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ESCUELA DE INGENIERÍAS INDUSTRIALES

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Grado en Ingeniería de Organización Industrial

Influence of Digitalization in Business and Industry.

Analysis and Implementation of Thingsee One Device

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TFG REALIZADO EN PROGRAMA DE INTERCAMBIO

TÍTULO: Influence of Digitalization in Business and Industry. Analysis and Implementation of Thingsee One Device

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Resumen:

En el proyecto se explican conceptos sobre digitalización como IoT, Cloud Services, Big Data… Así como conceptos de mercado. Estos se fusionan para lograr la digitalización del mercado.
De modo práctico se llevan a cabo con un dispositivo, llamado "Thingsee One", diferentes casos en los que se muestran los resultados.

Palabras clave:

IoT, Digitalization, Big Data, Thingsee, Data Management.

Influence of Digitalization in Business and Industry

Analysis and Implementation of Thingsee One Device

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Bachelor's thesis

Degree Programme Industrial Management Engineering

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ABSTRACT

Research Unit for Smart Devices
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ABSTRACT

Nowadays, companies are influenced by the rise of new technologies and digitalization. They are also immerged in a world of constant changes and high competitiveness. In this scenario, we examined in this thesis how organizations could enhance their performance by implementing digitalization into their processes.

The thesis is divided in two main parts. The first one refers to the theoretical background, where on the one hand it is explained technological concepts such as Data Science, Internet of Things, Industry 4.0 and Cloud Computing, and on the other hand it is provided fundamental knowledge in Supply Chain, Value Chain and Business Models. After the theoretical explanation part, we go through the analytical part, in which we studied whether digitalization should be implemented into business and industry.

In the analytical part we also survey the cases conducted by HAMK University of Applied about the Thingsee device, and the back-end infrastructure created for its use. Thanks to the Research Unit for Smart Devices we were able to work with this device and infrastructure, enabling us to come up with new ideas and applications.

We believe that introducing new technology and digital services to each layer of an enterprise, in a well-coordinated way, as we propose in this thesis, is an effective vehicle on creating value, achieving competitive advantages and positioning the company for the next revolution. From our point of view, after having optimized a company's current processes through digitalization, the next step should be to remove certain processes through digital services, improving efficiency, time to market and customer satisfaction.

Keywords Digitalization, digital services, big data, supply chain, value chain.

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1 INTRODUCTION

1.1 Topic of Thesis

Thanks to technological advances, a wide offer of products and services has arisen, which have a higher performance at lower costs than before. This development has been due to the improvement and cost reduction of production processes. Therefore, industry is facing a new scenario in which digital devices are increasing in number and influence in the production of a good or service.

As Industrial Management Engineering students, we have to get adjusted to the new tendencies in the industry and understand the technological changes. Consequently, this thesis is related to the optimization of products, services and its processes through the new means provided by the engineering today.

Optimizing products, services and processes will be approached from the digitalization of the organization's Value and Supply Chain. Before jumping into this issue, it is necessary to provide the reader a basic background into the concepts that will appear in this thesis. Hence, there is an explanation of the Internet of Things, Cloud Services, Data Science, Business Models, Value Chain and Supply Chain.

In addition, our project was provided with a Finnish-based device in order to understand the technology that was behind, from sensors, to data storage and data visualization. Moreover, we studied real user cases to analyze how a business process could be improved thanks to this kind of technology. The device in question is called Thingsee, and it contains several sensors that provide quite valuable information for countless situations.

Figure 1 represents the structure of the thesis:

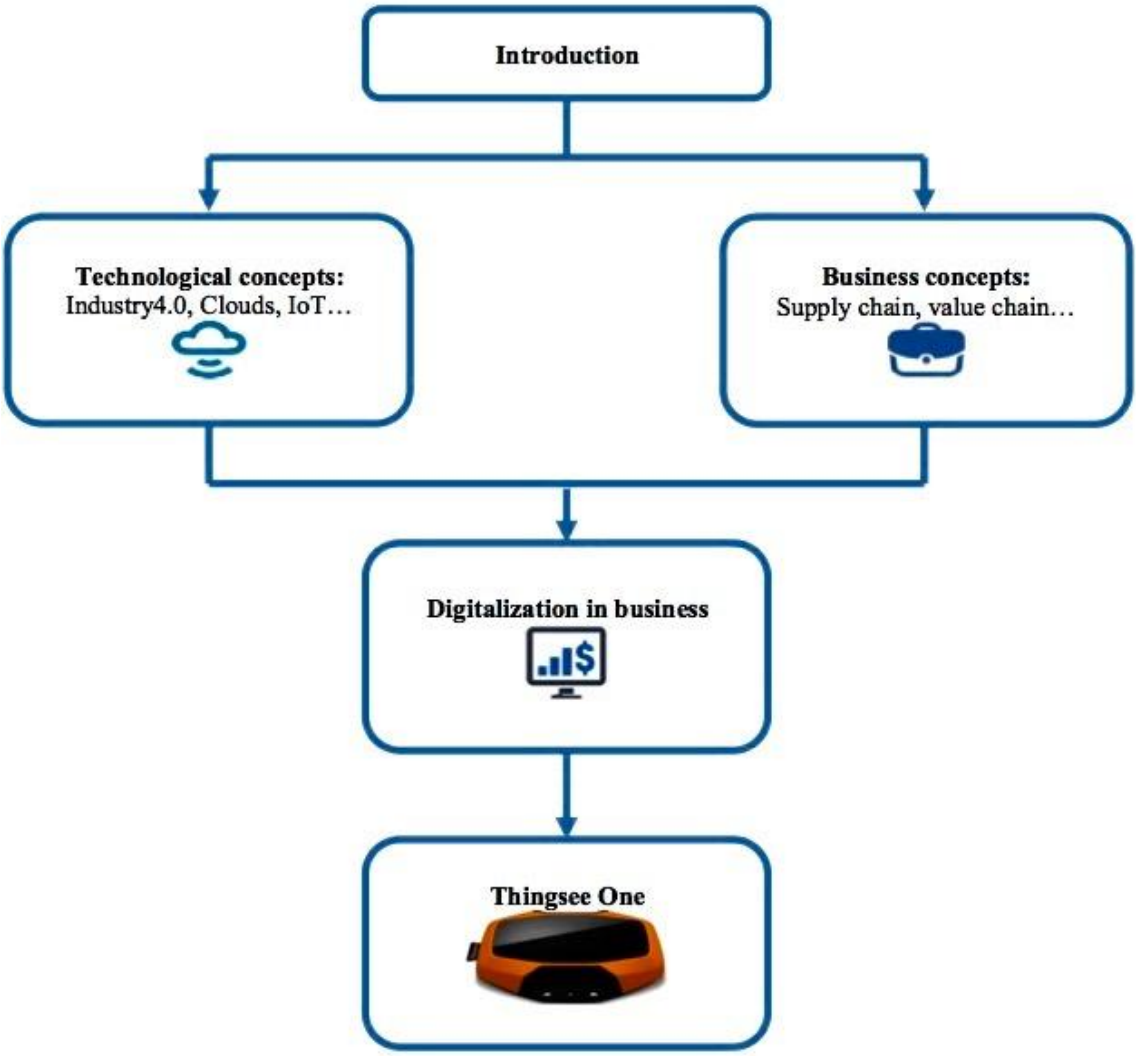

Figure 1 Thesis Content Structure

1.2 How to Improve Business Process by Using New Technologies

In order to succeed in business from a strategic point of view, it is necessary to take into consideration different factors where innovation stands out. Innovation of both products and processes, framed into what is called "technological innovation", is a key competitive tool because it allows developing new businesses adapted to emerging technologies.

The application of emerging technologies into business models allows from the development of new products that satisfy the needs of brands, to the optimization of processes and the increase of efficiency. Therefore, the use of these technologies ensures profitability and success in the market.

Currently it is said that we are in the 4th industrial revolution, which corresponds to an implementation of business models more flexible and efficient thanks to the advantages that the collection of large amounts of data, the processing and subsequent analysis allow. That is, the 4th industrial revolution corresponds to the implementation of the ITs or Information Technologies.

The Information Technologies correspond to the integration of computers and telecommunications equipment to support data gathering, transmission and manipulation. The implementation of IT involves two major improvements:

- Increase the efficiency of existing processes
- Allows totally new processes that are able to transform the business models.

The use of interconnected devices which store and transmit data represent large advantages in terms of processes are concerned. Among others, obviates the need of an operator monitoring the process continuously, or presence thereof in tasks involving some physical risk. Furthermore the use of those devices allow more precise, detailed and continuous process control.

As can be noted, the implementation of the ITs and the devices related to them, involves handling large amounts of data, which is why the implementation of Big Data systems is required, these systems will be explained in way more detailed in this thesis.

Thanks to the combination of Big Data systems and the use of the new technologies, the existing business models can be improved.

PART ONE.
THEORETICAL BACKGROUND

2 BACKGROUND CONCEPTS TO UNDERSTAND DIGITALIZATION

2.1 Evolution Through Technology

Due to the needs of markets, companies have had to adapt their production and business models in order to supply the demand in the most efficient possible way; this is achieved thanks to technological advances that have emerged.

In order to understand how the new technologies get to meet the new needs of the market, it is well worth to understand how the technology has evolved over the time. It is said that we are currently in the 4th Industrial revolution and it is necessary to understand the basis of previous industrial revolutions before explaining what is called Industry 4.0.

2.1.1 1st Industrial revolution

The first industrial revolution began in the second half of the eighteenth century in the United Kingdom, but it did not start until a few decades later in Western Europe and North America, and it ended between 1820 and 1840.

The 1st industrial revolution was characterized by the mechanization of the industry. Thanks to the invention of the steam engine developed by James Watt (1782) companies were able to increase production. The steam engine allowed the development of railways and the development of the steamboat, thus contributing to the momentum of the transport sector.

2.1.2 2nd Industrial revolution

It could be said that the 2nd industrial revolution was basically an improvement of the technology developed in the 1st industrial revolution, although major changes emerged.

Steam was replaced by electricity and oil as energy sources. Thanks to oil the internal combustion engine was developed and thanks to electricity the

street lighting was developed. Communication also experienced a big advance thanks to the development of the telegraph.

The production lines for manufacturing were developed, which contributed to the efficiency of factories. While some workers were performing the same task, others were doing another specific task in the product; thanks to this the amount of goods was increased significantly.

2.1.3 3rd Industrial revolution

The third industrial revolution, also called scientific and technological revolution, began at the end of the 2nd World War, and it could be said that has just ended and the concept of the 4th industrial revolution has appeared.

The highlights of the period could be the introduction of renewable energies, the use of nuclear energy, R&D and telecommunications. It emphasizes the creation of the Internet for data sharing, which is the basis of the next industrial revolution. The optical fiber for transmission of the data was also created. The factories are automated to avoid performing repetitive tasks by operators and also in order to achieve greater precision.

Digitalization has reached today near all the dimension of businesses and industries due to the dizzying growth of technology in the last decade. Thanks to the look taken we can understand the evolution of technological market where the main pattern has been that products have become cheaper, smaller and faster. This has led to a massive amount of data and devices, which are changing the way we approach many aspects and processes; that is the reason of the creation of the concept Industry 4.0.

2.2 Industry 4.0, Internet of Things and Industrial Internet

2.2.1 Industry 4.0

The concept of Industry 4.0 corresponds to a more organized model of the manufacturing means. In this model the so-called "Smart Factories" are able to provide a highly adaptable to supply and demand and to different manufacturing systems, as well as providing a better use of resources. This concept is not yet consolidated, but it is still in development and it will mark major changes in society, which is the reason why this model is known as the 4th Industrial revolution. Figure 2 illustrates the evolution of industrial revolution.

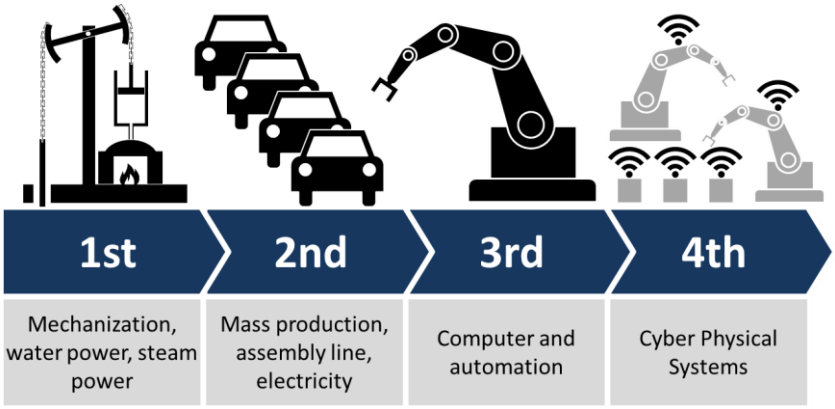

Figure 2 Industrial Revolutions (by Christoph Roser at AllAboutLean.com)

This concept is highly linked to the concept of Internet of Things. Combining the intelligence of the means, the availability of the raw materials and the interconnection between them, as well as with the network, the system is able to provide a flexible manufacturing model.

This manufacturing model, thanks to the interconnection with the means, provides an improvement in the supply chain, allowing to secure delivery dates or deadlines, managing a large-scale production with products adapted to the market needs and reducing bulky stocks.

For all this, the concept of Industry 4.0 provides a greater control of manufacturing and a greater flexibility. To achieve the implementation of this model is necessary to incorporate sensor and wireless connections, the factories must be able to gather enough data and to achieve the interoperability between its processes. To this the factories must implement the use of Big Data systems capable of outputting large amounts of data from the manufacturing environment systems.

2.2.2 Internet of Things

Internet of Things, or abbreviated form IoT, suppose a revolution in the relationship between objects and people, inclusive between just objects. The objects are connected between them and with the network in order to provide real-time data.

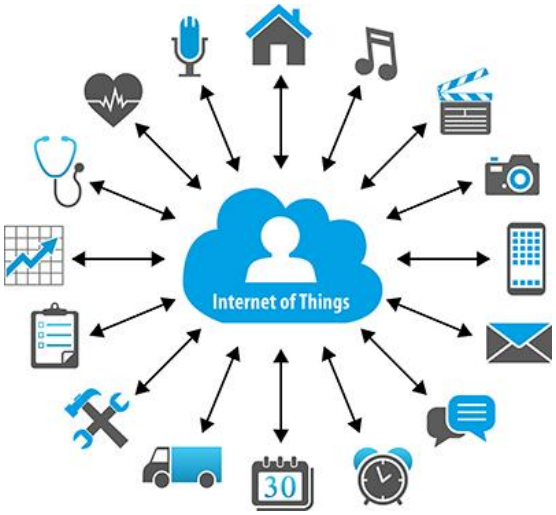

Figure 3 Internet of Things Representation (WireloTech, 2015)

The best way to understand this concept is through practical examples. Imagine a fridge that let you know which food is going to expire in a short period of time, or smart lamps that were able to light the room when light is needed in the ambiance, or an example which is already among us, bracelets which send information to the network about your statistics of health when you do sport. In this case with a simple chip, simpler than the one which is in our smartphones, the bracelet is able to send information to the network, process it, and send it to our smartphones to easily monitor parameters such as heart rate, speed, etc. But these are just a few examples of what the IoT is capable of, the implementation of this concept would suppose a drastic change in the way we see the world (World Economic Forum. "Internet of Things", 2015).

2.2.3 Industrial Internet of Things

Basically The Industrial Internet of Things (IIoT), also called Industrial Internet, is the use of Internet of Things technologies in manufacturing.

Figure 4 Industrial Internet of Things Representation (EMG, 2015)

The philosophy of IIoT is based on that the smart machines are better than human in terms of detection, accuracy and data communication. These smart machines and even the individual devices that comprise them, can monitor, collect, exchange, analyze, and instantly act on information in order to change their behavior or their environment, all without human intervention. This saves time and money to the companies.

This concept is especially important talking about manufacturing, since it means a greater control of quality, sustainability, traceability in the supply chain as well as the efficiency of it (Accenture, 2015).

2.3 Cloud Services

The Cloud Service, also called Cloud Computing, is based on the possibility of offering computing services through a network, which is usually Internet.

This new technology allows us to store our files and information on the Internet without the need of having sufficient capacity to store such information.

Some of the advantages of the use of Cloud services are:

- Low cost because there is no need to invest in infrastructure
- No need to have a large storage capacity
- Real-time information
- Access where and whenever you want via an Internet connection
- Safety in data

There are also certain factors that suppose a delay in the use of the Cloud Services, among others underscore the difficulty in assessing the reliability

of cloud providers. There is also the called “internal threat”, because users have access to much of the data that can be used inappropriately

The most known types of Cloud services are:

- **SaaS (System as a Service)** We could say that is the most important form of Cloud Service. It is based on a software application entirely offered by Internet, with full functionality and for all customers who want it. The company that offers the service is the one in charge of the maintenance of the application.

- **PaaS (Platform as a Service)** Offers everything needed to support the entire life cycle of the construction and commissioning of applications and web services fully available on the Internet.

- **IaaS (Infrastructure as a Service)** Instead of purchasing the servers, space in a data center or network equipment, clients buy all these resources to an external service provider.

There are different types of clouds according to the people that are managing them:

- **Public Cloud** A generic public cloud is represented in Figure 5. It is managed by third parties outside the organization. In the same cloud there could be running several different business without the users having evidence of it.

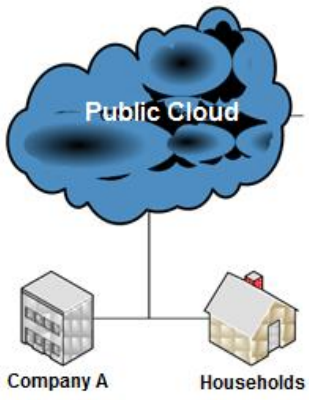

Figure 5 Public Cloud Representation. (Instituto Nacional de Tecnologías de la Comunicación, 2011)

- **Private Cloud** A generic private cloud is represented in Figure 6. The most common option for companies that want to maintain a high level of privacy in their data, because they are the same ones that decide who has access to the cloud.

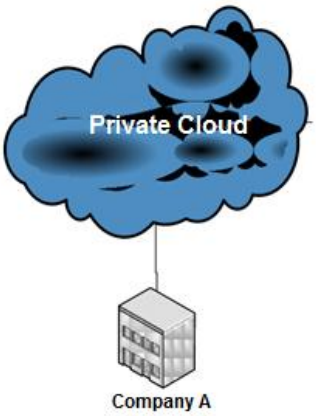

Figure 6 Private Cloud Representation. (Instituto Nacional de Tecnologías de la Comunicación, 2011)

– **Hybrid Cloud** A generic hybrid cloud is represented in Figure 7. The user owns certain part of the cloud but shares another part of it.

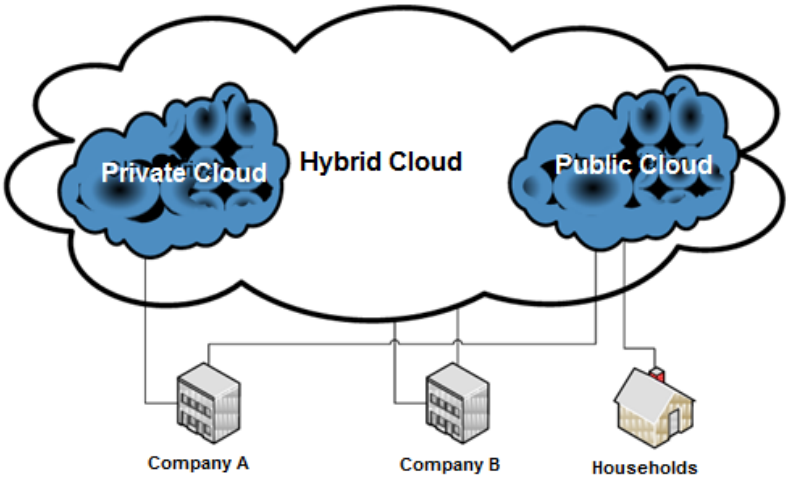

Figure 7 Hybrid Cloud Representation. (Instituto Nacional de Tecnologías de la Comunicación, 2011)

– **Community Cloud** A generic community cloud is represented in Figure 7. According to the NIST (National Institute of Standards and Technology) is the cloud which is managed by constituent organizations that have a common function or purpose, such as security or political.

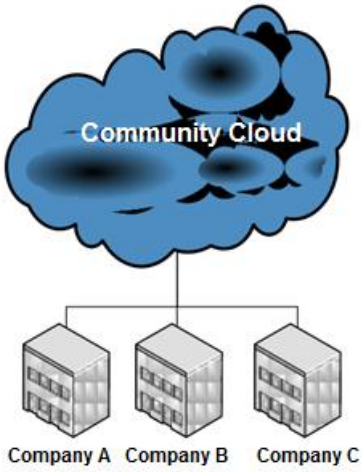

Figure 8 Community Cloud Representation. (Instituto Nacional de Tecnologías de la Comunicación, 2011)

Currently there are plenty of reputed Cloud Services such as AWS (Amazon Web Services), Sales force, the Cloud Service of Google... but for the project developed at the University of HAMK It has been chosen the one offered by Microsoft, known as Windows Azure, as it is one of the major initiatives in which the Cloud Computing refers. Windows Azure is an open platform for different programming languages like PHP or C/C++.

Some of the benefits of using this service are:

- Create, evaluate, debug and distribute Web services in a fast and accessible way.
- Eliminates the need to manage hardware.
- Reduce the generation and extent internal resources costs
- Perform high-volume storage, batch processing, and intense or high-volume computations
- Running generic processes in the cloud

The architectural component, which is responsible of providing the base services of Windows Azure in a transparent way respect the IT infrastructure, is called Windows Azure Fabric. This is responsible for ensuring that the application receives runtime, bandwidth and resources in general for the execution.

In the section of the backend infrastructure of Thingsee, the relation between Windows Azure with other tools that allow representation of the data stored will be explained in detail (Instituto Nacional de Tecnologías de la Comunicacion, 2011).

2.4 Data Science Concepts

2.4.1 Data Management

Data Management is constituted by multiple disciplines based on the treatment and management of data as a valuable resource.

In order to make these data useful they must meet certain characteristics as accuracy or reliability, but must also be timely in order to achieve competitive advantage through its use. But to be able to use the set of data obtained they first have to be processed to be transformed into useful data which must be subsequently analyzed. Therefore the data held by a company are considered as assets, which is the reason why they must be protected and treated as such.

Thanks to the data the strategic objectives of the companies are more easily achieved. Analyzing the data gathered, the market needs can be determined and companies are able to develop products that can satisfy almost unequivocally the customer needs. They also allow you detect trends, behavior patterns and even potential problems in the market. But as has been said before, to take advantage of all this information, must be processed and analyzed, in addition to meeting certain requirements.

All those data stored in the databases can be managed through the systems known as Data Base Management Systems (DBMS), which allow storage, modification and extraction of the information (Informatica, (2016).

The Data Management can bring benefits such as:

- Greater security
- Improved sales and marketing strategies
- Greater knowledge about the needs of the market
- Improved data management to reduce organizational risk

2.4.2 Open Data

The concept of Open Data is based on the use of certain data in an open way, without restrictions for the public, patents or any type of control mechanism that prevents its use publicly.

Advocates of the concept of Open Data argue that restricting the data goes against the common good and should be shared, due to most of the data have been obtained by government agencies through the funding of the citizenship. This refers to data such as weather, geographic or statistical data; but the sharing of the mathematical formulas, genomes or any type of information belonging to society is also desired.

Some feature that must meet the data in order to be referred as Open Data are:

- **Access and availability** The information must be available in a suitable and modifiable format, at a reasonable cost and preferably it should be able to be downloaded via Internet.

- **Redistribution and reuse** They should be able to be reused and even integrated with other datasets.

- **Universal participation** everyone should be able to use and distribute the information.

- **Without restrictions** They cannot be only open for certain purposes (as may be education) or be restricted to non-commercial uses.

The data obtained by public bodies not only allow transparency in national affairs but it can be useful for example for pharmaceutical companies in order to know statistical data of patients with different types of illnesses. This is just one example of the benefits that involve the sharing of useful data both for public as for companies (European Comission, 2015)

2.4.3 Big Data

The concept of Big Data refers to the management and analysis of large amounts of data, which cannot be treated in a conventional manner, because they exceed the capacity of the software tools talking about data processing.

This concept refers to the services created in order to process the different kinds of data in which Big Data is divided, which are:

- **Structured Data** These are the type of data that have a defined format and can be stored in tables. For example dates, numbers, strings…

- **Semi structured Data** The kind of data that don't have a particular format but have markers that allow us divide the set of data in different formats. For example HTML, JSON...

- **Unstructured Data** These data lack of format, therefore they cannot be structured in tables or summarized. For example text documents, PDFs, emails...

The aim of the Big Data systems is processing of data in order to obtain useful data to facilitate decision-making.

An example where Big Data systems are used is when companies gather information in order to understand the needs of the clients and to develop products which obtain great success in the market.

The difference between this new system and the conventional systems of management and analysis of data is determined by the concept "3 Vs": Volume, Variety and Velocity. This concept means that Big Data systems are able to manage a large amount of data that have a big variety at a high velocity.

Once the data have been stored the data have to be analyzed, there are several methods for this such as Data Mining, which is based on finding predictive behavior. This process is represented in Figure 9 (Blue Yonder. (2015). *Industrial Big Data Know the future – automate processes)*..

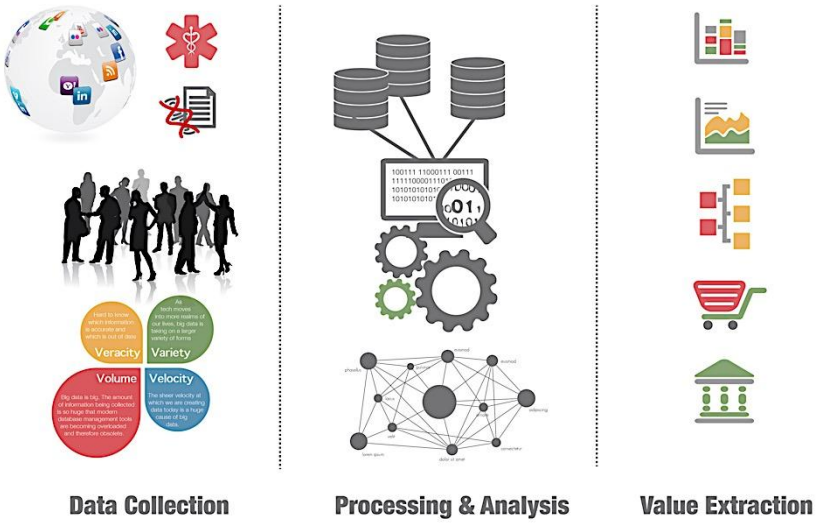

Figure 9 Big Data Processes (Yonder B., 2015)

2.4.4 Data Mining

Data Mining, also called Knowledge Discovery in Databases (KDD), is a process based on the detection of previously unknown patterns that can be potentially useful. Thanks to the information stored in databases we are able to identify trends and correlations that allow us to make predictions that can pose competitive advantages.

The technics of Data Mining can be divided into two different groups:

- **Supervised** One variable is explained by the rest of variables.
- **Unsupervised** There is no preferred variable.

Thanks to Data Mining we can perform different functions based on observations, for example:

- **Clusters** Groups are constructed by individuals which are similar to each other.
- **Associations** Observations are used to detect associations between variables.
- **Sequential Patterns** In order to identify patterns, sequences or trend

Data Mining is closely related to statistic techniques. Examples of these techniques used in Data Mining include:

- **Decision Trees** The trunk of the tree is the starting point of the decision. The branches start with the probability of the first event. The probabilities of every event produce two or more possible effects, some of which lead to other events.
- **Genetic Algorithms** In which solutions are randomly generated and evolve in order to find increasingly optimal solutions.

Some of the areas in which Data Mining is applied are:

- **Financial and Business areas**: In order to determine production and cost rates, marketing, fraud detection, discover customer profiles.
- **Health:** Managing and checking adequacy of treatments, diagnosis from information already stored in hospitals.
- **Science:** Genomics, biological data.
- **Computer Systems:** Attack detection and control of the system.

(Institut d'Investigació en Inteligencia Artificial, 2014)

3 THEORY BUSINESS MODELS, VALUE CHAIN AND SUPPLY CHAIN

3.1 Introduction to Business Models

The business model concept gained relevance in the last decade of the 20th century. According to influential authors and professionals in the Business Models field, such as R. Amit, C. Zott, or C. K. Prahalad among many others, this has been due to the prominent increase of Internet, the growth of emerging markets and the incipient concern of enterprises about issues regarding the lowest layers of the company. Since then, the business model concept has constantly been gaining importance in the business world. Even though many scholars and business practitioners have come up with multiple ideas, thoughts and publications concerning this concept, it is not possible to agree on a single definition. In fact, many publications about business models study the concept without even explicitly defining it. Therefore, in the following paragraph, it is exposed the definitions and explanations provided by the most remarkable authors of this topic.

- **Peter Drucker** He defines it as "assumptions about what a company gets paid for". A good business model should answer certain key questions such as who is the customer?", "what does the customer value?", "how do we make money in this business?" and "what is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?" (Ovans, A., 2015)

- **Joan Magretta** According to Magretta, a business model is "A set of stories that explains how enterprise work". In the same train of though as Drucker, Magretta focuses on assumptions over on money. She sees a Business Model as a compound of two parts, "part one includes all the activities associated with making something: designing it, purchasing raw materials, manufacturing, and so on. Part two includes all the activities associated with selling something: finding and reaching customers, transacting a sale, distributing the product, or delivering the service". These ideas match with the Michael Porter's theory about Value Chain as it can be seen later on this section. (Magretta, J., 2011)

- **Joan Casadesus & Joan Ricart** These scholars believe that a business model should collect the choices that the managing board has to make when determining the processes that define their activity. They classify the choices in three main categories:
  - **Policy choices** They refer to courses of action that the firm adopts for all aspects of its operation. For example, the location of the plant, the existence of unions or incentives.
  - **Asset choices** They refer to decisions about tangible resources, such as manufacturing facilities, equipment…

- **Governance choices** They reflect who has the rights to make the decisions concerning the other two categories (Ovans, A., 2015)

– **Raffi Amit & Christoph Zott** They believe that a business model should describe "the content, structure, and governance of transactions designed in order to create value through the exploitation of business opportunities" (Zott C. R. A., 2010).

Despite the diverse approaches presented, a generic Business Model should focus on setting the guidelines to create value. When talking about value we refer to the amount that customers are willing to pay for the good. It is important to point out that a company will only be successful if it manages to create sustainable value overtime. This means determining a strategy and an operating mode that establish how the company is going to obtain revenue, how it is going to manage human capital and how it is going to interact with its clients, investors and suppliers.

We believe that it is crucial that these ideas remain pervasive when a company elaborates a business model under digitalization.

3.2 Theory of Value Chain Analysis

Besides in business model concept, when defining the Value Chain concept, there is an author that outstands over anyone else. Michael Porter defined in his book "Competitive Advantage: Creating and Sustaining Superior Performance" (1985) Value Chain as a model that encompass the activities carried out by a company, since they receive an input, until the final good is sold and delivered to the customer. The reason why it became popular to analyse Porter´s Value Chain mode is because it allows the company to find out how to create the greatest possible value for its clients in an efficient manner.

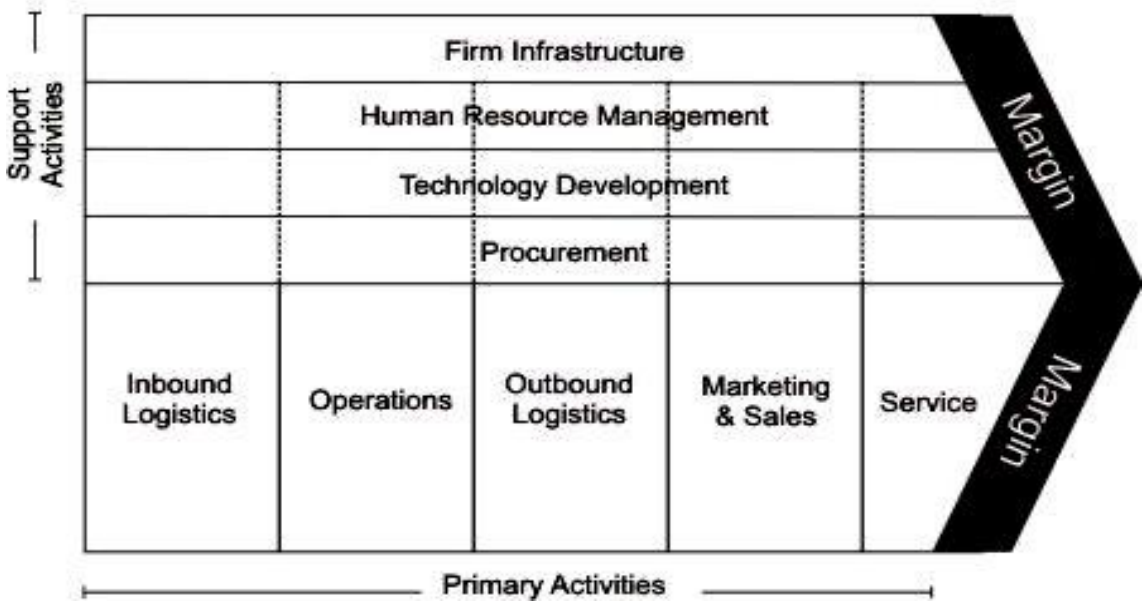

Figure 10 Value Chain Scheme (Mind Tools, 2013)

In the Figure 10, the activities of a firm are sorted into two main categories. On one hand, primary activities refer to those that influence directly the creation of the product or service. These include:

- **Inbound Logistics** Set of activities consisting on receiving, storing, managing and distributing inputs, such as raw materials, parts and other items dedicated to the production of the final good. In this activity, good relationships with suppliers are crucial in other to create value and obtain a competitive advantage.

- **Operations** These activities encompass those that convert inputs into the product that the final customer will buy. Operations are the core of the value chain and most of the value is created.

- **Outbound Logistics** Once the product or service has been developed and produced in the operation activities, they need to reach the final customer. Every activity indented to do so, mainly storage and distribution, compose the outbound logistic. Firms typically obtain competitive advantages when they manage to interact fast with customers and retailers and deliver the final product in a short time at a low cost.

- **Marketing** Processes which goal is to sell the final product or service to a chosen marketplace at a certain price. The firm's job in this process is to find the right combination of marketplace and price in other to maximize firm's profit and not revenue. In this stage, it is very important to make clear which are the company's competitive advantages.

- **Service** These are the activities that aim to maintain the value of the company's product or service to its customers once it's been purchased. Noticing the customer needs is the key to create value and obtain competitive advantages.

It is highly important to optimize primary activities in order to provide the firm a competitive advantage and to create value greater than the cost of the activity, and therefore generating more profit. This is the reason why "Margin" is represented in the Figure 10.

On the other hand, support activities' job is to provide assistance to the primary activities so they have a better performance. Michael Porter identified four main support activities:

- **Firm Infrastructure** Activities that support the enterprise-wide, such as accounting, finance planning, legal issues, administrative procedures… They are necessary so the organization can carry out its main activity and be able to use their competitive advantages.

- **Human Resources** Activities related to the search, recruitment, training and development of the staff. Employers and employees are a highly important source of value in order to create value and competitive advantages, and therefore, it is necessary to implement good Human Resources practices.

- **Technology Development** Refer to those activities of the company related to the research and development. The achievements accomplished in these activities have a crucial impact to create value and competitive advantages in the primary activities.

- **Procurement** Purchasing processes so the company receives the inputs necessaries to carry out its operation. This activity can provide value by finding the best supplier and negotiating the best prices.

Managers often compare their company's value chain with their competitors', this way they can find out if the firm has high or low costs in comparison with its rivals. Moreover, value chain analysis also points out its competitive advantages and can be a source of ideas that lead to differentiate from competitors. (Machuca, J. A., 1998).

As it will be explained in chapter four, digitalization fits in this model by helping to optimize these activities.

3.3 Theory of Supply Chain Management

Before getting deeper into the digitalization of the Supply Chain it is necessary to go over the fundamentals of Supply Chain, its management and its analysis.

3.3.1 What is a Supply Chain?

The term "Supply Chain" embraces every process that influence directly or indirectly the action of satisfying the client needs. A trivial supply chain scheme would be composed of suppliers, manufacturers, retailers and clients. Each link of the chain is connected to the neighbour links by flows. Basically we can sort the flows in three different types, goods' flow, financial flow and information flow. As it can be seen in the following figure, these are two-directing flows.

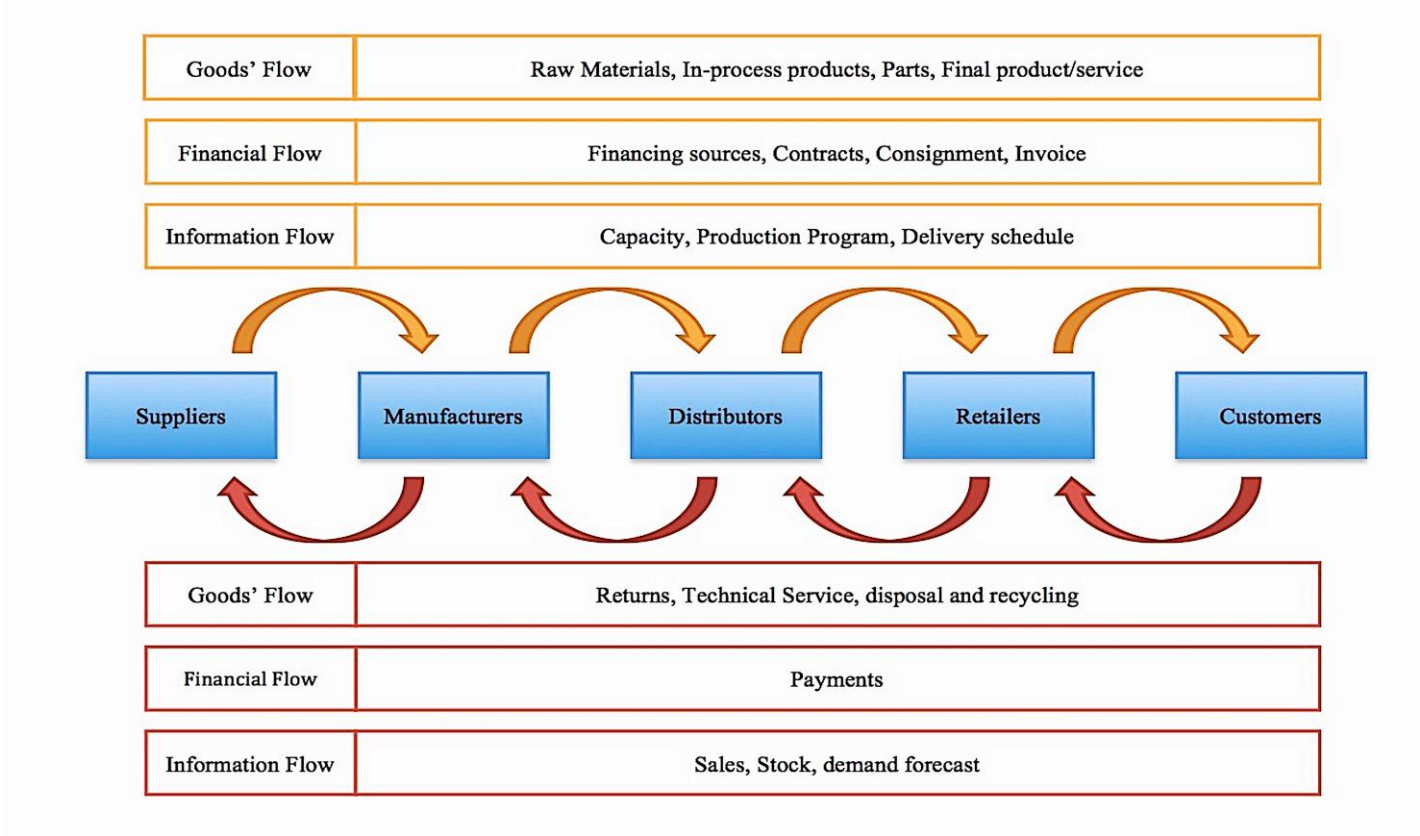

Figure 11 Supply Chain Structure

Unfortunately, an actual supply chain can be much more complex than that, it typically involves a whole network of suppliers and the production of the product or service can be carried out by a set of enterprise with different structures. In addition, the clients' nature can be varying and complex, and this influences the retailers. As it can have been guessed, each link has influence in the rest of links of the chain, for example, if the manufactures and retailers are complex networks, this can generate as well into a complicated network of distribution. This frequent framework has led companies to focus on Supply Chain Management in order to be successful. This task involves developing and managing a global network that consists in delivering

products or services from raw materials to end-customers through engineered flow of information, distribution and monetary transactions. Therefore, we believe that when managing a supply chain, it should be intended to optimize the chain as a whole instead of trying to optimize each link separately. (Meindl, S. C., 2014)

3.3.2 Structure of Supply Chain

In order to get a deeper understanding of Supply Chain, it is essential to categorize the different types according to the enterprise structure

– **Vertical Integration** It consists on bringing the Supply Chain inside of one organization. A very clear example of Vertical integration was Ford Motor Company in its early days. Henry Ford had to face two main problems to which finding a solution that would satisfy both seemed impossible. On the one hand, the supply chain network was too small to satisfy the high demand, but on the other hand it was too expensive to stockpile a large amount of parts and materials. In this scenario, Henry Ford decided to own the whole supply chain having total control over it. Ford Motor Company owned coal and iron mines, rubber plants, a rail network, and glassworks among many other factories. A vertically integrated supply chain grows by adding departments, merges or by acquisitions of companies at different stages of production or distribution within the same industry, in an attempt to create a self-sufficient enterprise.

The main characteristics of vertical integration are:

- It allows developing specialised assets
- Synchronization provides a better understanding in terms of quality and helps to lower the cost of transactions between entities.
- It gives more control over the business
- Components of the supply chain cannot compete separately in the marketplace
- Decreases flexibility because big company decisions affect many components of the chain
- It requires a very big investment to get the company underway

– **Lateral Integration** is the most common approach to manage the multiple activities within the supply chain. It is about expanding a business either within the same industry or a different one. Different business that are laterally integrated usually have similar distribution channels, they have some technology or operation in common or share some processes throughout their supply chain. A company can achieve this growth through internal expansion. This can occur when a retailer increases the variety of products it sells in a specific category. An example of lateral integration would be a telephone company that enters the Internet and/or Cable TV market. The parts

that compose the supply chain can be different companies or departments of the same company.

The main characteristics of lateral integration are:

- It deals with components of the SC as suppliers or Customers by transactions, contracts...
- Each SC component focuses in their core competencies
- Good to achieve economies of scale and scope

3.3.3 Supply Chain Management Objectives

For an effective implementation of digitalization, is necessary to understand and keep in mind the objectives that Supply Chain Management pursues. Each firm has its own goals according to its mission, vision or its current situation; however every supply chain is concerned with the efficient integration of suppliers, factories, distributors and stores so that the goods are produced and distributed in the right quantities, to the right places and at the right time. This enables us to list two objectives:

– **Efficiently Use of Resources** In order to achieve this goal, there should be improvements in different areas, however every modification should be helping the optimization of cost.

  - Replenishment of materials, parts and products when it is necessary. This means working to reduce the time between an order and reception, which implies a better coordination between links of the chain. In summary, optimizing the stock levels.
  - Reducing the cost of transportation.
  - Producing at the adequate quality, neither at higher quality than required nor under the product specifications.
  - Having the adequate equipment and manpower

– **Improve Customer Service** Is the ability of the company to address the needs, enquires and request of customers. This involves having the product or service available when the customer demands it and providing it with the quality desired. In addition, it should be satisfied the customer requests after the purchase. If these three aspects are fulfilled, then the supply chain has achieved customer satisfaction.

More over, a generic Supply Chain should also consider achieving the following goals:

– **Strength partnerships** A partnership in supply chain is based on trust, sharing risk and cooperation towards achieving competitive advantages. Some typical competitive advantages yield from partnership are adding value to a product, shorter time to market and improve its access, build financial strength by increasing income and sharing costs, add technological strength by sharing expertise,

strength in operations by lowering costs and cycle times, enhancing strategic growth to access new opportunities, Improve organizational skills by sharing knowledge.

– **The three V's** Today's industry has different patterns, sourcing is more complex than before, partially due to opening markets and emerging countries, products have shorter life cycles, there is a constant innovation… each patterned aided by the increase of information technologies and competitiveness. This can lead to an undesired variability in the plans and results. In this scenario, the 3V's of Supply Chain have increased their relevance. It a rule used by supply chain managers that aims to reduce the variability of the processes by increasing visibility and velocity. (PricewaterhouseCoopers. 2012).
  - **Visibility** All agents must have access to the information across the whole supply chain. It will be vary valuable to trace their customer service policies.
  - **Velocity** Due to the constant innovation, high volatility and competitiveness, a company will manage to obtain a great competitive advantage if they are able to react fast to changes. With this purpose, supply chain managers intent to reduce execution times, minimize inventories… This aspect is crucial to win or loose clients.
  - **Variability** It has to transmit with high reliability the demand received. This aspect is very important since the scenario that many supply chains face is very volatile, so it is necessary to develop a managing strategy that removes the undesired variability.

Figure 12 Supply Chain 3V's Rule

□□

It is important that these goals are achieved simultaneously without trade-offs among them. "Efficiently Use of Resources", "Improve Customer Service", "Leverage Partner Strengths", and "The Three Vs" are objectives that are broadly common to most firms. Nonetheless, Value Creation is undoubtedly the main purpose of every organization and therefore the objectives cited have to intent to maximize the creation of value.

3.4 Differences between Value Chain and Supply Chain

Both concepts refer to models created to understand how businesses work, but from different approaches. There is not a borderline that dictates whether a certain business aspect, such as an operation, a department or process, belongs to the Value Chain or the Supply Chain. As explained before, Value

Chain is a model that describes the activities that a company carries out to deliver a product, while Supply Chain refers to the network composed by everything involved (organizations, activities, processes, information, resources….) in the creation of a product, from the raw material to the final delivery. This section may be helpful when we get deep into digitalization so the reader do not get lost among apparently similar ideas.

PART TWO.
ANALYSIS AND APPLICATIONS

4 DIGITALIZATION OF BUSINESS AND INDUSTRY

As discussed in previous chapters, we are observing a new trend in technology, a significant amount of new products, systems and services are orientated to connect devices and machines, generating a large amount of data. In the following images, we can see at a glance how digitalization is growing by the amount of connected devices and the market development.

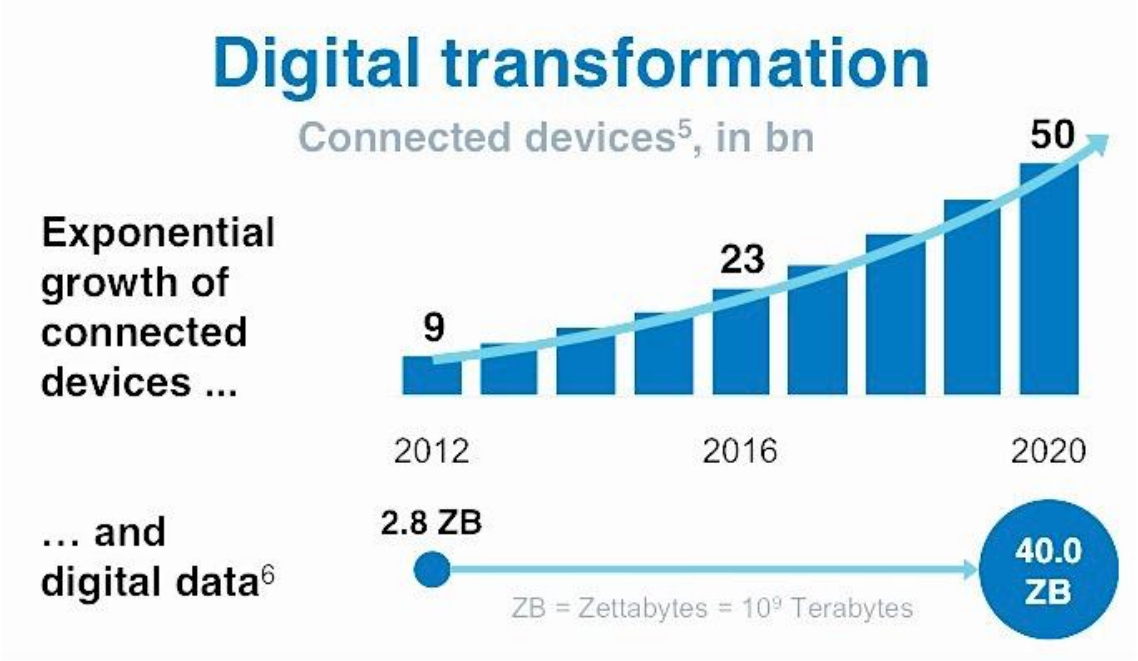

Figure 13 Evolution of Digital Devices Used (Gaus, D. H., 2016)

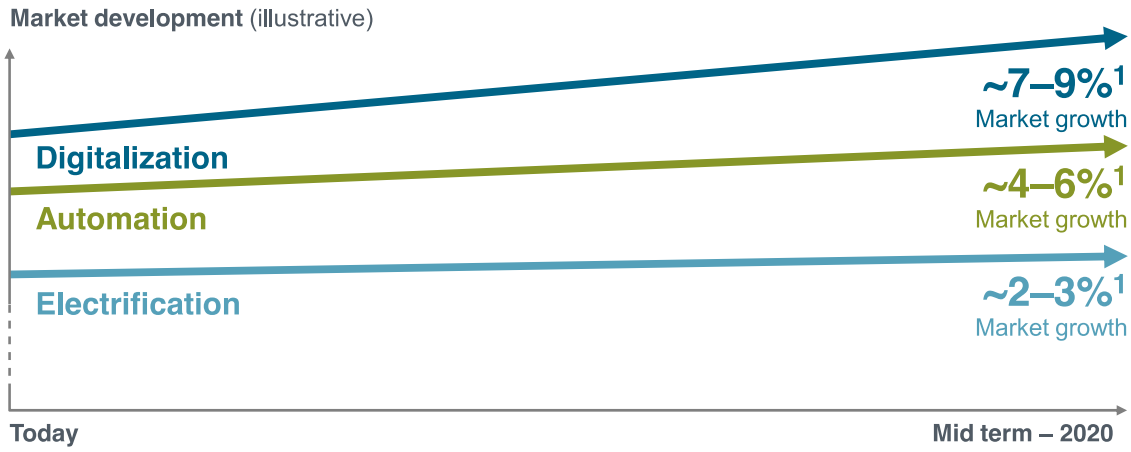

Figure 14 Market Growth (Gaus, D. H., 2016)

We can observe that not only digitalization has significantly grown in the recent years but it is also expected to grow even faster in the coming years.

Humans intend to use the data generated to create value. We have observed that individuals and enterprises, in most the cases, are not changing what they are doing, but how they are doing it. Therefore, we approach digitalization as a tool to improve the Value Chain and Supply chain, which are models that existed before the digital era.

4.1 Digitalization of Supply Chain

4.1.1 Traditional, Digital and Hybrid Supply Chain Models

The purpose of this chapter is to make clear the three different types of supply chains according to their level of digitalization that are being examined in this thesis.

- **Traditional Supply Chain** This concept refers to processes basically carried out on paper. We would also like to add to this type supply chains where even though computers are being used, there is an absolute lack of synchronization and each process has to be done manually. Nowadays, this sort of supply chain is very rare in medium sized or major companies, but is still present in small businesses.

- **Hybrid Supply Chain** This is the most common type of supply chain regardless the size. The original definition of a hybrid supply chain is that one in which paper-based and IT processes coexist. As with traditional supply chain, we understand that hybrid means that not every process synchronized. This means that the supply chain contains manual, partially synchronized and fully synchronized processes.

- **Digital Supply Chain**: Thanks to the previous definitions, this one can be intuitive. A digital supply chain should be composed by IT-based process and rely on digital tools. Synchronization reduces significantly the managing workload; every task in supply chain management that is possible, it is done automatically, leaving for manpower the decision-making issues. Enterprises are starting to switch to this sort of structure, especially those with a substantial size. In the following section it will be explained its benefits and the procedure to implement it.

4.1.2 Digitalizing Supply Chain

Why transferring to a digital supply chain

The vertiginous growth of technology, and consequently, of digitization is having an important influence on the industry and businesses in all of its aspects. In addition, the business world is everyday more and more competitive. In this scenario, a company cannot give up on any potential competitive advantage and they are almost obligated to embrace a digital transformation to their business. An effective digitalization will allow organizations to boost their performance by enhancing their strong capabilities and improving their weaknesses so that ultimate goal of a supply chain can be achieved, as explained in the previous section, this is to create value.

Along with the influence of technology and high competition, another pattern of today's business world is the high volatility, and supply chains cannot turn away from it. Through digitalization, the supply chain managers should turn this hazard into an opportunity; by intensively analyzing the data provided by the digital services, a supply chain could anticipate to the consequences of volatility and obtain a significant advantage over competitors. Data analysis is also a key aspect when digitalizing a Value Chain, however we considered more adequate to explain it under the Supply Chain because it can have a bigger impact. This is because a supply chain, as explained before, is a system composed of different organizations, which means that the flow of information can be one of its weaknesses. Information might be transferred too slowly and distorted. The goal here of digitalization is to transfer the information fast and clean between links of the chain, and if advanced analytics is successfully used, anticipation to events would be a crucial competitive advantage, something unthinkable before the digital era. Improving communication has undoubtedly benefits on process by improving its flexibility, performance and reliability. (Griffin-Cryan, M. R., 2011).

Business Process optimization

Due to our industrial engineering profile, we would like to analyze business process optimization from a manufacturing approach in order to contribute to this thesis with our work experience and area of expertise.

Digital services can be very helpful to optimize business processes since they enable integration and synchronization among them. We consider that this is a key aspect in supply chain management; the interaction and coordination among different organizations is very complex and this makes integration and synchronization of processes much more difficult. Those supply chains that manage to do it effectively will gain great advantages over competitors. Other benefits of digital services orientated to process optimization are the collaboration with customers and suppliers and detect industry scenario.

For instance, when managing the flow of goods, it is important to visualize the checkpoints and milestones that want to be monitored. The key here is to ensure through the data, that the physical process is running according to

the objectives planned. It can also be taken advantage of the data when setting the goals, for example, by knowing the scenario, customers' and suppliers' demands and other aspects yielded by the data analytics.

In the case of manufacturing, digital services can significantly help to automate processes. What we look when automating an operation is to reduce costs without giving up on quality or even improving it. However, when automating a process, it typically looses the flexibility necessary to deal with external factors such as suppliers' capacity and demand. Digital services can synchronize process of the suppliers and the manufacturer, and analyse patterns in market to achieve an accurate prediction of the demand, so the supply chain can be optimized. (Siemens AG., 2015)

How to transfer to a digital supply Chain

In order to carry out an effective transformation to a digital supply chain, the conversion has to be integral, which means adapting the supply chain to digitalization from its basic pillars to its surface layers. The management team should begin by developing a digital strategy and adapting its business model to digitalization, which we consider the basic pillars. Hereafter, it should be analysed the operations of each component of the supply chain in order to the implement digitalization to the business and industrial operations. Implementing partially digitalization not only may not help to create value, but also can create incompatibilities among processes. According to the management-consulting firm McKinsey & Company, they have seen many companies that invested millions of dollars to integrate theirs supply chain management systems and they have severely failed by even destroying their value.

So that the process of digitalization is integral, we suggest that a supply chain should follow the next steps:

- **1. Design a digital strategy** It is important for a Supply Chain to know where they are and where they want to be, this is the reason why objectives were explained in the section "Theory of Supply Chain". Hereafter, it should be studied how digital service can make progress desired.

- **2. Educate Staff** Digitalization will introduce in the organization new technologies and consequently changes in the working routine. It is crucial that employers and employees understand and feel confortable working with the new tools, so they can focus on their job, which is what really add value to the enterprise.

- **3. Analyse processes** Once it has been determined where does the supply chain needs to improve and the manpower can handle the change, processes and activities should be analysed in order to implement the new technology and digital services.

- **4. Apply the new digital services and technology** Implement the new technology, systems and services without disturbing operations.

- **5. Analyse data** The data provided by the digital services can help the supply chain understand what is going on, find out the causes of weaknesses and strengths, observe patterns, predict future trends, yield ideas…

- **6. Embrace new opportunities provided by the digital service** Take advantage of the information and ideas provided by the data, and materialize it into value creation and competitive advantages

- **7. Go back to step 1** Following the concept of Kaizen, a manufacturing philosophy that states that every process should be continuously improved, and observing that technology is in permanent development, we considered that the process of digitalization has to be constantly updated.

Since several authors believe that the culture of a company should be adjusted to digitalization, we would like to point out that we do not believe that culture transformation should be included in the process. We understand that digitalization should be a tool to achieve more competitive advantages and more effectively, but it should not be the reason why an organization modifies its values, mission, vision or nature.

4.2 Digitalizing Value Chain

These technologies are changing how things are designed, made, and serviced around the globe. In combination, they can create value by connecting individuals and machines in a new "digital thread" across the value chain

It has been proved by successful cases, that digitalization can bring to the enterprises many significant advantages; for example, operating models can become more flexible, dynamic and controlling, production process can be optimized, new patterns can be detected and become new ideas that potentially could make a difference in the market. The mean to all of these potential improvements is the data analysis provided by digital services.

Operations improvement

As explained in "Digitalizing the Supply Chain" section, digital services are becoming crucial in order to optimize production processes, and obviously this is also an important aspect when analysing the value chain of a business.

The ideas about coordination between producers and suppliers exposed in the section "Digitalization of the Supply Chain" can also be applied to the

Value Chain model when we intend to improve the primary activity of Inbound Logistics through digitalization. Equivalently, to the primary activity outbound logistics we can apply the ideas of synchronization between customers and producers in a digital supply chain.

Regarding to process optimization, there are many similarities between digitalizing the value chain primary activity "Operations" and optimizing process in a supply chain. Another case in which digitalization can also help to improve a manufacturing process is when it comes to equipment maintenance. In many factories, maintenance involve high costs, stopping the production line, not satisfying the demand… Thanks to data analytics, it can be predicted accurately when maintenance is going to be needed, preventing emergency stops and idle time, causing negative financial impact.

The difference between digitalizing value chain and supply chain, is that in the first one intends only to improve a certain business entity, meanwhile the second seeks to optimize globally a whole network of organizations that compose the supply chain. Each enterprise should consider whether is more convenient implementing digitalization considering one or the other model. In large corporations, it can be more fruitful considering both of them. (Siemens AG., 2015)

Customer service improvement

The last primary activity of the Value Chain, Service, can also be significantly improve through digitalization. A digital customer service system should provide clients a faster interaction and accessibility, so their doubts and requests are solved effectively in the shortest time possible.

Now that we have a goal to pursue when implementing digitalization into customer service, we can start discussing how the transition should be done. Moreover, a company has to keep in mind that the final customer is their source of income and therefore listening to their requests and implementing them is crucial to success.

Transferring from a traditional to a digital customer service system is not only adding new interaction channels to the existing ones such as call centers and technical services at retail stores, the organization should be capable of absorbing data, analyzing it and applying the outcome in order it to improve any activity in the value chain. The transfer procedure should also include an analysis of the current customer service, find out where are the weakness so the implementation of new channels fix theses problems.

The following graphic is a result of a survey on digital customer service carried out by Mckinsey & Company; it displays the channels used for interaction between the company and customers, who has access to the information and who provides it. In addition, and following our statement that digitalization should be integral and synchronize business process, the organization management systems, that are explained in the next point, should be ready to automatically received data from the customer service in a well structured way. (Banfi F. B. G., 2013).

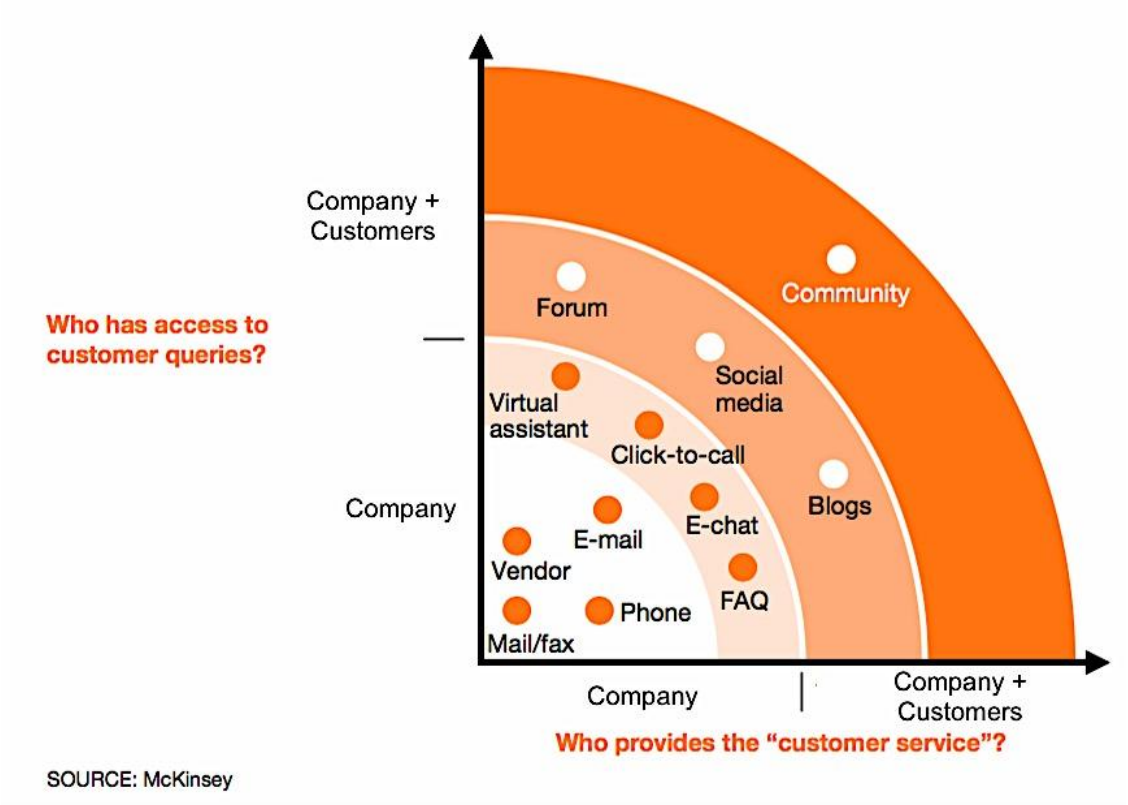

Figure 15 Customer Service Channels (Banfi F. B. G., 2013)

As it can be seen in the graphic, digital channels have surpassed traditional channels as the chosen source for customer and technical service.

The reason why the graph axis are fragmented in "Company + Customer" and "Customer" is because thanks to new channels, customers are helping each other to solve product issues. They are very interesting since a customer approach sometimes is more helpful for the user than a company approach and they barely imply costs to the enterprise. Moreover, they are a good source of ideas for improvement that do not require analytics, and they are precisely digital channels the ones that provide these advantages. (PricewaterhouseCoopers, 2015)

Thanks to digital channels, the organization can obtain more information from the customers, faster and more efficiently than before, and intending to build a better brand image.

Before closing this point, it is interesting to share the conclusions of the survey made by a benchmark company like McKinsey & Co. They point out that the main benefits of digitalizing customer service activity would provide a company the following benefits:

- **Lower costs** While traditional methods such as regular mail, e-mail, or click-to-call all hover around the call centre cost, the costs of digital approaches are estimated to be significantly lower.

- **Higher customer satisfaction**. McKinsey survey results are clear evidence that a purely digital journey drives higher customer satisfaction.

- **Richer differentiation** High-quality digital customer service is a key to differentiate a company from its competitors. It reinforces the brand image, customer loyalty and improves customer experience.

- **Innovation (new ideas)** Thanks to advanced data analysis, we can observe patterns that explain what is happening in the company and in the industry, and the tendency they are taking. With this information, we can realize causes of strengths and weaknesses find new opportunities in the market and detect threats. We believe this is the keystone to establish new business insights, innovate in business processes and develop new technology

Managerial advantages

We believe that digitalization should be implemented throughout the whole organization; this means that it will involve not only the primary activities (Go back to Theory of Value chain if necessary) but also the support activities. Therefore, the way the business is managed should be influenced by digitalization. In this context, many enterprises have introduced a digital service known as IT Governance. It is a type of information technology system in which managers and executives rely for supervision, monitoring, control and direction of their organization. These tasks are now carried out faster and more effectively, reducing management workload and leaving for the managers the task of making decisions. IT Governance assist managers in decision making by providing accurate data, faster and well organized. (Shuptar, D., 2012)

4.3 Influence of Digitalization in Business Models

As it has been said several times throughout this chapter, the digitalization of an organization needs to be integral, and therefore, the core of every business, the business model, cannot be left behind. So that concepts are not mixed, is good to point out that this section is highly related to the first step, “Designing a Digital Strategy”, explained in the process of digitalization a supply chain.

Before getting deeper into the design of a digital strategy, we will discuss how the digitalization fits in each definition of business model, explained in the section 3.1, “Introduction to Business Models”.

- **P. Drucker** This author stated that a business model should be based on “the assumptions about what a company gets paid for”. Since we understand digitalization as a tool and that a company should keep doing the same activities but in a different way, the core of a business

model should not be affected. Nonetheless, P. Drucker states that answering the following questions are also necessary to build a business model:

- "Who is the customer?"
- "What does the customer value?"
- "What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?"

The Data provided by digital services and its analysis can be a great advantage to accurately answer these questions.

– **J. Magretta** If we consider J. Magretta approach to Business Models, " A set of stories that explain how an enterprise work", then digitalization has a direct influence. In previous sections, we explained how digitalization can improve the processes and activities of an organization, in other words, how the enterprise works.

– **J. Casadesus & J. Ricart** If we remember, these authors approach a business model as a set of choices, policy, asset and governance choices. From our point of view, digitalization should only affect asset choices. Thanks to digital services, an organization can update their equipment so that processes are accomplished more efficiently.

In any case, in order to attempt an integral digitalization, a digital strategy should be included in every business model since the rise of digitalization will affect to every sector. The executive team should visualize how digitalization will influence their current business model and value chain, identify the business processes where the greatest value can be created, realise which areas of their business model are vulnerable to the new trends and how can they address them, and decide whether is necessary to strengthen the staff to be able to deal with new systems, services and processes.

5 THINGSEE AS AN APPLICATION IN THE DIGITAL SERVICE ENVIRONMENT

5.1 What is Thingsee One Device?

Thingsee is an open software device developed by the Haltian Group. This device is provided with various sensors for measuring different parameters and sends the data in real time.

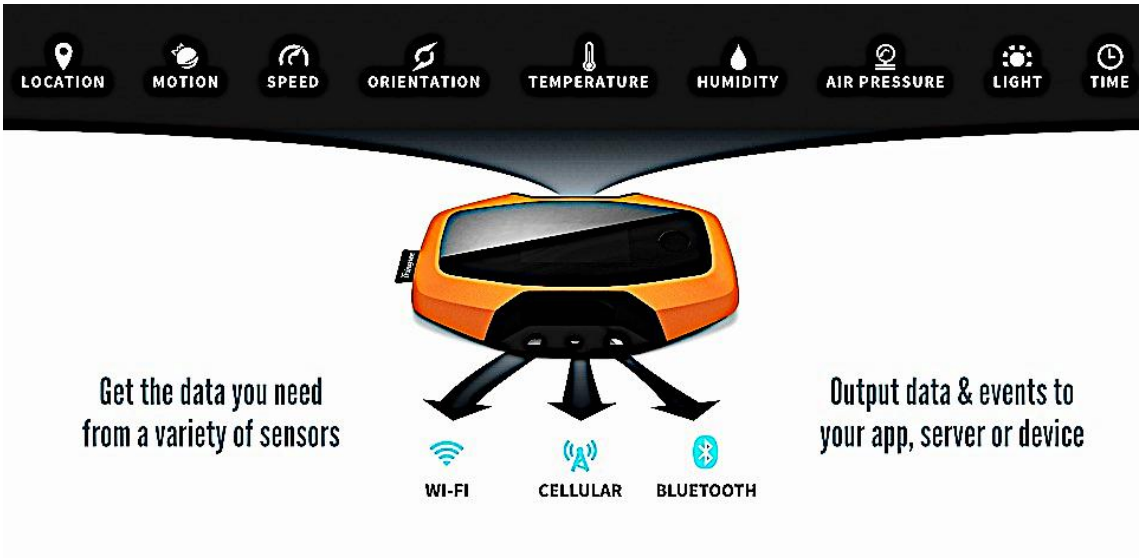

Figure 16 Thingsee One Device. (Thingsee – Haltian Group, 2015)

Concretely, the following sensors equip this device:

- Temperature
- Speed
- Luminance
- Humidity
- Acceleration (in different axes and also Impact)
- GPS
- Pressure

As an open source device, it can be programmed for measuring only the desired parameters every determined time, which makes this device very versatile. Thingsee can only support a program in its memory, but they can be unlimitedly stored in the web interface

While the data is being gathered, this information is sent to the cloud, an own cloud or to the Thingsee cloud. This allows the use of the data collected and their representation. To facilitate the data sending, the device can be configured for send them via Wi-Fi, Cellular, Bluetooth or USB; it also allows sending SMS to report the occurrence of certain events.

Thingsee has been tested under different pressure and impact conditions, so it is a robust device able to be used in more extreme conditions. It is also weatherproof, as it is able to withstand weather conditions which other devices wouldn't be able.

5.2 Back-end Infrastructure

5.2.1 What is a back-end Infrastructure?

In software engineering we can differentiate two types of infrastructures, Back-end and Front-end. The first one refers to servers, databases and data processing, in other words, the insights of computing, what is behind from user's interface; meanwhile Front-end is precisely about user's interface, where interaction software-user takes place.

The back-end Infrastructure referred in this thesis is a system developed by the Research Unit for Smart Services from HAMK University of Applied Science that encompass every technological component necessary, from the sensor to the final application of data.

Before getting deep into this Back-end Infrastructure it is necessary to provide the reader a basic background with the main components and terminologies that will be used so it will be easier to understand when it gets more complex. In the following figure it is exposed a trivial generic diagram of the Back-end Infrastructure:

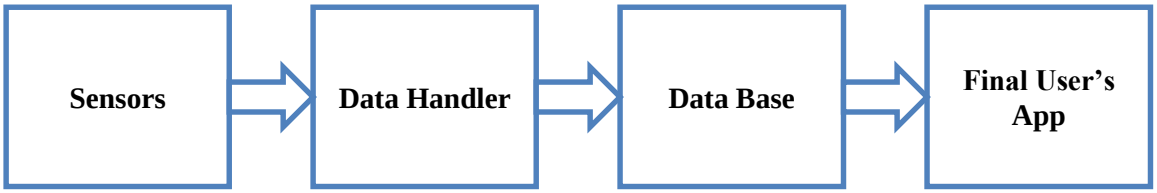

Figure 17 Trivial Back-end Structure

- **Sensor** It is a device that is able to detect actions or external stimulus and respond accordingly. These devices can transform physical or chemical magnitudes in electrical quantities.

- **Data Handler** The process of handling data consist on manipulating the input data coming from the sensor so that it can be properly read, edited and stored in the database.

- **Database** It is a warehouse where a big amount of information is stored. The data has to be organized in order to be easily found and used. It is typically hosted in a server, which is a remote computer to which a group of computer have access.

– **Final User's Application** This component refers to the utilization of the data collected by the sensor. The level of interaction between the system and the user depends on the application, however it is common to each one of them that the user visualizes the data in an understandable way. Typically the software carries out certain calculations so that the user gets more information at a glance from the same amount of data collected.

5.2.2 Back-end Infrastructure of HAMK

The Back-End infrastructure mainly developed by Ernani Rodrigues de São Thiago at the Research Unit for Smart Services has the following layout:

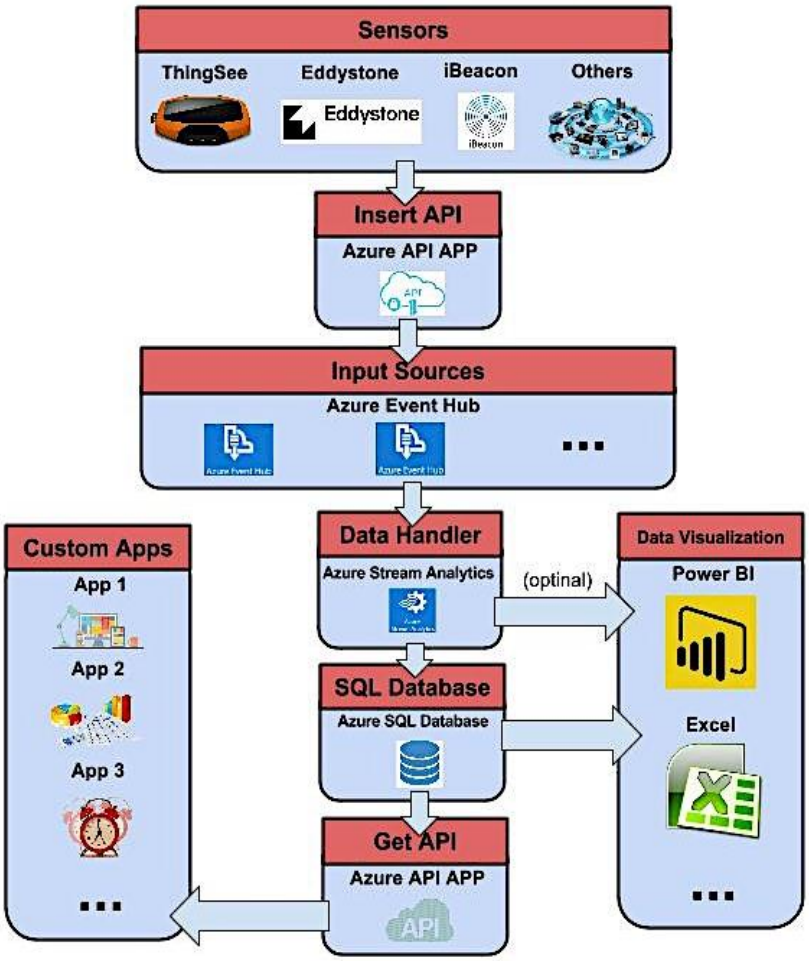

Figure 18 HAMK's Back-end Infrastructure (Thiago, E. R., 2016)

In this point, it is presented the information provided by the Research Unit for Smart Devices' wiki regarding their back-end infrastructure. This information is aimed for those who have a computer science background.

– **Sensors**

- **ThingSee** It is a device that contains several sensors, such as temperature, speed, luminance, humidity, acceleration, GPS and pressure.

- **iBeacon** They are low cost Bluetooth sensors that measure the proximity of others devices. In section 6.2.2, it will be explained more in detail it characteristics and applications.

- **Eddystone** It is a low energy beacon developed by Google. It belongs to the same family of sensors as iBeacons, but these ones are developed by Apple. Therefore, they also measure proximity of other devices and are connected via Bluetooth.

– **API**

To access the Input Sources (Azure Event Hubs) it is necessary that the client of the devices supports SSL and is able to use a specific library provided by Microsoft. SSL is a security protocol that encrypts the connection between the browser and the Internet. Some devices have a built-in client that is too hard to change or simply does not support SLL (such as ThingSee). This API was created to be a non-SSL alternative endpoint, and it is also used to "clean" the data that come from the devices, that sometimes contains unused information.

This API was developed using C# and MVC patterns, basically, it takes the data, cleans it and sends it to Azure Event Hubs. It currently has two endpoints, one of which is a specific implementation to handle Thingsee's data, and another General that supports the standard data.

– **Input Sources - Azure Event Hub**

Azure Event Hub is a highly reliable and scalable service that allows the connection of devices across platforms. On the current design, this service is used as a fast processing input for sensor data. This service receives large amounts of data and connects this data to the Data Handler.

– **Data Handler - Azure Stream Analytics**

The Data Handler is an Azure Stream Analytics service. This service is the main engine of this architecture, basically, an Azure Stream Analytics can have many input sources, and once this input sources are connected to this engine, it's possible to configure Azure Stream Analytics to send the data to a number of different services:
Azure Stream Analytics Output Options (SQL Database, Event Hub, Power BI, Table Storage, Service Bus, Document BD)
Currently, we are using this service to put the data on Power BI interfaces and databases.

- **Database - Azure Data Base**
  As previously mentioned, it's possible to configure the Data Handler to insert the data in a number of different databases, like SQL Databases, Table Storages, Document DBs and others. A database would store sensor's data and could also help to export the data to other platforms.

- **Data Visualization - Microsoft Power BI**
  There are two main visualization tools developed by Microsoft. Power BI is a cloud-based analytics service, very flexible, which allows to build dashboards and interfaces with drag-and-drop components. Those components include graphs and tables, also, it's possible to develop a custom visual with basic HTML, CSS and Javascript. The classic Excel can be used to visualize data from databases on spread sheets. (Thiago, E. R., 2016)

5.3 Potential Improvements

Thingsee device, in spite of being currently in production phase, has certain lacks and failures that must be solved in order to improve the product. Therefore we suggest the next improvements or implementations:

- **Incorporation of a position sensor** This would increase the versatility and would add a great value to the product, since the position sensor is actually one of the most used sensors. Thanks to this the product would be more used and more applications could be developed.

- **Improved GPS** The GPS of the device doesn't work properly when it is inside a building or when it is using a Wi-FI network. We consider this a serious mistake because it could be useful in the traceability process of certain pieces or in products inside buildings or warehouses.

- **Program updating** The updating of the program through the "Backend Update" button is inefficient, most of the times it doesn't work, forcing you to restart the device in order to change the program. It should be able to make it just from your computer without having to manipulate the device; this could mean the use in manufacturing without stopping the production.

- **Modification of the temperature sensor** It should measure the temperature of the ambience, not the temperature of the device. This forces to the device to reach the temperature of the ambience in order to obtain real values. This is highly inefficient if it is required to measure the temperature changes in short periods of time.

- **Change in the location of the SIM card** In order to introduce the SIM card is necessary to remove the screws and remove the device,

this results not very ergonomic if changes in the SIM card are required.

- **Change in the location of the RESET button** In order to reset the device it is required to unscrew the back of the device and to press the button. The RESET button should be on the outside of the device because of clear reasons of ergonomics.

- **Create purposes through the smartphone app** The app for smartphones of Thingsee should also allow to create purposes and send them to the device. The monitoring of the data that the app is offering is pretty lame.

6 USER CASES

6.1 Horticultural Lepaa case

6.1.1 Synopsis of Project

At Lepaa it was intended to determine the conditions in which potted lettuce grows in an optimal way to produce higher quality.

To carry out this project five groups of different samples were subjected to different environmental conditions. These environmental conditions were given by the following parameters:

- Temperature
- Humidity
- Luminance

These factors were measured by Thingsee One device, which accompanied the potted lettuces throughout the growth process.

After the growth process, the quality level and the sustainability were evaluated in order to determine in which conditions the potted lettuces grew better and how the different parameters affected them (Nurminen S. (2016) *Lepaa case*. Report).

6.1.2 Test Arrangements

Thingsee One Settings

One potted lettuce was randomly selected from each type of the five samples and assigned to a Thingsee; this device was placed next to the lettuce during the growth process.

In order to facilitate the data collection and the representation, each Thingsee was named differently, according to the treatment and the observer.

Ernani Rodrigues de S.Thiago programmed all the devices with the following settings:

- Humidity every 30 minutes
- Temperature every 30 minutes

The measurements lasted for 4 to 16 days, during that period the lettuces were daily photographed.

Restrictions on the placement of the lettuces

The lettuce will be maintained in an upright position in each storage location. The lettuces will be packaged in transparent plastic bags (open at the top), and will be marked with the number of treatment.
About the placement in the storages:

- Storage in refrigerator: Free placement, but neither in cooler locker nor close to the fruit.

- Storage at Room Temperature: Not close to the radiator or to a drafty place, for example at the height of the kitchen table.

The factors observed will be wilting, color, basal leaves, state of rottenness, etc.

Program

The preliminary plan was determined on 19th January 2016 and its specifications were as follows:

Table 1 Lepaa Project Preliminary Program (Nurminen S. (2016) *Lepaa case*. Report).

Treatment number	Depository / Duration	Depository / Duration	Depository / Duration
1	Cold room: 2 days	Room temperature (20˚C): 4 days	Refrigerator: 2 weeks
2	Cold room: 2 days	Refrigerator: 4 days	Room temperature: 2 weeks
3	Cold room: 2 days	Room temperature: 4 days+ 1 week in Refrigerator	Room temperature: 1 week
4	Cold room: 2 days	Refrigerator: 4 days + 1 week Room temperature	Refrigerator: 1 weeks
5	Cold room: 2 days	Refrigerator: 4 days	Refrigerator: 2 weeks

Finally the plan was modified on 24th February 2016 in order to accelerate the process and its specifications were the following:

Table 2 Lepaa Project Final Program. (Nurminen S. (2016) *Lepaa case*. Report).

Treatment number	Depository/duration	Depository/duration	Depository/ Duration
1	-	Room temperature: > 4 days	-
2	Cold room: 3 days	Room temperature: > 10 days	-
3	Cold room: 3 days	Room temperature: 4 days	Fridge > 6 days
4	Cold room: 3 days	Room temperature: > 10 days	-
5	Cold room: 3 days	Room temperature: >14 days	-

This case started on 11th March and finished on 28th March, when the last information was gathered from the greenhouse device. All other devices finished during the week of 14th March and 21st March.

Problems

- The device of treatment number four did not work properly. The cause of this could not be solved.
- The devices did not have enough battery for supporting the whole test. Buying power banks solved this problem.

Conclusions

As expected, treatment number five got better results because a priori was more appropriate. Treatment number four could not be compared with the data obtained due to malfunction of the device.
Although Thingsee was only used in order to verify that the conditions were the ones desired, it also allowed verifying if there was any unexpected change when passed from one process to the next one.

Being just a project in which Thingsee was merely a testing device, its function was not essential in the project, but it was a clear example of the control that these devices allow without the need of an operator controlling the complete process.

6.2 Other Cases

6.2.1 Mapping Thingsee

HAMK University of Applied Science is currently developing its own project based on the implementation of a mapping tool through the display data program PowerBI.

The aim of this project is to know the position of the selected device, in this case Thingsee, in real time and with a determined accuracy, thus reducing the margin of error.

This application is interesting in multiple businesses, but it is clear that the most useful application would be for controlling the traceability of the products of a company. Placing a Thingsee device in a delivery truck, it would be possible to know the exact position of the product in real time; this would allow the companies giving an approximate delivery time. This device would also allow knowing if the product has been damaged during the delivery process. The acceleration sensor could detect impacts in real time, which would lead in determining if the defect of the product is because of the transportation or due to a production error, so the costs may fall in the delivery company instead of the production company. Moreover it would allow knowing if the transport conditions were appropriate, if there is any limitation on the product.

Another application could be in a car rental company, so they would always know the position of the vehicle, thus preventing theft. This project entails certain limitations, for example, Thingsee's GPS doesn't work properly in closed places. That is why so its placement within a truck (in order to measure the temperature or humidity at which the products are exposed) could mean the malfunction of the GPS sensor, that is the reason why we proposed the improvement of the GPS in this chapter.

Another limitation is the accuracy of the GPS sensor. If the range is too wide, the difference between the position of a point and the next one may be too large, making this function very inaccurate. This imposes the need of measuring the data more often in order to determine properly the traceability, but that supposes a problem of overheating in the device and a problem with the battery life.

Therefore through the improvement of the GPS sensor of the device, all these problems could be solved. But in case of using the actual device, it should be taken in account the problems explained and the device should be connected to a electric source in order to prevent that the battery doesn't last long enough.

6.2.2 iBeacon

First of all it should be clarified what a Beacon is. These are low cost Bluetooth devices that measure the proximity of others devices.

iBeacon, the protocol developed by Apple on Beacons, is defined by Apple Inc. as *"a new class of low-power and low cost transmitters that can notify their presence to iOS devices by proximity"*(Apple Inc, 2016).

Figure 19 iBeacons (Future of Advertising Hackathon, 2015)

Basically the iBeacon can work in two ways:

- **Passive mode**

  This mode only get "hits" from other nearby devices and stores that information in a database for analytical purposes. A clear example would be the using of the iBeacon to create heat maps of where people have walked around, which could be very useful in the field of marketing. Ernani Rodrigues de S.Thiago, student of the Federal Institute of Sta. Catalina proposes selling this information to companies with marketing purposes, since they would be able to determine in which exact points the advertisement must be placed, as they are the busiest.

- **Active mode**

  In this mode you can send information to different devices. A good example of this, propose by Ernani S.Thiago, would be in a museum. The iBeacon could send information of each piece of the museum to the devices which have the necessary application when they pass near them.

Thus the iBeacon would be a guide for the people who wanted that information, note that applications could not be free in order to do business with them, because of the lack of a museum guide.

HAMK University proposes the use of iBeacons (in active mode) in the greenhouses located in Lepaa. This would allow to obtain information about each type of plant or vegetables found growing there each time you pass by its side. This is a similar idea as the museum one, but with own benefit for the University of HAMK, in which Mikko Kotsalo of the Research Unit is responsible for the project of iBeacon.

6.2.3 Suggested Cases

We believe that Thingsee has a great potential in the field of mapping. For this application we have come up with two kinds of business in which the project would fit perfectly:

- **Courier companies**

  Today most of the courier companies offer a tracking system for the package to deliver, but only consists on a mark each time that they pass by an office or a checkpoint.

  Thanks to Thingsee device and the Mapping tool, it could be done a package tracking more precise and accurate. Sending data every short time wouldn't be required, with the data being sent every 30 minutes for example the battery of the device would last long enough to track the shipment virtually without charging the device (although the device could be connected to a power bank anyway).

  This application is especially interesting in express parcel services, because it allows to the customer to know at all times the position of the product, thereby increasing customer satisfaction and the quality of the services offered by the company. Such shipments are expensive for the customer, so that increase of the quality of the service would help increasing the demand of this kind of express delivery service.

  It could also be useful, as mentioned before, if there is any impact that could damage the product, so that the company can determine which company is responsible for the damage suffered.

- **Company of vehicle rental entertainment**

  There are motocross motorcycle rental companies or dirt bicycles companies that could use these devices in their favor. Placing a Thingsee on the handlebars of one of those motorcycles it could allow us to know the location where you are, the velocity and acceleration at every moment. This information can also be represented over time in graphics

thanks to the PowerBI tool, allowing to see the evolution along the circuit and contrast it with graphics of different devices, in order to compare, in an entertainment way, who had the best results.

This could also allow finding out if the motorcycle has been stolen thanks to the application that Thingsee has already integrated. This application allows knowing if the device has exited the previously specified area. Because of this, Thingsee could be already implemented in this business without the need of the mapping tool.

Moreover, if certain improvements like the suggested in section 5.3 are implemented, Thingsee could have another potential application:

– **Waste Management Company**

We would like also to highlight the usefulness of the project developed by the garbage collection company ENEVO. Placing a position sensor in the container lid it could be determined if the container is almost full and must be emptied. Thanks the combination of the sensor and the logistic tools, the route can be optimized, saving time and money. The limitation of this implementation is that the sensor has to be placed in containers which have a lid that can be closed automatically (either through spring or by the own weight) because otherwise the sensor will not measure the required information if the lid is open.

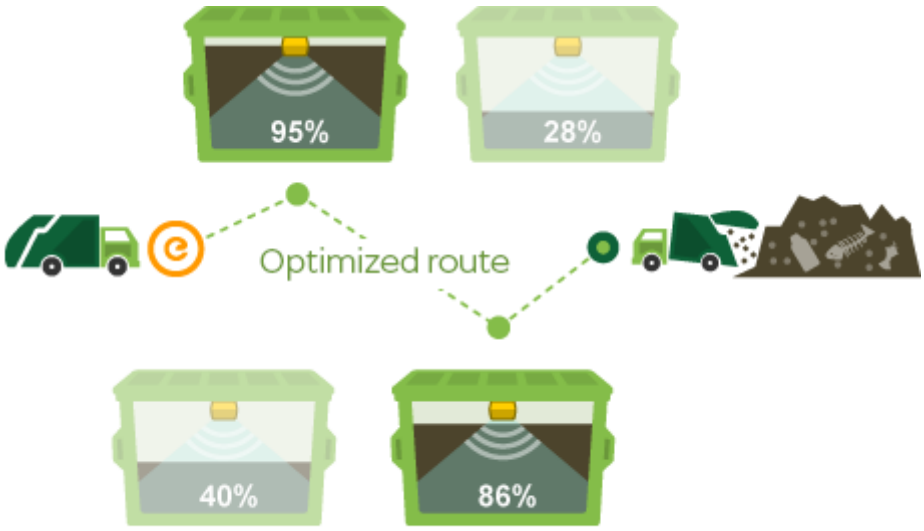

Figure 20 ENEVO Project. (ENEVO Group, 2016)

This is especially interesting in warm countries such as Spain. With the high temperature, the garbage odors are detached more easily, so the implementation of a system as developed by ENEVO would be very useful.

7 CONCLUSIONS

Technology is progressing increasingly faster and it is giving the chance to companies to optimize their processes and become more efficient, which is necessary in order to become more competitive in a market of changing needs. The scenario into which enterprises are immerged nowadays is so volatile and competitive that they cannot afford giving up on any potential competitive advantage. This has provoked innovation and technological development so that they have become necessary features for the success of a company.

Along with the rise of new technologies, digitalization is also increasingly present in business and industry today. Nevertheless, there are still organizations that could further exploit the benefits of new technology or implement it for the first time.

A clear example of this is the horticulture sector, a traditional business in which the implementation of electronic or digital systems has been believed to be practically unnecessary. Although automation has already been implemented into irrigation for example, the sector could still benefit more from new technologies. The greenhouses of Lepaa are a clear example of the potential of devices such as Thingsee. This project could be extrapolated and applied throughout the horticultural industry in order to determine the best conditions for growing all kinds of plants and vegetables. As mention earlier, we believe that Thingsee also has also a great potential in Mapping.

Adaptation of the new technologies always requires big investments, which takes time to be amortized. That is why many companies are afraid of changes, because they require time, money, new knowledge and sometimes implies stops in production in order to update the systems. Once the systems are adapted to new technology, the companies discover the great potential of these new tools, and eventually not only the investment has been written off, but has increased the efficiency of the company and companies result much more competitive in a market in which there is no place for companies that don't defend their position.

The adaptation to the 4th Industrial Revolution, based on data management, is supposed to bring a company competitive advantages, especially for those who arrive first. Being one of the first companies, allows a greater market share in which to get customer loyalty. However the later a company enters the technological revolution, the longer it takes to gain a considerable market share and they would have to compete more aggressively in order to getting space in the market.

The use of devices such as Thingsee enables innovation in sectors that are believed to be already mature or without a margin for improvement through technology, such as the horticulture sector for example.

Therefore we believe that bringing new technology and digital services to all the layers of an enterprise, in a well-coordinated way as proposed in this thesis, is an effective vehicle for creating value, achieving competitive advantages and positioning the company for the next revolution. This desire of companies to become leaders in their sectors is making them invest on examining future trends and this can be very broad. If we stick to the topic of this thesis on digital services optimizing business processes, we believe that the next step that organizations should take is to remove processes through digital services, and through that they will improve efficiency, time to market and customer satisfaction.

8 SUMMARY

For the development of this project we created the following scheme, which was also explained in the introduction chapter:

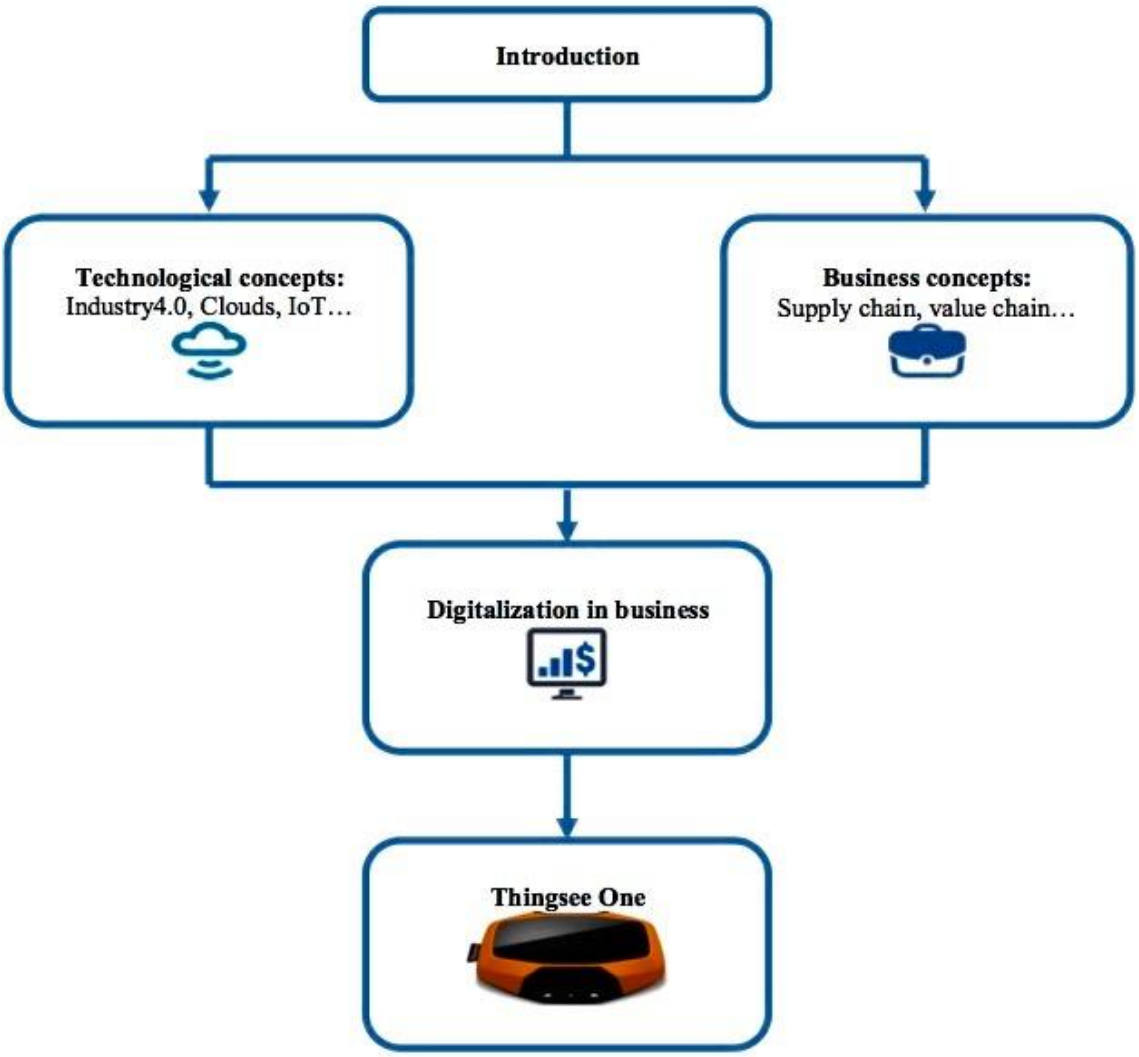

Figure 21 Thesis Content Structure

The first part of the thesis was a brief introduction to the project in which we explained its purpose and the current scenario in the business and industrial world. The theoretical background was composed of technological concepts and business concepts as follows:

- Technological concepts:

- This part is based on Data Management. The chapter begins with an historical explanation of the industrial revolutions, to give rise to the introduction of the Industry 4.0 concept. This allows us to understand the reason of the explanation of concepts such as Big Data, Open Data or Internet of Things.

- It is also explained Cloud Computing and its types, so that the reader has a better understanding of these concepts.

– Business concepts: In this section we provide fundamental knowledge in Supply Chain, Value Chain and Business Models in order to build in the reader the necessary background to understand how the digitalization can bring great advantages into business and industry.

After the theoretical explanation, we go through the analytical part, which combines concepts and ideas to give rise to the digitalization in business and industry. This section is part of the analysis because the digitalization of business is currently in process, so there is a reference theory to follow for its implementation. Our approach is to analyze and conclude how digitalization can help the industry and business.

In the analytical part we can also find the explanation of the cases conducted by the HAMK University of Applied about the Thingsee device, and the back-end infrastructure created for its use. We also suggest some practical cases in which the device could be useful, as well as certain improvements for the device.

The thesis ends with conclusions, this summary and the bibliography.

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