of the most basic criteria for businesses and is directly linked to the *trust* factor.

According to Alaba et al. (2017) there are significant differences between the issues that an IoT network has to face as opposed to other wireless networks or any conventional network, as the former are developed on Low-power and Lossy Networks (LLN).

A different categorization of the risks that a company is required to face in terms of breach of its security, has been made in the work of Grabowska (2020), where the risks are divided into:

- Low-level security issues
- Intermediate-level security issues
- High-level security issues

Low-level security issues have been considered by the authors, based on a study of research conducted in literature, to be *jamming adversaries, insecure initialization, low-level Sybil and spoofing attacks, insecure physical interface and sleep deprivation attack.*

Intermediate-level security issues are *replay or duplication attacks due to fragmentation, insecure neighbor discovery, buffer reservation attack, RPL routing attacks, sinkhole and wormhole attacks, Sybil attacks on intermediate layers, authentication and secure communication, transport level end-to-end security, session establishment and resumption, privacy violation on Cloud-based IoT.*

High-level security issues are considered by the authors to be *Constrained Application Protocol security with internet, insecure interfaces, insecure Software/firmware, and middleware security.*

The previously mentioned threats can affect both the physical and hardware layer, but also the link and network layer. There is no one-size-fits-all solution to every problem, but individualized solutions to each issue have been studied separately in the literature, which will not be further analyzed in this research in a technical way.

The bottom line is that the risks involved in the use of IoT technology are many and every additional opportunity given to companies through it, must have predicted what could go wrong in order to prevent it in the future.

The European Union Agency for Cybersecurity (ENISA) published a survey in 2019 on good practices for IoT security, to analyze the prevailing concerns, but also to explore the most prevalent solutions to maintain the cybersecurity at high levels. Emphasis was placed on Software Development Life Cycle (SDLC) and how to develop applications in a secure manner and on the ongoing monitoring of each phase of the production process, such as security vulnerabilities, secure deployment etc. The phases of SDLC are shown in detail as suggested by ENISA, in Figure 16.

Figure 16. SDLC phases. (2019). [Illustration].[16]

Then, insights are provided by security experts, which result in a concentration of the potential risks that threaten the IoT in the SDLC process and from that point on, the ways to deal with and predict them are defined.

Quality assurance is a basic prerequisite for the requirements of an IoT technology in SDLC, but even more important is the hardware to cover basic security issues. Therefore, the prevailing rationale is that security should not come after the design process, but it should be one of the first steps to be taken. Thus, some of the steps that are considered necessary in the early stages of software design, are policies related to user password change, business recovery plan and other tactics that ensure the smooth operation of software, without excluding the involvement of third parties to ensure the standards regarding the required safety.

Following the research, the *STRIDE* model (*Spoofing, Tampering, Information Disclosure, Repudiation, Denial of Service and Elevation of Privilege*) is recommended, which is a

[16] https://www.enisa.europa.eu/publications/good-practices-for-security-of-iot-1

model that serves as a way of detection and ranking of threats. Based on the study's taxonomy regarding assets that can be useful in the environments focusing on software development, the main categories are: *data*, including big data, back up data, operation data, test data and more, the *human factor*, which includes the security team, administrators, end-users, decision-makers etc., *maintenance*, such as updates, monitoring tools, documentation and data loss prevention, *software design*, which has requirements, specifications and design tools and *software deployment*, with features such as automation testing frameworks, deployment strategies, embedded systems and cloud services. Moreover, assets are the software development, with underlying components, guidelines and development tools, the software components, having as strong points the Code, APIs, communication protocols, algorithms, database management systems and more and finally, the SDLC infrastructure, which has to offer physical assets, support services, development environment and networks, testing environment and networks and integration environment and networks.

The threat taxonomy of the study mainly focuses on threats that have to do with the *personnel* involvement, with issues having to do with *outages,* with *unintentional or accidental damages, physical attack, legal threats, failures or malfunctions, nefarious activity or abuse* and *damage or loss.*

3 Case Studies Worldwide

For the sake of this Chapter, several papers and case studies were studied and will be analyzed, in an effort to understand the use of IoT in important business areas. As mentioned above, "one size does *not* fit all", therefore cases from specific industries will be studied in detail, along with relevant pieces of literature that have been written, in order to understand how companies worldwide have integrated IoT in their operation and differences between various industries in how they apply and operate them.

3.1 IoT in the Agriculture industry

The field of agriculture is one of the sectors worth studying in relation to IoT, as it has existed for years and its functions have already been radically differentiated with the participation of technology. It is an example of how technology can automate operations within a business and, to a lesser extent, how it can facilitate the operations of a manual job. It is, moreover, a sector that is directly related to the country's economy, but also affects people's daily lives, as it also affects one of the basic needs for livelihood, which is food.

An example of IoT technology application in the field is the “agriculture greenhouse production environment measurement and control system” (Zhao et al., 2010), which is a method of measuring important parameters regarding the agricultural process, such as temperature, the humidity of soil and the conditions in a greenhouse in general. Through this method, data is collected in real time, using the help of specific technologies such as Radio Frequency, Short Messaging Service, Wireless Application Protocol pattern and the Web. Thus, with the data obtained in real time, the production space can be controlled at the same time. The structure of the system consists of a terminal link, a business link and a Machine-to-Machine support platform.

Sushanth & Sujatha (2018) add one more factor that increases the importance of the involvement of IoT in agricultural systems and this is the factor of security, especially in terms of production in unrestricted areas (e.g., fields). Incidents that could affect the crop and have to do with safety, range from the "attack" of insects or even small animals on the crops, to the robbery of crops by thieves. For these reasons, the authors of the

study developed a proposed model, which includes a robot, capable of ensuring the smooth and unimpeded flow of crops in the fields. This robot is remotely controlled and has sensors and devices connected, such as camera, a sensor that detects obstacles, a siren, but it also has practical properties that are useful in harvesting, such as cutting and spraying. Particularly important is the built-in GPS function of this robot, which allows it to move autonomously within the limits of the crop. Regarding security a. from insects and animals, the robot can prevent the former through the ability of spraying and the latter by scaring them, mimicking the properties of the scarecrow and b. by would-be thieves, the warehouse, which is part of the smart system, will also be equipped with motion sensors - among other things - which can detect and therefore prevent robbery.

The importance of having a WSN (Wireless Sensor Network) system in the fields is emphasized by Muangprathub et al. (2019), in order to always connect and provide data to farmers . The research shows that IoT can help farmers save time from measurements, so that they can use it in other jobs that can increase their income. Thus, a system was developed by the authors of the article, measuring important parameters for the maintenance of a field, which is managed through an application on a smartphone. The system can provide important services to farmers, such as the ability to instantly irrigate their crops and its architecture consists of three layers: 1. The environmental data acquisition layer, which collects data through sensors 2. The layer which has the role of data collection within a server and 3. The application layer, which is the stage where the collection and proper analysis of data serves to manage the fields. The exact way that these layers work is shown in detail in Figure 17.

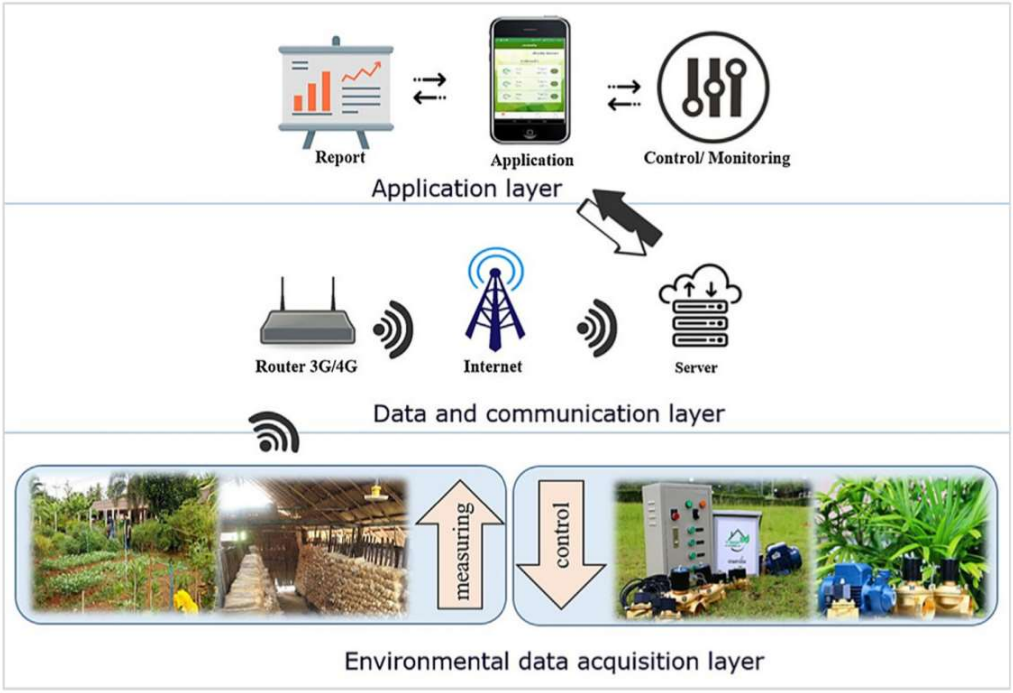

Figure 17. Muangprathub et al. (2019). *The architecture of the control system.* [Illustration].

But beyond the research level, we can find a significant number of companies that have integrated IoT into their daily lives and are now characterized by the term *AgTech*, which describes "products and/or services which contain or are enabled by patented technology into the agriculture value chain" (United States Studies Centre [USSC], 2018).

CropX is a company that deals with optimizing and automizing farm management, by integrating data (Cropx Technologies, n.d.). The company dedicates great importance to water saving and sustainability, which it fulfills by collecting data regarding the condition of the soil and how much it needs to be irrigated. In this way, it helps to make more accurate predictions to minimize waste cases. These data are communicated to farmers through an application, along with measurements on how much the seedlings are expected to grow and therefore their needs, field segments that may be problematic and need more attention, weather forecast depending on soil needs and more. The application offers the ability to connect all the fields that one can have, to monitor them at the same time. From a technological point of view, the application and the website operate by collecting and transmitting data directly to the cloud, using low-power wide-area network protocol, satellite, and cellular connectivity.

Similar services are offered by the company Farmobile (Farmobile, 2020), which focuses on the data and enables the farmers who create their Farmobile account, to analyze the data that are collected, but it can also train them on how they can peak the possibilities that their website provides, depending on the areas they have.

The start-up company Amber (Amber Agriculture, Inc., n.d.), offers an innovative technology, which uses small wireless sensors and IoT, in order to manage the crops that are stored for a long time. It enables farmers to know the condition of their grains, their humidity or temperature levels and other useful information to decide whether they are suitable for sale and distribution.

3.2 IoT in the Banking industry

The banking sector is one of those called upon to manage sensitive data and data which is always plentiful. The issue of data management is therefore very important, as banking enterprises are called upon to make decisions immediately and quickly, based on this data. If we consider, how much more, the progress and development that has taken place in the last decade in the banking sector, with the strong involvement of e-banking and mobile banking systems, services that are now requested by customers of all banks for convenience, the volume of data is growing, but also makes imperative the strong presence of security solutions. As shown in Figure 18, the sources that produce data for banking organizations are now numerous and this makes the need for control imperative. That is why in the banking sector, an average of 0.4% of revenue is now dedicated to IoT (Lande et al., 2018).

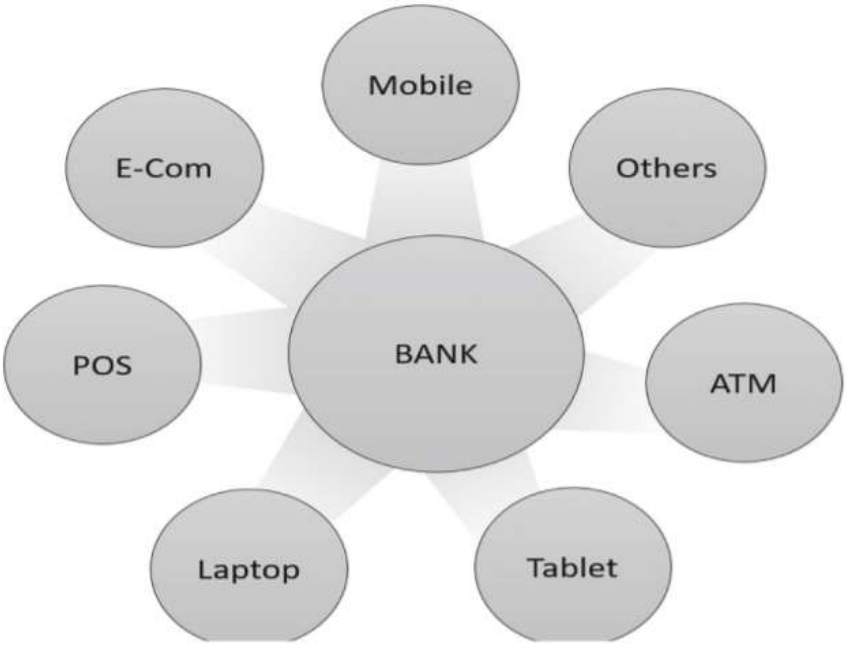

Figure 18. Boumlik & Bahaj (2017). *Different source of data for financial institutions*. [Illustration].

The concept of IoT, therefore, and according to what has been mentioned above in the present study, comes to "be buckled" on the needs of the banking sector. As mentioned by Boumlik & Bahaj (2017), IoT enables banks to offer their customers all the new technologies (e.g. Smart ATM, NFC, tokenization) and new payment methods (e.g. contactless), so that they can take advantage of trends and increase their revenue.

There has been a lot of research on the issue of interception and fraud in the banking system, which in most studies deals mainly with simplified security measures that in some cases do not include new technologies.

In the research of Khanboubi et al. (2019), even more factors are added for consideration, since according to the authors, there are 7 main digital trends that use IoT and directly affect the banking space and they are: mobile banking, M- banking, crowd-based financing, virtual money, high frequency trading firm, cyber criminality, big data and IT analytics.

What these terms mean and how they are used will be summarized below:

- *Mobile banking:* The ability of the user to access his bank account from any digital interface and to be informed in real time about the status of his account.

- *M-banking:* The M-banking concept embraces the idea that all objects can potentially make automatic payments. Hence the example of the *wallet of things*, which is essentially a way of saving money and making payments, without the need for a bank account.
- *Crowd-based financing:* As the term explains, crowd-based financing is the raising of money for a specific purpose by a number of people through the internet. Well-known platforms and websites that use this payment method are Kickstarter, Indiegogo, Patreon, gofundme and more.
- *Virtual money:* The term virtual money corresponds to Blockchain technology. By using Blockchain technology, which was mentioned in the previous chapter, IoT platforms are able to provide greater security and ease of use for the user, as it stores user transaction information, applies strict user identification rules and makes payments particularly fast.
- *High-frequency trading firm:* The term virtual money corresponds to Blockchain technology. Using Blockchain technology, mentioned in the previous chapter, IoT platforms are able to provide greater security and ease of use for the user, as it stores user transaction information, uses strict user identification rules and makes payments particularly fast.
- *Cyber-criminality:* The issue of security has been extensively discussed above. Specifically, however, in the banking sector, the significant use of biometrics is added, so that authentication and validation can be even more indisputable in payment procedures.
- *Big-data and IT analytics:* These two parameters are the ones that make it possible for the user to control every banking activity and to be able to have a picture of his activities.

These digital trends, then, influence and are influenced by the Internet of Things, which is why they have been studied more and more in connection with them in recent years. According to Lande et al. (2018), there are two main points that directly affect IoT and which give banks opportunities to grow:

- Utilization of data resulting from the use of sensors, for a better understanding of customer habits

- Collaborating with companies that manufacture or distribute sensors to provide payment services for those transactions made by devices.

Following, some examples of companies that deal with the banking sector and take full advantage of what IoT can offer them will be analyzed.

- *Dynamics Inc.*

  Dynamics is a company that makes payment cards, which as the company itself says are "a computer-in-a-card" (Dynamics Inc., n.d.). The Dynamics wallet cards are battery operated and provide a gateway to communication between customers and banks, which is why they have been funded by many banks and maintain a partnership with them. One of the services they offer, in addition, is that they send direct notifications to the banks about the details of the payments made.

- *Armis*

  Armis is an agentless company that comes to solve the issue of security, offering IoT security to various companies, including those in the banking sector (Armis, 2020). They work by giving companies the ability to see all the devices connected to their network, automatically recognizing the connected ones, and disconnecting the devices that are unmanaged. Their mission, as they claim in their website, is “to enable enterprises to adopt new connected devices without fear of compromise by cyber-attack”.

- *Kontakt.io*

  Kontakt.io is a company that advertises as a "leader in location IoT" (Kontakt.Io, 2020). In practice, this means trying to simplify the provision of location-related data to companies. The company develops Bluetooth beacons (small wireless sensors that can be attached anywhere) which can be used for mobile payments and more. The solutions proposed by the company combine software, hardware and cloud options and its main purpose is "to automate manual processes" and "digitize physical order traceability".

- *Stripe*

San Francisco-based Stripe aims to provide a secure payment infrastructure to all types of businesses by providing software to manage them online, in the cloud (Stripe, n.d.). In practice, it provides companies of all sizes with what they need to make and receive payments, while helping them avoid fraud, send invoices, manage corporate expenses and more.

3.3 IoT in the construction industry

Construction sites are considered to be saturated sectors, mainly in terms of staff and people surrounding it (Woodhead et al., 2018), since its processes had remained in a stagnant phase and had not evolved for a long time, being attached to outdated methods (Ghosh et al., 2020). It is an area that has evolved a lot during the last century and the values that were consolidated at that time may not have been easy to shake. That is why this is not a business sector that has welcomed IoT so warmly and project managers and investors still have doubts about their effectiveness in their work. Nevertheless, progress has already been made in this area and several cases in which the implementation of IoT has significantly improved construction work.

There are some key points where the construction sector is lagging, and these may be the ones that are slowing down (Digiteum, 2020). The main issues facing the construction sector are:

- Lack of staff, as most workers are older and about to retire
- The delivery of the projects on time and within the framework of the initially defined budget
- The control of the works and the evaluation of the teams
- Security issues
- Waste management issues
- Outdated technology

But how can IoT contribute to the development of the sector and to the solution of its problems?

Figure 19. IoT Smart Building Give and Take[17]

First, IoT has the important property of tracking, something that the construction site seems to need. With the help of IoT, companies can monitor the progress of their employees and the progress of their work, collecting data in real time and having control and knowledge of what can change the way work is done. In the same way, excessive wastage of materials can be avoided. By reporting waste data during each task, managers can make predictions and better estimates for the next task. The factor of human error is thus significantly reduced. The issue of security can be controlled through IoT and wearable technology. Accidents can be avoided by workers wearing special helmets or vests that have sensors and control their movements or vital signs. Figure 19 displays every aspect in which IoT could transform the manufacturing process.

For the above reasons and not only, IoT is estimated to greatly affect the financial part of the construction sector, resulting in a 22% - 29% savings of the total cost of work (Ghosh et al., 2020). There are, however, significant examples of companies that either take advantage of the benefits that IoT can offer them to improve their operations, or have developed the IoT solutions themselves in order to implement IoT solutions to solve day-to-day issues. Some of these companies are:

- Blackberry Radar

Blackberry Radar provides a monitoring and tracking solution for companies, operating with wireless sensors that can detect the exact location of their assets (Blackberry, n.d.).

[17] https://www.smart-industry.net/iot-smart-building-the-future-of-construction-catching-up/

Specifically, it can be track trailers, chassis and flatbeds, intermodal containers, equipment, and railcars. It offers construction companies a practical solution to have control over the transport of their materials and equipment, with devices that are easy to install and maintain, as well as help maximize ROI. It offers companies useful details through its online portal, through which managers can see information such as asset load status, accurate GPS location, dwell, and detention time and more.

- Vibralign

According to Acoem Fixturlaser (n.d.), almost half of all machine breakdowns happen because of misalignment. Vibralign is a company that deals with precision maintenance equipment (VibrAlign, 2019). They use 3D animation in combination with Fixturlaser's technology, which focuses on

- Hyundai AAVM

Hyundai's AAVM (All Around View Monitoring) is a video camera system that is able to observe a machine from all its angles during work (Hyundai Construction Equipment Americas, Inc., 2019). This system is available for excavators and Wheel loaders from the same manufacturer and gives a significant advantage to these machines, as it greatly adds to the safety factor, as the machines can be monitored during the work and accidents are completely avoided. Part of the system is IMOD (Intelligent Moving Object Detection), which, as the term says, detects obstacles - whether people or objects - and notifies the operator of the machine.

- Remote Eye

Remote Eye is a solution for engineers to supervise the work of workers during work and give their advice if needed (Remote Eye, n.d.). It works with an application via mobile, tablet or via wearable technology and specifically, smart glasses. The streaming that takes place, is done through a secure platform and is encrypted so that there are no interceptions and leaks. The whole system can be integrated with the backend system used by the customer, enabling IoT and Big Data analysis.

3.4 IoT in e-commerce

The e-commerce sector is one that is gaining more and more power every year and continues to be very profitable. Especially in 2020, when people stayed at home for a long

time, traditional commerce declined, while online had a 146% increase in online orders (Wertz, 2020). But what is the connection between e-commerce and IoT?

As mentioned in the first chapter, the presence of IoT in the companies that have to do with the commerce, has radically changed the Supply Chain management. Through sensors and RFID tags, companies are able to track the entire journey of a product, which of course facilitates the company, by helping to improve the way and time of delivery of orders, but also the customers, so that they know exactly when they will receive their order, which makes them more satisfied with the company and the possibility to choose it again for their purchases, more likely. It can also help companies identify errors and failures in the course of a merchandise and prevent it from reaching its final destination, the customer.

Respectively, Inventory Management is affected, i.e., the whole process that a company does to control its goods during its purchase, construction, storage, and use. Information about the condition of products in a warehouse, for example, is much more easily accessible when transmitted through sensors, which saves time and manpower for companies, while for customers, it is useful when checking the actual availability of the products they are interested in. The term Warehouse IoT was created to explain exactly this process of IoT involvement in warehouses, which serves to always provide companies with precise control of their goods (Nichols, 2019).

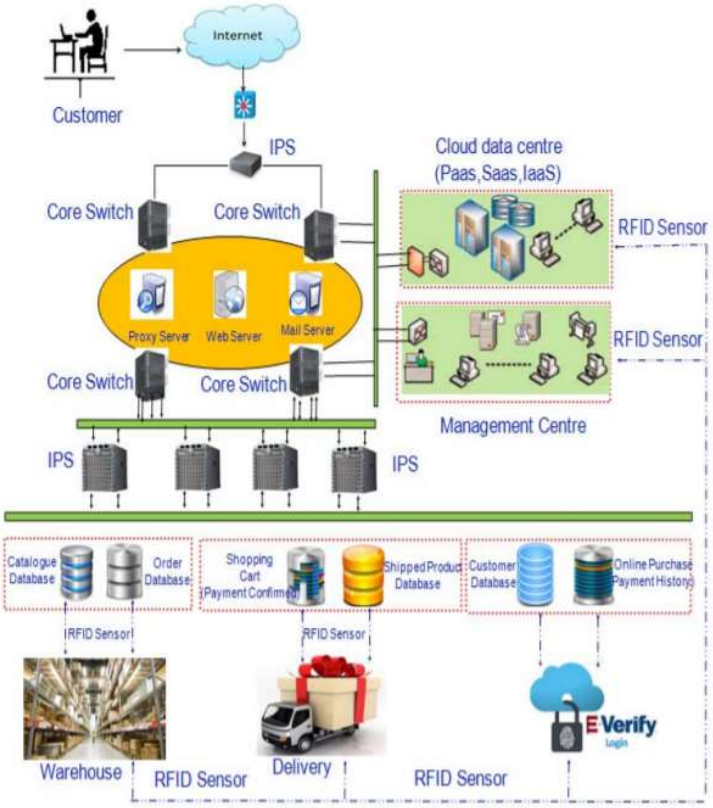

Figure 20. Singh & Singh. (2015). *Reference IoT Architecture for E-commerce.* [Illustration].

Singh & Singh (2015) propose an e-Commerce architecture that includes the strong role and involvement of IoT. As shown in Figure 20, the parameters that make up this model are Warehouse, Management Center, Cloud Data Center, Catalog Database, Order Database, Shopping Cart database, Shipped Product database, Customer database and Online Purchase database. Each domain connects to the other, starting with customer requests, which go through the management center and the Cloud Data center, to reach the Warehouse, which connects to the Catalog database, Order database, Management center and Cloud data center through RFID sensors.

Moreover, a particularly strong parameter for the adoption of IoT in e-commerce, is the factor of personalization, especially in terms of the suggestions made to customers regarding their next order. An example could be this: through smartphones, social media users follow certain pages that interest them, like or look for a specific type of post, which can also be linked to a specific type of product. Thus, data is collected that can form a specific profile for them and lead them to product ads that meet this purchasing profile.

However, in the most specific issues of e-commerce, IoT is called upon to provide solutions and contribute to the smooth flow of processes. A special case of E-commerce is that of fresh products (Ruan & Shi, 2016), as obviously the question arises of maintaining their freshness in the process of delivery to the customer. RFID sensors can be used to control the temperature of the boxes carrying fresh products, as well as to check their general condition, so that they go to the customer in good condition.

Another reason that makes the use of IoT imperative in e-commerce, is serving customers with disabilities. On the one hand, the possibility of online shopping is a great help to people with disabilities, as the process is done from the safe environment of their home and does not require any movement. There are, however, different types of disabilities besides those that affect movement: the sensory disability, which involves hearing and vision disabilities, the motor disability, which refers to the partial or total disability of body parts, and the cognitive disability, which has to do with difficulties in mental tasks. Sohaib et al. (2017) develop a service model for people with disabilities in online shopping, where people can use speech recognition to create their shopping lists with the help of RFID readers, but also to make their payments also via RFID chips on their smart devices or their credit cards. Such a feature in E-commerce companies, would greatly facilitate people with disabilities and would give an advantage to the companies that own it, expanding their buying public.

One of the most typical examples of IoT application in e-commerce is that of Amazon and their service, Amazon Pay (Amazon Pay Blog, n.d.). This service helps consumers to make their shopping experience completely personalized, but also makes it very easy to update the status of the order that has been placed at any time. It provides the convenience of payment service, in a similar way to PayPal (that is, payment to third party websites with security and reliability), and can be combined with Alexa, Amazon's virtual assistant, which can accept voice instructions during checkout. According to the company on its website, for small and medium-sized enterprises the service can bring significant benefits, such as "optimization of checkouts", "increase of conversions" and give a promotion to how smaller enterprises handle innovation, something that will improve their image and possibly bring more customers who will be tempted by the convenience of new technologies and ways of service during payment and more.

Regarding the delivery of orders, whether they are inbound or outbound, the company Tive, through a cloud-based software and special trackers, offers full visibility in the course of orders during transport, for parameters such as location, temperature and condition of the goods, analyzing this data at the same time and providing companies with detailed reports so that they can improve their supply chain (Tive, 2020).

Magento is a well-known e-commerce platform that many companies prefer. Through the platform, the collaborating companies can aim at customized advertising, identifying the shopping patterns through the insights that are collected and related to the trends on social media (Magento, 2019). Therefore, using this facility provided by the platform, they can do more targeted targeting to their customers, turning even one-time buyers into loyal customers. It also facilitates the detection of failures before they reach the customer, so that businesses are prepared to deal with them and provide a smooth customer service.

3.5 IoT in the Engineering industry

In the first chapter, reference was made to the Industrial Internet of Things, a term that describes the even more targeted use of IoT in the field of Manufacturing, but also to the term Industry 4.0, which essentially refers to the same thing. As mentioned, the introduction of IoT in the construction industry is considered by many in the literature as the fourth industrial revolution and an event that came to change the way things work radically. The evolution of IoT and their presence in a factory, significantly changes and improves the processes during the life cycle of a product (Cedeno et al., 2018). Thus, the term "Smart Factory" is created, which indicates an environment that has integrated IoT in its functions (Grabowska, 2020).

The advantages of the involvement of IoT in the construction sector were briefly mentioned in the previous chapter, but it is important to emphasize them again, so that the examples that will follow from their application to real companies will be realized. For Shrouf et al., (2014), the characteristics of a smart factory are:

- Mass customization, a feature that takes mass production one step further, as the focus is on the needs of the consumer
- Flexibility, ie production that takes into account various parameters

• Factory visibility and optimized decision-making, e.g., transparency, which in itself helps in better decision making

• New planning methods, which means the “use of abstract planning procedures based on digital models with a stronger parallelization considering the planning of mechanical and electronic systems”

• Creating values from big data, ie the exploitation of the large volume of information coming from the smart devices with the analysis, in order to identify possible patterns or anything else that can be helpful for the better flow of the processes and for the understanding of the habits of buyers

• Creating new services, mainly in terms of customers and their entire shopping experience

• Remote monitoring, which as mentioned above, can save time and money, but also provide greater accuracy and reduce errors during production processes

• Automation and changed role of man, since the former makes the need for manual work much smaller. An example is shown in Figure 21.

• Proactive maintenance, i.e., the forecasting of needs based on a study of data, a fact that can prevent unpleasant surprises. In Figure 21, for example, an end-to-end IoT solutions performance testing is displayed.

• Connected Supply Chain, which is also related to factory visibility, since all the processes inside the factory are known and so employees can have a complete picture of each stage in production

• Energy management, which requires knowledge of energy consumption levels within the plant

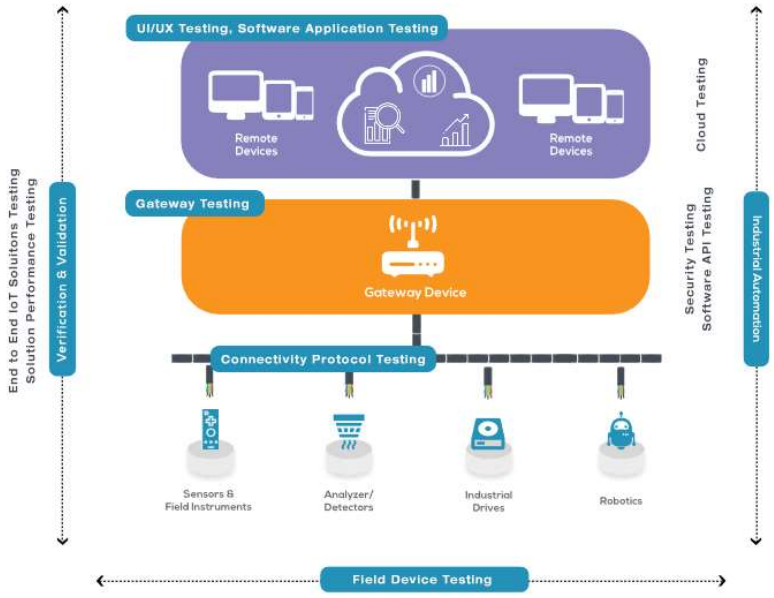

Figure 21. End to End IoT Solutions Testing[18]

Next, some companies that provide IoT services targeted at the construction sector will be listed.

- Augury

  The company Augury provides its services to construction companies, which mainly focus on tracking production machines and their condition, combining IoT and Artificial Intelligence (Augury, 2020). According to the company, they help companies "align their maintenance, operations and reliability team", while reducing the chances of failures in the production process through forecasting - proactive maintenance.

- Axoom

  Axoom is a German company that provides software companies with a software and a cloud platform. Essentially, it offers consulting to medium-sized construction

[18] https://www.protocoltestlab.com/smart-factories/

companies, giving personalized solutions according to the needs of each company, aiming at a complete Digital Transformation in each case (IoT ONE, n.d.).

- Alluvium

In a similar way, Alluvium supports construction companies in a digital direction, providing them with a cloud platform that, while at the same time introducing the term digital into the construction space, focuses on human resources and security. In short, what this provider offers is a way of providing enhanced employee oversight through digital insights, which are acquired by connecting factories with IoT and Artificial Intelligence (Alluvium, 2020). Of course, manual workers, having this knowledge, feel more secure during their work and therefore, their productivity increases. The technology used includes cloud-based inventory systems and GPS, which can provide real-time data.

- Machinemetrics

This company provides its services in various business sectors and among them in the construction sector. As it states on its website, even today many construction companies work by checking and analyzing their work manually, which is a vulnerability, as the data concerning such a large volume of machines most likely do not correspond to reality and certainly this process is time consuming and tedious for employees (MachineMetrics, n.d.). Machinemetrics offers a gadget that connects to any machine via the Ethernet port of the control and from there draws data in real time, transmitting it directly to a cloud platform.

3.6 IoT in the food industry

As mentioned in subsection 2.4., the case of food is a special case in terms of its life cycle as a product and it is particularly difficult to maintain its condition during movement, until the final stage in the supply chain, which is delivery. of the customer. We could say that perhaps food items are the most "unpredictable" marketable product, but also the one that needs the most controls to meet the standards set by law (Verdouw et al., 2016). Particularly noteworthy, however, is the way in which small and medium-sized enterprises cooperate with multinationals, i.e., the way in which the network of this sector is structured.

The particularity of food as a marketable product, makes it want special attention during its management and movement during the various stages of its life cycle as a product. The main issues that need constant monitoring and attention in the food business sector, is its maintenance and preservation for a certain period of time, depending on the type, its safety, as certain foods can even become dangerous to human life. , if they have not been taken into account and are not in line with certain standards, but also an issue that mainly concerns consumers, which is transparency about the details of a product's life, from the beginning of its life and its place of origin, up to the stages it has gone through to reach the hands of the consumer. In addition, with the help of IoT, products can be more easily detectable during transport, to determine if they are stored under appropriate conditions (IoT Times, 2019). The sensors and RFID tags can be found on their labels and packaging.

By implementing IoT, some companies have found a way to answer these questions.

- CogniPro link

  This service is owned by Sealed Air, which provides packaging services. CogniPro link is a cloud-based technology, which connects with the equipment of the product packaging and draws data from them (Sealed Air UK, n.d.). This can predict failures in the production process but also find solutions to problems, the moment they arise, avoiding financial losses for companies.

- Domino’s Pizza

  The stores of the well-known restaurant chain Domino’s pizza use IoT to reduce food waste and increase the safety of their ingredients, in order to avoid unpleasant situations (Silver, 2017). The company also provides the tracking of orders for the customers, using IoT, informing them during each stage of their order, as shown in Figure 22.

Figure 22. Domino's and IoT: Reinventing the Pizza Story[19]

3.7 IoT in the hospitality and tourism industry

According to some, the tourism industry has the reins in the use of IoT in its operations (Car et al., 2019). In this area, certain parameters are "used" that are also used for the use of IoT, smart devices, in homes and in the daily life of people, something that does not apply to other business areas. Does this mean that a hotel, for example, can have the same evolution as a home that is transformed into a smart home with the help of the appropriate smart devices?

Initially, "smart" tourism, as the term derives from the introduction of new technologies in this field, consists of an alloy of IoT application, Artificial Intelligence, Cloud computing technology and other technologies that are also applied - perhaps and in the same way - in industrial and administrative design. The factor that stands out here, in terms of the use of these technologies, is that of the personalization of services that can give a travel experience to consumers. According to Mimos Berhad (2014), the main points to focus on in terms of the use of IoT in tourism are, among others:

- The use of data derived from location technologies, something that can give travelers a sense of security, but also the ability to better plan their travel time, having the opportunity to have more and more accurate data on locations, distances, etc. This clearly benefits travel agents to create personalized packages and activities.
- The facility provided by IoT to travelers during their stay at the airport. This can mean that travelers can receive information about airplane arrivals or boarding gates, or how their travel documents are boarded / checked, which can save time. and reduce travel inconvenience.

[19] https://webstorytelling.org/index.php/2017/05/14/dominos-and-iot-reinventing-the-pizza-story/

• As a commercial product, travel services can be promoted in a more targeted and personalized way to travelers, whether through location-based services or through preferences based on data from previous travel experiences or through data derived from social media.

The concept of the “smart hotel” is also emerging in which the adoption of technologies similar to those of the smart home has begun to be utilized in the hospitality areas. Smart devices, automated actions and personalized rooms have begun to make their appearance dynamically in the field of hospitality. The recent "connected room" project in Hilton and Marriott hotels, creates an environment where your hotel room can meet your needs (Ting, 2017). However, it has to do not only with the addition of smart devices in the rooms, but also with the reduction of human resources (Kim et al., 2020). In addition to the voice assistants Google or Amazon that these rooms may have, money has begun to be made available for technologies specifically developed for smart hotel rooms, such as IoT-based lighting solutions tailored to the needs of guests and saves money on hotels (Amer & Alqhtani, 2019).

There is also a lot of research in the literature that has dealt with the development of models for the operation of the smart hotel and deals with many individual practical issues that can totally transform the experience of a visitor. Amer & Alqhtani (2019) have developed a model for room access to guests' friends and family and an IoT-based wake-up service. The work of Stepan et al. (2018) states that the way to have the personification in the smart rooms of a hotel presupposes the presence of a smartphone in each of them, something that however cannot always happen as some guests may not have a smartphone. In addition, it describes a scenario in which guest data is already stored in the hotel system prior to arrival (via the hotel website) and remains stored for their next visit. Check-in is automatic to avoid time-consuming and face-to-face procedures.

In reality, however, and so far, the following examples have been applied by and in some hotels, which are typical cases of IoT technology for the service of guests:

- Alibaba’s FlyZoo Hotel

  The FlyZoo Hotel, a product of the e-commerce company Alibaba, combines the technologies of IoT and Artificial Intelligence to offer the visitor a completely personalized experience (Brennan, 2019). It has a series of automated procedures for

guests, such as check-in or opening the door with face scanning and the exclusive use of an application, without the need for the service of an employee.

- Oaky

Oaky is a platform that provides hosting sites with the ability to increase their revenue, helping them segment and send personalized offers to their customers, especially in terms of upselling services. It works by connecting directly to the hotel's Property Management System and automatically receiving information about the details of booked guests (Oaky, n.d.). The platform then takes over the jurisdiction through the hotel to send personalized emails to visitors, through which they can access its website directly.

- Marriott's Bonvoy app

The application of the Marriott hotel chain, Bonvoy, makes it easy for those interested to search and book the hotel of their choice in 130 countries, to make mobile check-in, as well as to use services during their stay, such as the mobile key to enter their room or make special requests regarding their stay on staff via their mobile phone (HTN Editors, 2019).

3.8 IoT in the Library and Information industry

The field of information in general and libraries in particular, is one of those that could be said to be a little behind in terms of the use of technology, in relation to the technological developments that society has incorporated in recent years. While computers have infiltrated their services and assisted employees in their day-to-day operations, the software they use is not state-of-the-art and does not help speed up processes and serve stakeholders more quickly and efficiently. So, can libraries incorporate more futuristic applications?

As mentioned in the first chapter, IoT technology can create Digital Twins, that is, make possible the presence of a physical thing in cyber space. Having this knowledge and know-how, we can initially at a theoretical level, assume that books and any document can, through RFID tags, exist as a digital object and that anyone can determine its availability in a library, which at the same time it can be physical and digital. Its digital form can be in the form of a mobile application (Pujar & Satyanarayana, 2015), where in

addition to the availability of a document, it provides more information about a document, map or instructions on where the document / book is. This in the physical library and information on lending details for each user, e.g., for the borrowing days he is entitled to or for a possible fine he must pay. This of course benefits both users and libraries, especially if a book is missing. Figure 23 shows a smart library that works with the help of IoT technology and RFID tags.

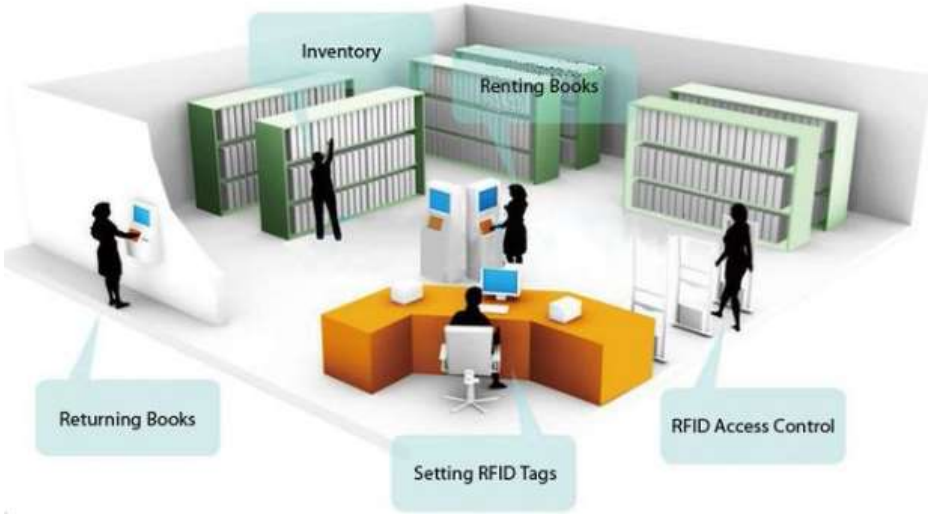

Figure 23. Intelligent library management system. (2019).[20]

[20]https://twitter.com/madeinfriuli/status/1191671825325051904?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1191671825325051904%7Ctwgr%5Ef_2-libraries%2F

A real example of use of the above is the University of Chicago's Mansueto Library, which in addition to its distinctive architecture, is also known for the automation of its functions (IFLA, 2019). It works in two parts: one is what customers see and the other is hidden and consists of a book depository with a very large capacity. The system used by the library includes only robots and not humans, thus enhancing student productivity, finding the required documents in a very short time (The University of Chicago Library, n.d.).

"Book-O-Mat" is one more example of how technology can be used to assist the services of lending libraries. This is a self-service book dispenser, which serves those interested in renting books without requiring direct physical contact (Kjeldgaard, 2020). The books are reserved through the website of the respective library and through the Standard Inter-change Protocol (SIP2) to the Learning Management System (LMS), the interested parties are informed when their books are ready for receipt. To verify their credentials and pick up their book, tenants only need to scan their card into the machine.

3.9 IoT in Marketing and Digital Marketing

The data collected through IoT, offers a lot of insights to companies and therefore, many opportunities to reach their customers with more targeted value propositions (Maier, 2016). In addition, IoT opens a new field for creativity to marketers, while making their services more customer-centric (i-SCOOP, 2020). As shown in Figure 24, the ways in which marketers can use IoT to their advantage but also to the delight of their customers and the services they offer, are summarized: the analysis of consumer shopping habits, information about the how customers interact with each device, detailed consumer journey data, the ability to target real-time ads, and interact more directly with customers to resolve issues that arise.

Figure 24. How will marketers use IoT? (n.d.).[21]

Of course, the contribution to digital marketing is also evident in the above, since we have now reached the point where digital is an integral part of marketing. More specifically in terms of digital marketing, IoT contributes significantly, offering marketers the convenience of "smarter" CRM systems (Brenner, 2020), the presence of social media that can predict the next right move and increased Click Through Rate, among others, as shown in Figure 25.

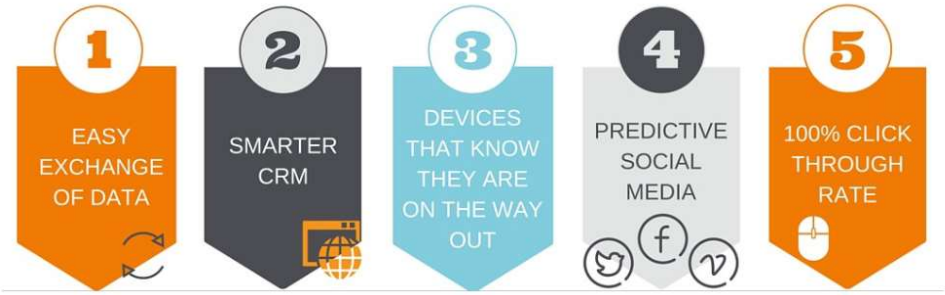

Figure 25. 5 Ways in which the Internet of Things will make Marketing smarter. (2020).[22]

[21] https://www.i-scoop.eu/internet-of-things-guide/internet-things-marketing/
[22] https://marketinginsidergroup.com/strategy/marketing-internet-of-things/

The part of the devices used by the consumers is of great importance, even before the data is obtained from them, as the extraction of data from the consumers presupposes the existence of "smart" devices on their part and then the installation of applications that favor this pumping, as shown in Figure 26. This information has to do not only with the interaction of consumers with a particular brand, but with their lifestyle, with processes they do from the time they wake up until they go to bed, which helps companies to outline customers and create more personalized products (Digital Marketing Institute, 2018).

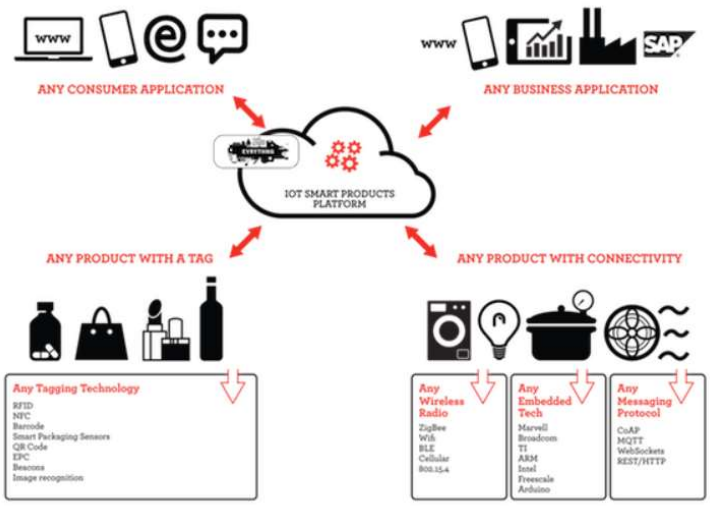

Figure 26. The Internet of Things in a marketing consumer and application context. (2015).[23]

[23] https://chiefmartec.com/2015/06/marketing-internet-things-closer-think/

Figure 27. GPS-enabled Beer Packaging Leads Consumers to Heineken Brewery. (n.d.).[24]

An important parameter that enters the marketing game in relation to IoT, is that of branding, i.e., how a company establishes its name to be associated with its values, its vision, or even its own product. Branding is very often associated with the packaging of the product, as is typically the case with Coca-Cola, with its characteristic color, bottle shape, etc. Through IoT, a package can tell the story of a company in an interactive way, but also to provide information about the product itself that the consumer is holding in his hands.

In this way, the company Heineken created the first GPS-enabled bottles, which led the user to the special brewery of the company. The bottles contained an accelerometer, GPS, vibrations and a rotating cap, as shown in Figure 27 which gave directions, providing a fun way for consumers to spend their time and an experience that would connect them with the brand, creating a pleasant memory of it (CPO Editorial Staff, 2015).

Nivea used IoT for a campaign aimed at raising consumer safety awareness, a concept related to the company's profile as a consumer caregiver. So, he offered a bracelet that had Bluetooth technology, to parents to wear to their children on the beach, in order for them to watch them through the respective application. They then set the distance

[24] https://www.chiefpackagingofficer.com/gps-enabled-beer-packaging-leads-consumers-to-heineken-brewery/

that children were allowed to move away from and if they exceeded it, they received a warning and were led to the children (Adweek, 2014).

Finally, Kellogg's company, wanting to have a greater impact on younger consumers, created a skate park, using RFID tags to launch the cameras to capture the tricks of skaters, then uploading them to the company's social media.

In conclusion, we can see that in terms of marketing and branding, companies choose to use IoT for unique actions that will attract their audience, but which they have filtered through the valuable data collected through IoT.

3.10 IoT in the Pharmaceutical industry

Digitalization in the Pharmaceutical industry and the Healthcare sector in general, has changed the flow of processes for some. IoT has been used to optimize their diagnostic systems and to perfect prescriptions for patients as much as possible, something to which wearable technology has also contributed significantly (Dialani, 2020). However, this is not only something that affects the patient side, although in this area it is the main concern, but also the production and construction process.

Specifically, IoT in the manufacturing process of the Pharmaceutical Industry:

- Can help design the product, creating a "human-centered design", which is based on information obtained from patients, their needs, capabilities, access to healthcare, etc. (Steiner, 2019)
- Can contribute to the manufacturing process and automate processes for faster and more efficient production, as shown in Figure 28
- Can provide real-time patient information so that critical issues can be resolved promptly and remotely (Wipro, n.d.)
- Allows for monitoring of medicines when they leave the factory, as some are sensitive to the maintenance conditions they need. Thus, it can be judged whether they are suitable for marketing (Infiniti Research, n.d.).

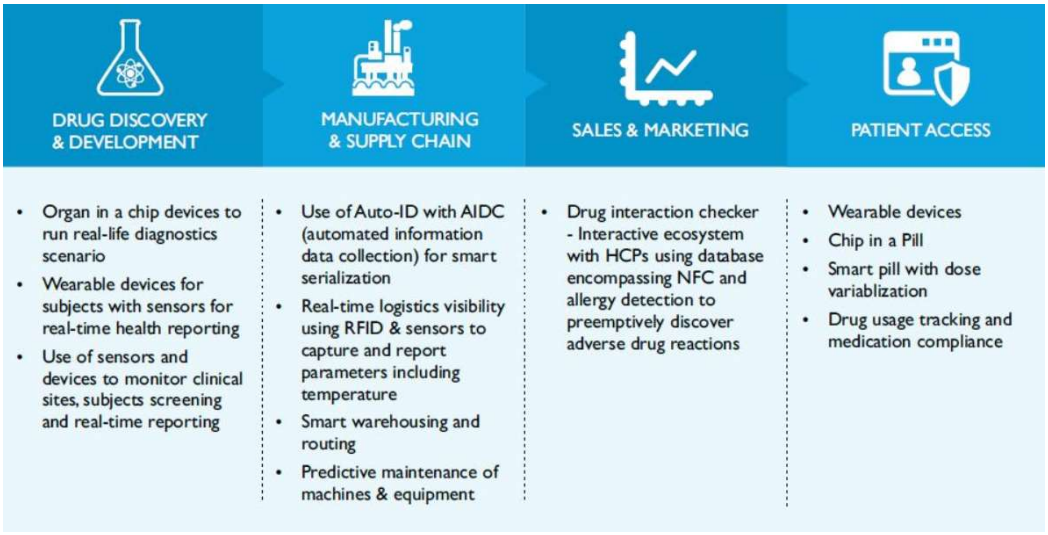

Figure 28. IoT Application Across Pharma Value Chain. (n.d.).[25]

The "Pharma" IoT, as briefly mentioned the use of IoT in the pharmaceutical sector, provides for the digitization of pharmaceutical products, but also directly related procedures, such as clinical trials and patients care (Chircu et al., 2017). However, as emphasized by Steiner (2019), because this sector has to do with health and with the human condition and life, in many cases the question of ethics arises. Thus, the integration of technology in specific cases must be questioned several times before it takes place.

In the related literature, a number of models have been developed that integrate IoT and digital into the pharmaceutical manufacturing process. In the work of Hernandez & Yamaura (2018), the issue of keeping medicines in the right conditions was developed, and in particular, the issue of "Cold Chain management", which is the term in the pharmaceutical field that describes the storage conditions of medicines at a specific low temperature, from their production to their consumption. According to the authors, 20% of the medicinal products that need special care in their maintenance, are destroyed due to non-observance of the proper conditions in their movement. The aim is to reduce the rates of human error, to fill the gaps in its operation with the current use of technology and to control the maintenance temperature more easily. They propose to do this by attaching IoT devices to the external packaging, which will record data on location,

[25] https://www.wipro.com/pharmaceutical-and-life-sciences/nextgen-pharma-takes-smart-strides-with-internet-of-things/

temperature, vibrations, etc. and transmit them via 5G technology, while AI and M2M technology can contribute to improving decision-making.

Similarly, in the work of Pachayappan et al. (2016), it is proposed to use IoT for the transport of pharmaceutical products, using high technology and the use of sensors, in order to collect data on the status of products and the means of transport in real time. Figure 29 shows how the sensors are used to control all the factors that affect the product during transport, as well as the condition of the load itself.

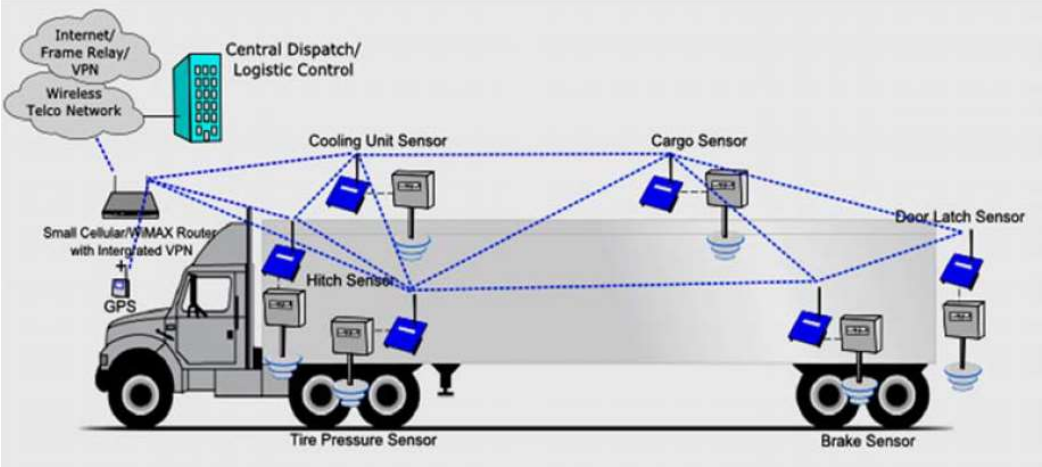

Figure 29. IoT enabled smart container. (2016).[26]

[26] https://www.academia.edu/29223217/Smart_logistics_for_pharmaceutical_industry_based_on_Internet_of_Things_IoT

One company that offers IoT services only for the pharmaceutical sector, is the Dutch start-up AntTail, which develops IoT solutions for safe transport, control and more generally transparency in accounting and construction procedures in pharmaceutical companies (AntTail, 2020). Its services move in three main axes: a. Temperature monitoring, through wireless sensors that record important data, which are transmitted to the company's Cloud service and then analyzed. b. Transparent and connected Logistics, ie the knowledge of the condition of the product at any stage within the Supply Chain and c. Thermal mapping for warehouses, something that becomes automated and very fast, eliminating the need for specialized human resources.

However, regarding the application of all the above in practice, no official data were found to confirm the use of IoT by pharmaceutical companies, except for a variety of articles and papers with proposals for their incorporation. It is not known whether any pharmaceutical company has proceeded to digitalisation, or whether companies in this field simply do not disclose such data.

3.11 IoT in Real Estate

The field of Real Estate traditionally comes to mind as a profession that requires human presence to be accomplished. Professionals must be present to be able to demonstrate the land for sale and interested parties must also be there to be able to examine it thoroughly before deciding to buy or rent it. This parameter, which until now has been associated with this profession, is time consuming and requires significant travel time, especially for professionals, who move to go from one place to another, in addition to the office in which they work.

Technology has penetrated this space long ago, in the form of gadgets and online platforms that helped sell and find ads, as well as in the form of sharing economy platforms, which include users in the game. However, it has been slow to incorporate disruptive technologies and innovative management methods, unlike other business sectors, with the result that much of the management of such a lucrative sector is managed in traditional and time-consuming ways.

The penetration of IoT in this sector presupposes a great deal of familiarity of the employees with the new technologies, as it is one of the few sectors in which they should be managed directly, in contrast to for example the trade area, where the sellers do not have the phenomena so much friction with the object, a topic which will be developed in the next subsection. Of course, it also requires the immediate involvement of the user.

A "smart" space is a lure for a shopkeeper, who wants to offer the latest technology trends to his consumers and all the amenities it brings, providing him with the background to gather the data he needs to analyze and understand them. customers and their buying habits. However, the new era of Smart Homes also plays an important role, which for some people occupy their personal lives, but in this area it is also a matter for professionals, since this new reality can make a house much more attractive for those interested. Customers on their own are looking for automated solutions that will make their day easier, which could be achieved later with the addition of smart devices, but when a home offers it from the beginning, it is considered an advantage. This, of course, is also subject to the general concept of smart cities, which require a more efficient use of infrastructure.

Nevertheless, there are not many existing models in the literature that analyze a possible use of IoT in the field of Real Estate, nor a significant number of companies operating in this field, except for the application Rently, which is an application that combines IoT with Real Estate, by optimizing several processes that were previously handled manually (Softermii, n.d.). This application records all the characteristics of the space for rent or sale, which automatically arranges the viewing for potential tenants, ensuring security after requesting and cross-checking the personal data of people who have access to the space by obtaining the key through a Smart LockBox.

In conclusion, the reasons why no data were found above may be due to the fact that, on the one hand, Real Estate companies buy their systems from companies that develop generalized data collection and analysis solutions, without being specifically involved in the development of software that targets Real Estate and on the other hand, because the concept of smart buildings that was discussed, is still in an experimental stage.

3.12 IoT in the Retail industry

Despite the growing tendency of people to shop online, physical stores have not lost their power. Although there is a physical presence, in terms of the buildings in which the stores are housed, the employees and market consultants serving the consumers and everything else that is subject to the natural world, technology is evolving for these parts as well and constantly contributes to improving their services.

Commerce companies use IoT to record their customers' movements and behavior from the time they enter the store until the time they decide to leave, collect data and analyze the busiest corridors to do there their advertising activities or use this data to the delight of the customer, so that they can suggest the most relevant products for everyone (Dlamini & Johnston, 2016), as well as automated checkouts, which reduce the need for human resources in in stores (Dlamini, 2017).

In general, the trade sector uses IoT for predictive maintenance, as is the case in other business sectors, to track goods during transport, to carry out supply and demand planning more efficiently through sensors, to optimize prices to satisfy customers who have online access, as well as to record the consumer journey of a consumer, until he reaches the checkout (SAS, n.d.).

In the research of Rajabi & Hakim (2015), a shopping center model is developed, which aims to properly inform consumers about the actual availability of products on the shelves in real time, but also to track the progress of customers in in a mall. This scenario works by using an application, which customers are supposed to download as soon as they enter the mall and then give some information about their personal information, their ID number, the product categories they are interested in, to the specific product they are interested in buying, until their application informs exactly the store and the location where they will be able to find it. From then on, the model envisages the use of NFC technology for payment at the checkout, through which market information will be stored, in order to use them for proposals in future markets.

A question that arises is if the trade sector is ready for these changes. In addition to models in the literature that have been developed on practical issues on which IoT technology could be applied, a number of studies have been conducted to examine whether commercial companies themselves are currently able to manage this new treaty. Patil

(2016) uses the Technology Acceptance Model (TAM) to examine the attitude of employees towards the penetration of technology in their field and in their daily work, which emerged as one of the most important factors for employees. is the confidence in IoT and therefore, if this factor exists, they are more likely to adopt it. This can be achieved through frequent testing and training of employees on the job, giving them the opportunity to become familiar with them. Serral et al. (2020) use a Maturity Model (MM) as a tool to determine whether companies have the specifications to be able to integrate IoT technology, but also to set strategic goals. The subjects of the research were people who work in the field of trade and either have strong experience from the field itself or experience in the use of IoT. The main conclusion of this research was that clearly the chances of collecting customer data increase significantly using IoT sensors, but the restrictions on data privacy and the cost of their adoption, is a major obstacle.

The ZEBRA survey (2019) states that, at the moment, IoT devices are being used by employees to scan barcodes, check prices and see the actual availability of products, which in turn helps to help more customers in service, saving them time but also improving their shopping experience, as shown in Figure 30.

Figure 30. Shopping activity on smartphones during shopping trips. (2019).[27]

[27] https://connect.zebra.com/2019Shopper_EMEA

However, in the same survey, it is reported that customers are less willing to give their personal information, shopping in physical stores, in relation to how they feel shopping online, while only 13% state that they feel confident and proceed to trust personal his data on a trading company and how, in fact, he considers trading companies as one of the least trusted, as shown in Figure 30.

Some of the real-life cases, where companies have taken advantage of IoT for better sales and better management, can be found in stores, warehouses and Supply Chain management:

- AWM Smart Shelf, is a company that, with customers of large retail chains (e.g. Walmart), has developed IoT solutions so that the stores that adopt them can be characterized as smart (Smart Shelf, n.d.). It offers various services, such as Automated Inventory Intelligence, which makes accurate tracking of products on the shelf, for faster and efficient restocking, or the Retail Data Engine, a mechanism that records data and actions in real time. , relating to shopping habits, demographics, facial analysis and more.
- In the area of engagement of costumers, the company Plexure has created a platform that collects data from consumers through mobile marketing, in order to offer them the most personalized options (Plexure, 2020). The company claims that it motivates customers to shop in physical stores, making them offers in real time and creating a profile through this engagement, which helps businesses in the right segmentation and targeting.
- In the area of Smart Warehouse, the company Digital Lumens, through its application, SiteWorx, offers businesses intelligent lighting and smart devices, facilitating decision-making, through data and the insights it gathers. Through the Cloud, it creates a network that ensures the security of the operation of facilities and equipment, then offering detailed analysis and reports through the dashboard of the application (Digital Lumens, 2020).
- An example of Supply Chain management, referred to in subsection 2.4, concerns Tive, which uses trackers to track goods during transport and collects data that leads to reports that help companies understand and improve their supply chain (Tive, 2020).

3.13 Summary

Summarizing this chapter, a table was created in order to bring together the ways of using and implementing IoT in each business sector discussed above.

Business Sector	**Areas of Use**	**Examples**
Agriculture industry	• Collection of data for important parameters • Security of unrestricted areas	• CropX • Farmobile • Amber
Banking industry	• New payment methods • Protection from fraud • Better management of data	• Dynamics Inc. • Armis • Kontakt.io • Stripe
Construction industry	• Monitoring of progress of work • Waste management • Limitation of human error and accidents	• Blackberry Radar • Vibralign • Hyundai AAVM • Remote Eye
E-commerce	• Better control of Inventory Management • Better control of Supply Chain Management • Personalization • Better control of products during transportation	• Amazon Pay • Tive • Magento
Engineering industry	• Mass customization • Remote monitoring • Proactive maintenance • Connected Supply Chain • Energy management	• Augury • Axoom • Alluvium • Machinemetrics
Food industry	• Transparency about products' lifecycle • Monitoring of products during transportation	• CogniPro link • Domino's Pizza
Hospitality and Tourism industry	• Personalization of services in travel experience	• Alibaba's FlyZoo Hotel • Oaky • Marriott's Bonvoy App

	• Easier access in airport information • Smart hotels • Automatic check-ins	
Library and Information industry	• Documents as digital objects – Digital Twin concept • RFID access control	• University of Chicago's Mansueto Library • Book-O-Mat
Marketing and Digital Marketing	• Analyzation of customers' buying habits • Real-time notifications, targeted ads • Quick resolution of issues • Smarter CRM • Predictive Social Media • Increased Click-Through rate	• Heineken GPS-enables bottles • Nivea safety awareness campaign • Kellogg's social media campaign
Pharmaceutical industry	• Optimization of diagnostic system • Human-centered design • Automation of manufacturing process • Real-time patient information • Monitoring of medicines – Cold Chain management	• AntTail
Real Estate	• Personalized suggestions • Remote showings • Smart buildings	• Rently
Retail industry	• Predictive maintenance in Supply Chain management • Automated check-out • Targeting and engagement of customers	• AWM Smart Shelf • Plexure • Digital Lumens • Tive

4 IoT in Greek Businesses

According to the official report of the Europa.eu in 2019, which analyzes the national initiatives on digitizing industry, Greece has a position below the average, since in the previous two years, it held only the 27th position out of 28 European countries. The country has a small percentage of adoption of digital practices in public policy, but also at the level of small and medium enterprises, the use of digital media is limited. However, after a period of 10 years of economic decline, which significantly reduced the country's GDP, in 2016 a new ministry was established, the Ministry for Digital Policy, Telecommunications and Media, which has since been responsible for any integration, design and creation of ICT investments in the country. The burden, then, has fallen on SMEs and startups, since larger and multinational companies deal better with the integration of new technologies.

Greece participates in 4 of the 7 approved research and development projects at pan-European level, raising a total of 3.36 million euros of Community co-financing, amounting to 6.5% of the total available. Greek participation exists in the projects BIG IoT, Agile, SymbIoTe and Vicinity. The following 7 bodies participate in these projects: National Center for Research & Technological Development (CERTH), GNOMON Informatics SA, Municipality of Pylaia Chortiatis, Econais A.E., Bioassist A.E., Intracom A.E. Telecom Solutions, Hellenic Telecommunications Organization (OTE) (Capital.Gr, 2016).

Since 2018, with the initiative of Digitizing European Industry (DEI), movements have been noted that aimed at stimulating the circulation of new technologies in small and medium enterprises, such as Digital Step and Digital Jump, both initiatives of the same year (2018), where they targeted Digital technologies such as Social Media, Mobile services, cloud, Internet of Things and Cyber security and were addressed exclusively to small and medium enterprises. Other funded programs include the "Digital transformation of the agricultural sector", aimed exclusively at the agricultural sector and with targeted digital technologies mobile services, cloud, Internet of Things, Big Data, Data analytics and Artificial Intelligence and "Equifund", a program with a total budget of 15 million euros to strengthen all areas of activity of small and medium enterprises, focused on technologies such as Robotics and Automation machinery, Big Data and Data

analytics, 3D-Printing, Artificial Intelligence and Internet of Things. It is noted that several programs focus on the agricultural sector, while all include it, which shows the importance of this activity for the country's economy and the number of people employed in this sector nationally.

However, the factor of difficulties in achieving a digitization situation in the country, which concerns most of the sectors and companies, is also mentioned. The main difficulties, according to the report, are the so-called "brain drain", a term that describes the lack of human resources with basic ICT knowledge and skills, as well as the reduced training provided to employees of small and medium enterprises, in terms of new technologies. What is missing and is considered a weakness, is the insufficient concept of innovation and the inability to adopt new practices, as well as the limited cooperation between companies, universities and research centers, all events that are directly related to the limitations imposed by regulatory framework.

Nevertheless, there have been significant movements by Greek companies in recent years, which have highlighted the country's upward trend towards the adoption of digitization. There are companies that offer IoT services to other companies, but also examples of companies that have adopted IoT tactics for the purpose of greater financial profit. The sectors where there is greater mobility, in terms of the adoption of IoT in Greece, are those of telecommunications and IT, sectors that mainly provide their services to companies and individuals. In the field of Informatics, notable examples are the companies:

- ATCOM

  ATCOM is an IT company that, among other activities, offers IoT and experiential capabilities, using Big Data in order to improve engagement and communication between companies and their customers (Atcom.Gr, n.d.). A typical example of their work is Netvolution 5.5, a multi-awarded Content Management System, selected by various e-commerce, catering and other types of companies, which, among other things, offers the possibility of centralization of ordering procedures, simplification of payments directly through the Extranet and real-time integration with back-office systems. Their customers are large catering chains, such as the Greek companies

Gregory's and Goody's, banks such as Alpha Bank and Eurobank, but also Aegean Airlines, IKEA and more.

- Synaphea

The Greek company Synaphea uses Blockchain technology to serve the sectors of Banking, Shipping, Insurance, Finance, Healthcare and the Internet of Things, creating with the latter a bridge between the blockchain and the real world (Synaphea, n.d.). The company creates real-world applications that "harness the unique properties of the blockchain", based on the Hyperledger, Ethereum and Rootstock distributions and implementations.

- Synaisthisi Platform

In 2015, the Institute of Informatics and Telecommunications NCSR Democritus in Athens, proposed a software architecture in the implementation of the SYNAISTHISI platform. It is a platform that deals with various issues of IoT research, with the ability to be applied in various business areas (Pierris et al., 2015). The platform is fully-distributed cloud-based and its architecture consists of physical objects, which through middleware and cyber-physical convergence, reach the final application [Figure 31]. Its design covers various needs, being horizontally-scalable and capable to support current ongoing needs, extensible to keep up with the growth of clients' business, operational with a large number of devices, friendly to the most popular open messaging APIs, deployable in a distributed fashion over multiple cloud systems and versatile to customize application needs with a Service Builder requiring limited programming effort (Greek News Agenda, 2016).

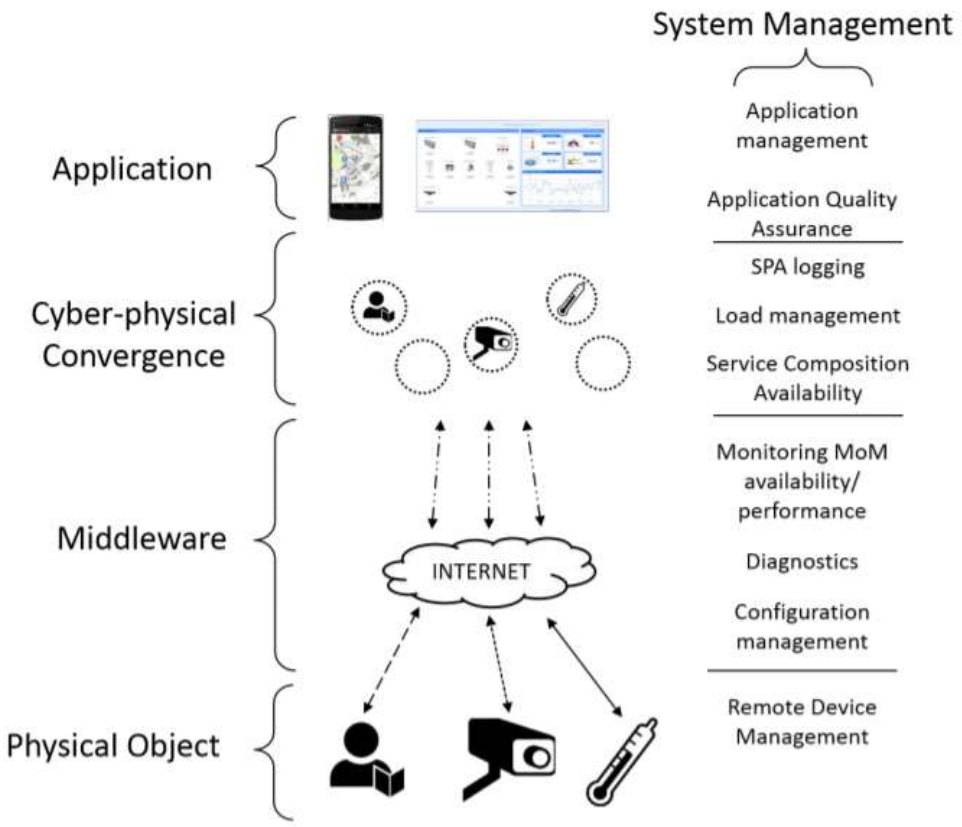

Figure 31. Pierris et al. (2015). *Overall picture of SYNAISTHISI platform architecture. Additionally, the Storage and Security layers are pervasive across the architecture.* (2015). [Illustration].

The importance, therefore, of this platform for the development of the Greek business sector but also in general for the adoption of digital tactics in the country, lies in the fact that it enables networked devices to interconnect through intuitive interfaces and it allows the creation and management of services very quickly and easily.

Finally, it is worth mentioning the company METIS Cybertechnology, which operates in the field of shipping. Using AI, Machine Learning and IoT solutions, it enables companies to assess their past performance, monitor their present operation and predict their future behavior (METIS Cyberspace Technology S.A., 2020). They use a cloud-based analytics platform and a data acquisition system, while separating with the provision of an AI-powered virtual personal assistant, which acts as a chatbot, enabling user interaction

with the platform and providing instant access to any kind of information but also with the ability to plan tasks, to diagnose problems and resolve critical situations.

The truth is that apart from IT companies experimenting with various projects related to the development of IoT solutions for companies, the data are incomplete to non-existent for most of the areas discussed in detail in Chapter 3. However, it seems that most of the actions that include IoT in Greece are related to the field of agriculture.

4.1 Initiatives in Smart Farming

One of the main employment sectors in Greece is that of agriculture. Many IT companies have developed programs that integrate IoT and develop the concept of Smart Farming for the country.

Telesto is a company that specializes in IoT solutions, Smart City applications & WSN infrastructures (Telesto, n.d.). Its areas of activity, however, include cases of the development of IoT solutions for agricultural enterprises, such as the example of Pavlidis Vineyards, in which leaf, humidity and soil sensors were installed (shown in Figure 32) for the collection of data controlled through an application with the aim of increasing profit and protecting natural resources.

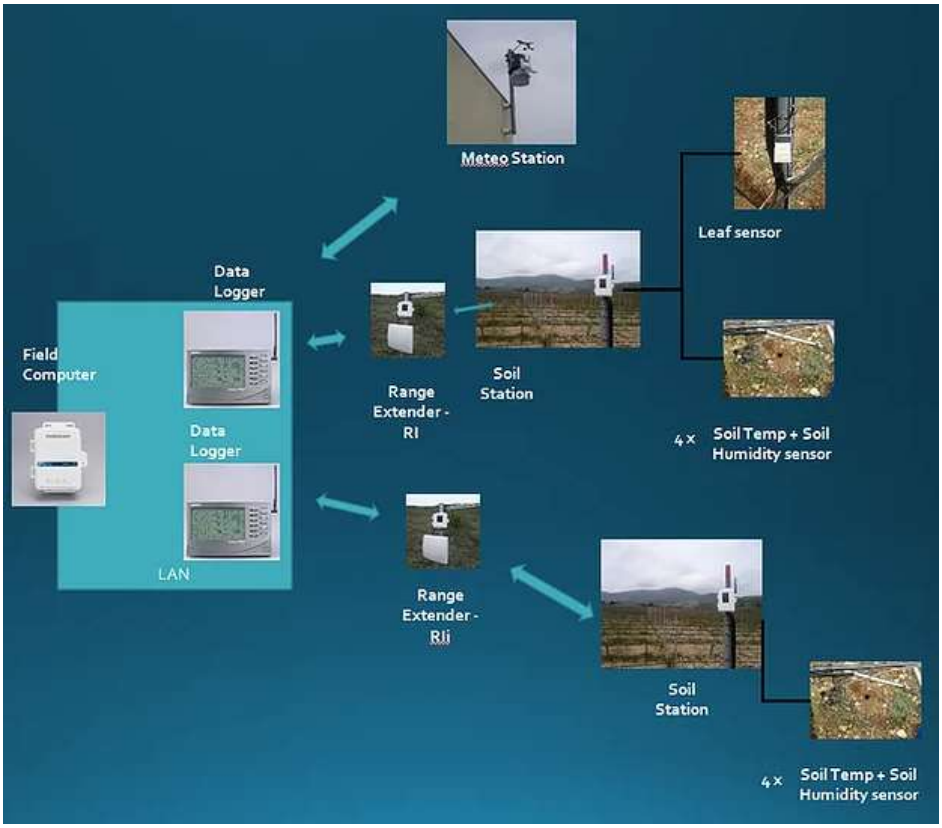

Figure 32. Telesto. (n.d.) *Pavlidis Vineyards*. (n.d.). [Illustration].

The company Future Intelligence is a telecom engineering company that developed the first IoT equipment exclusively designed and manufactured smart farming application in Greece. A system was created that uses sensor controllers, which along with the Wireless Network components, create an IoT infrastructure that transfer the microclimate conditions to a properly designed cloud platform and then to end-users, via a Web Interface. The company, with this innovation for the level of Greece, was officially included in the European Commission's recommendations reports for best practices in smart farming for 2020 (European Commission, 2020).

Following the same pattern, the Gaiasense platform, created by the IT company Neuropublic, is a Greek innovation, which deals exclusively with smart farming solutions. It is a platform that works by collecting data from the fields, the satellite, the scientist and the farmer, providing the tools to the researcher to analyze all aspects of his client entries (NEUROPUBLIC S.A., n.d.). The platform acquires large-scale data from all farming areas, providing the researcher a real-world environment for his research.

In general, in recent years in Greece, agricultural producers have turned their attention to solutions that will help them reduce production costs and start using inputs (water, fertilizer, plant protection products) in a reasonable context, which leads to precision agriculture solutions enhanced by IoT integration (INNOSETA, 2019).

4.2 Deficiencies in Greek reality

Regarding other business sectors, there has been a significant lack of data, which cannot be determined whether it was related to non-disclosure of data by potential companies that have taken steps towards the integration of IoT in their operations, or a complete lack of such actions in the country.

4.2.1 Banking Sector

Regarding the integration of IoT in the banking sector in Greece, it is important to take into account the great crisis of 2020. Quarantines have significantly affected the Banking and Financial Services (BFS), affecting global economies. and pressing the Banking and Financial Institutions to ensure smooth operation in the midst of a crisis. The goal, now, is the digital transformation of all Greek banks.

For greater ease of use of the services offered by banks, in addition to the mobile apps that are now a necessity to be offered by users to every bank, the features that have been embellished, with services such as entering the application using a fingerprint, for faster data accreditation, the quick transfer service, for immediate money transfer and using the recipient's phone number or email and more.

However, there is no exact data on how Greek banks use IoT technology to facilitate their customer service. According to Accenture (2018), which examines digital skills maturity in the banking industry at the national level, Greece seems to be in a below-average position, although executives in the field recognize the value of digital technology and are ready to invest in big data and cybersecurity. However, although some Greek banks have made some investments in the adoption of digital techniques, they continue to show a low adoption rate of emerging technologies, including IoT. This is, therefore,

a sector that, at the national level, is highly focused on digital strategy, digital production and digital customer, but less focused on digital operations.

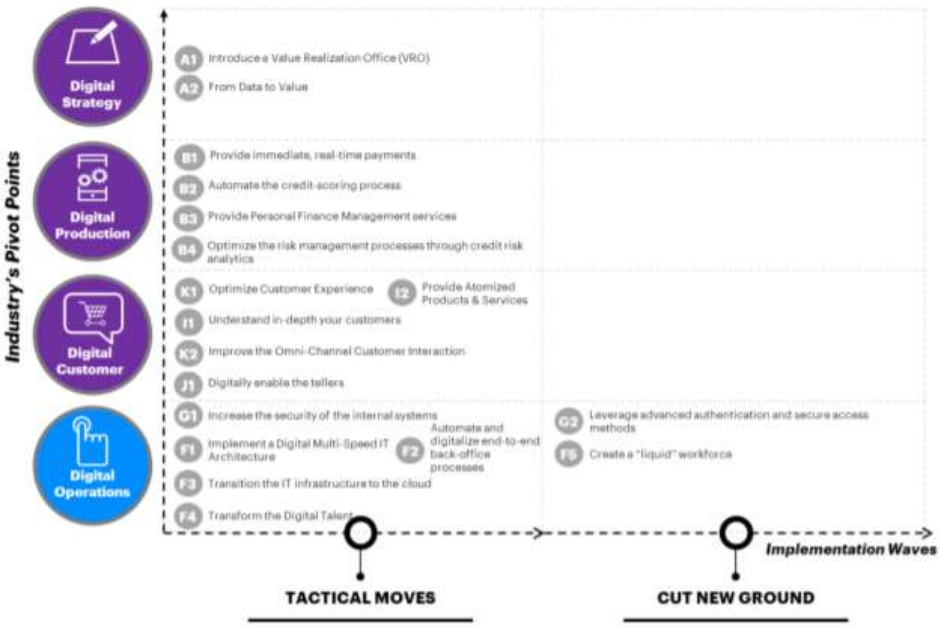

Figure 33. Classification of Suggested Initiatives Across Three Dimensions. (n.d.).[28]

[28] http://www.sev.org.gr/Uploads/Documents/50550/Communications_Industry.pdf

The proposed tactics to change the current situation are:

1. The security of the internal systems to be increased
2. A digital multi-speed IT architecture to be implemented
3. End-to-end back-office processes to be automated and digitalized
4. The IT infrastructure to be transitioned to the cloud
5. The Digital Talent to be transformed
6. Advanced authentication and secure access methods to be leveraged
7. A “liquid” workforce to be created, as shown in Figure 33

4.2.2 e-Commerce

According to Ecommerce Europe & EuroCommerce (2018) the European e-commerce turnover increased by 12.7% to € 540 billion in 2017. Northern Europe, to which Greece belongs, has increased the percentage sales in recent years, ranking second in Europe after Eastern Europe with a percentage of 17.7% for 2018, coming from a 14.5% in 2017.

In 2017, there were more than 3.5 million shoppers in Greece, with sales reaching $ 6.15 billion (Privacy Shield, n.d.). Three years later, e-commerce users reached 5.2 million and user penetration hit 50.3% approximately (Statista, 2020). Understandably, this is a very lucrative and very popular sector. However, in particular, Greece is in the top 10 of the most difficult European countries to develop business moves, meaning mainly the regulatory limitations (Ecommerce Europe & EuroCommerce, 2018).

4.2.3 Reports and statistics

In an attempt to make a comparison of data and developments worldwide with regard to the integration of IoT in business, a significant shortcoming was observed in most of the areas discussed in Chapter 3, without it being known whether the relevant data have not been made public or no action has been taken to integrate disruptive technologies.

However, we can make some assumptions about the reasons for not finding the right data. In the 2018 report of the World Economic Forum, on the readiness of the countries

to welcome the advanced technologies in their production process and to enter into Industry 4.0 status, Greece collected a rather low grade that put it in the category of nascent countries, that is, those with a limited production base at a given time, which indicates a low level of readiness due to poor performance, something that is calculated through Drivers of Production. The Drivers of Production for this report were: technology & innovation, human capital, global trade & investment, institutional framework, sustainable resources and demand environment, whose score ends at an average of 5.0 out of 10 [Figure 34], while regarding the Structure of Production, where the factors of Complexity & Scale were judged, the score was 4.4 out of 10.

Figure 34. Greece Readiness Overall Assessment, Drivers of Production. (2018).[29]

[29] http://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf

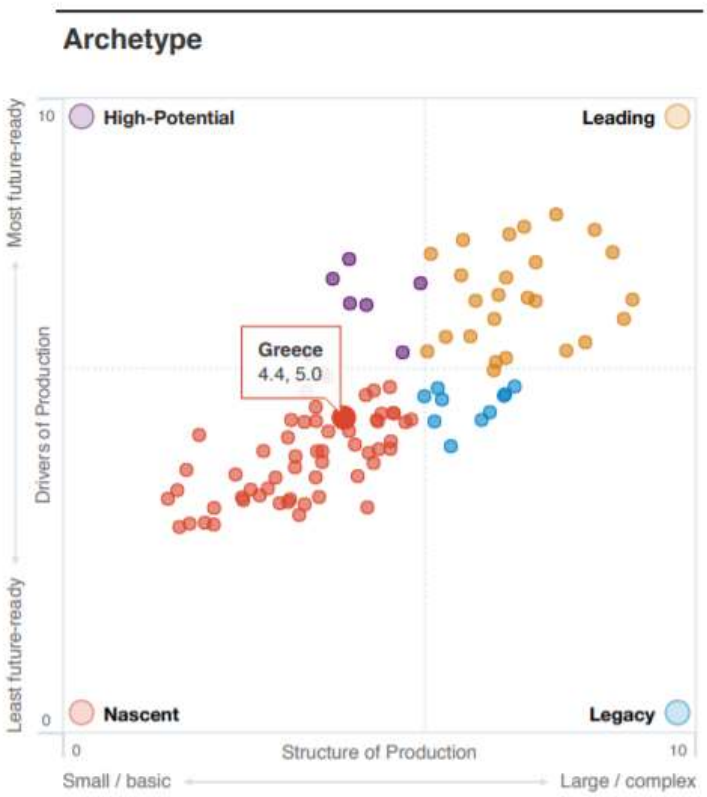

Figure 35. Greece Readiness Overall Assessment, Archetype. (2018).[30]

These scores, which move marginally at the base, compared to other European countries, such as Germany, with an average of 8.68 out of 10 and Switzerland, with an average of 8.39 out of 10, show significant deficiencies in the infrastructure of the Greek and an urgent need for change in order for the country to keep pace with the European average [Figure 35].

This report, perhaps, confirms the fact that, neither in the literature nor on the internet in general, researches or data have been found that confirm the existence of infrastructures that include IoT, in the industries of Construction, e-Commerce, Engineering, Food, Tourism, Library and Information, Real Estate and Retail.

[30] http://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf

5 Conclusions

From what was discussed above, and as a general assessment, we can see that in Greece, in contrast to the examples abroad, where depending on the sector there are separate examples of development of IoT solutions and disruptive technologies, the solutions developed for each sector, are from IT companies. These companies are naturally engaged in the general development of new technology models that include IoT, which may mean that, in some cases, models are developed that are subject to the logic of "one-size-fits-all". Changes happen in any case with the involvement of a third party, which is almost always an IT company and not internally, as could be done by developing solutions tailored to the needs of the company or by companies that develop solutions specifically for a business sector. As for where there is a greater boom, in terms of the use of IoT in the business sector, it is certainly found in the agricultural sector, which confirms the increased employment of Greeks in this sector. The examples discussed in Chapter 3 for each business sector, could be an example for Greek companies, in that: a. the more information there is about the buying public, the way they think, the way they buy and their needs, the more power the business has b. automation saves time and money in the long run c. the way smart technologies ensure.

Such a radical and revolutionary change, as the one brought about by Industry 4.0, naturally scares organizations and executives, not only in Greece, as this is something that is happening worldwide. In the Deloitte survey, 1,600 executives from 19 countries were asked if the leaders of businesses and government agencies were ready to take advantage of the possibilities that new technologies can bring to their clients, organization, society, etc., only 14% of them were highly confident about it (Deloitte Greece, 2018). But the point is that this reality is now all around us and apart from business, it affects our society and our daily life, entering even our most personal space, our home. Therefore, it is something that cannot be missing from our work, especially with the data we have on increasing productivity and various other benefits it can offer, such as increased security and a strong sense of connection with customers.

Regarding the continuation of this project, the questions that arise after everything that has been mentioned are mainly: a) what do the decision-makers of Greek companies by

each mentioned sector think about the use of IoT, b) what are the tactics they have already adopted that concern IoT and c) what are the obstacles they have encountered in adopting IoT in their internal operations. To find answers to these questions, it would be useful to create questionnaires addressed to employees of Greek companies in each sector from those mentioned in section 3, at a time when the market and the external conditions allow it.

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