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A strategy for the integration of hyper-automation technologies into the Portuguese companies

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Dissertation presented as a partial requirement to obtain the Master's degree in Information Management

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A STRATEGY FOR THE INTEGRATION OF HYPER-AUTOMATION TECHNOLOGIES INTO THE PORTUGUESE COMPANIES

by

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Dissertation presented as a partial requirement to obtain the Master's degree in Information Management with a specialization in Marketing Intelligence

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ABSTRACT

Today´s competitive world demand companies to explore and discover new business automation technologies in order to evolve their processes and obtain tremendous benefits, from increased efficiency to reduced costs. The business processes that currently involve a lot of manual work or are considered as non-value added to the company are in the lead to automate so employees can focus their knowledge into more relevant tasks.

The purpose of this study is to propose a strategy for the integration of hyper-automation technologies into current Portuguese companies' processes and by this way increase the competitiveness of the Portuguese companies. An analysis of the subject and understanding the relevance of hyper-automation processes is conducted, as well as a collection of information from Portuguese companies of their automated processes, as the basis to identify business needs that may be included in a strategy to apply hyper-automation technologies.

It will be gathered relevant literature on the domain being analyzed for building a comprehensive body. The results will be analyzed to understand in what extent Portuguese companies would adjust from hyper-automation technologies, reporting the benefits inherent to technological evolution and measure in which areas/departments the managers believe hyper-automation will have a major influence in the short-term.

KEYWORDS

Hyper-automation; Robotic Process Automation; Artificial Intelligence; Workflow Automation

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LIST OF ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
BPA	Business Process Automation
BPI	Business Process Integration
BPM	Business Process Management
CSF	Critical Success Factors
CIP	Confederação Empresarial de Portugal
ICT	Information and Communication Technologies
IoT	Internet of Things
IPA	Intelligent Process Automation
ML	Machine Learning
NLP	Natural Language Processing
RPA	Robotic Process Automation
SME	Small and Medium Enterprises
WEF	World Economic Forum

1. INTRODUCTION

According to World Economic Forum, more than 70 million jobs will suffer changes or be completely replaced by machines and algorithms over the next three years. Nevertheless, for every job disrupted, two news job roles will be created during the same period of time (Ricoh, 2019). This might get seen as challenging but also should be faced as a great opportunity to companies simplify, automate and be more efficient.

Simplification. Automation. Efficiency. Since the beginning of the human history, man always had critical thinking on how to make a task simpler, execute autonomously, and achieve faster with better results. The evolution of human civilization had its peaks during the revolution of technologies of each era, from the automation of water transport through aqueducts by the Mayans during the agricultural era, to Ford´s installation of the first moving assembly line for the mass production of an entire automobile in the industrial era, and finally in the digital era when companies start to compile information and develop their communication technologies to take actions based on a more reliable base to achieve more efficiency throughout the processes (Cascio & Montealegre, 2016).

As defined by Gartner, hyper-automation "deals with the application of advanced technologies, including artificial intelligence (AI) and machine learning (ML), to increasingly automate processes and augment humans. Hyper-automation compile a broad range of tools that can be automated, which require agility to lapidate individual automation technology" (Automation Solutions, 2019). The idea is to create new and increasingly autonomous knowledge, accessible for everyone and disseminate in the organization so they can be part of the transformation with the intention of responding to the fast-paced technology growth (Chatti, Klamma, Jarke, & Naeve, 2007).

To simplify, hyper-automation refers to the mixture of automation technologies that exist to augment and expand human capabilities – "takes the robot out of the human" (Berruti & Taglioni, 2017). The most known term regarding the robotization of human tasks is robotic process automation (RPA), but hyper-automation takes an ecosystem of next-generation tools and is able to organize them and create a new way of work taking advantage of each skill that each automation technology has. As a result, it´s possible to take further steps and rather than simply use technologies like RPA to complete repetitive, replicable, and routine tasks that can be written as rule-based, hyper-automation can help harmonize work between people, robots and systems spreading computerization to every non-routine task where big data becomes available (Aguirre & Rodriguez, 2017).

This will push automation processes from isolated solution to enterprise-wide solutions. The possibility to join AI to the equation then contributes with greater intelligence decisions to the mix. This leads to another level of understanding to the automation as AI can analyze a lot more data than a human can, recognize patterns in data and learn from past decisions to make increasingly intelligent choices.

Employees and future employees need to take into consideration that hyper-automation can create a workplace hyper-connected that is always informed, agile and able to use data and insights for quick and accurate decision-making (Agrawal, Gans, & Goldfarb, 2019). In today's digital age, where the ecosystems of machines and humans are inextricably linked, employees need to constantly keep up to date with their knowledge and develop new skills related to using new technology so they can

co-habitat and allow the emerging of the hyper-automation raise efficiency, increase worker performance, reduce operational costs, and enhanced customer service through a quicker and better response time.

The purpose of this study is to develop a strategy using hyper-automation technologies into current Portuguese companies' processes. In this sense, the focus of this study will be on the weight automation has on the current Portuguese companies´ processes, which fields/areas/departments are currently more influenced by automation technologies and what is needed to take the next leap and incorporate hyper-automation on it. To achieve this purpose, it will be collected information of technologies that embody hyper-automation to better understand each field, and afterwards present a strategy to the most affected fields/areas/departments of Portuguese companies to automate processes.

1.1. BACKGROUND AND PROBLEM IDENTIFICATION

Today´s competitive world requires businesses to proactively seek better ways to overcome wastage of resources in not meaningful tasks, reduction of operational costs, improve production and freeing up personnel (García-holgado & García-peñalvo, 2009) to perform higher-level activities which add more value to the company.

Bill Gates once said – "The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency". It is important to make the right decisions to efficiently exploit available resources and take appropriate strategic decisions (Gallia, 2019).

Digital transformation, automation and innovation are impacting all sectors in the market, by improving their productivity and consume experience (Ebert & Duarte, 2018). According to McKinsey & Company report "Automação e futuro do emprego em Portugal", this transformation it should be seen as relevant work because it allows to reduce 30% of the costs, turn processes faster, more flexible (able to work 24/7), increase handover projects quality and empower companies´ knowledge through collected data (McKinsey & Company, 2019).

Many organizations aiming to be one step ahead of the competition are turning towards process automation solutions (Yuhn & Park, 2010). Terms like workflow automation, hyper-automation, RPA, AI, and many others will become common throughout companies. Some of these technological concepts will be explained in greater depth.

Although some new technologies of process automation, and specially the relevance growth of AI, are already known for the companies, there remain a great gap between the full potential of hyper-automation and what is being applied. Some of the reasons is a lack of a cleared defined strategy for integrating the available solutions and the unawareness of the hyper-automation possibilities.

1.2. STUDY OBJETIVES

The objective of the research is to proposal a strategy for the integration of hyper-automation technologies into the current Portuguese companies' processes and by this way increase the competitiveness of the Portuguese companies.

To reach this goal the following intermediate objectives were defined:

- understanding the subject and relevance of hyper-automation processes.
- collect information from Portuguese companies that have focus on processes automation - in order to understand their processes and how they would adjust with hyper-automation, reporting the benefits inherent to technological evolution.
- identify the business processes that may be hyper-automated and the impact that this approach may have on, and measure in which areas/departments the managers believe hyper-automation will have a major influence in the short-term.
- propose a strategy for the applying hyper-automation technologies in the Portuguese companies.

1.3. STUDY RELEVANCE AND IMPORTANCE

Prior to industrial revolutions, humans had centered around improvements in automation and connectivity in order to strengthen productivity. The Fourth Industrial Revolution has become a global buzz word since the World Economic Forum (WEF) adopted it as an annual issue in 2016. It is characterized by hyper-automation and hyper-connectivity based on AI, big data, robotics, and Internet of Things (IoT). AI, big data, and robotics can contribute to developing hyper-automation that can increase productivity and enhance industrial production. Robots work 24 hours non-stop and assimilate more data than humans ever imagine, and, particularly, robots using AI can make decision by themselves as human being on complicated processes. Along with the hyper-automation, the hyper-connectivity increases not only at national, but also global level by using information and communication technologies (ICT) (Park, 2018).

In this context, it should not be a surprise that the knowledge, skills and abilities required by employers during the Fourth Industrial Revolution are different compared to the knowledge, skills and abilities required by the other three industrial revolutions. It is estimated that many jobs in the near future will be delegated to AI or become automated (Frey & Osborne, 2017)

In this sense, AI is expanding meaningful traction within top corporations (Bean, 2018). It is reported that the take-up of AI-enabled systems in organizations is expanding rapidly (Miller, 2019) and AI is transforming business (Daugherty & Wilson, 2018). The new wave of AI systems has improved an organization's ability to use data to make predictions and has substantially reduced the cost of making predictions (Agrawal, Gans, & Goldfarb, 2018). With more advanced technology at companies' disposal, it will foster their ability to solve their problems faster using less resources.

Hyper-automation is a new feature that allows processes to work in order to optimize the amount of human support needed. This shift - moving the burden of human processes to technology - has the potential to redesign the way work is done within a company. It is noted that humans are still needed in most cases to enable or execute data collection, and human judgment will often be the arbiter of any action taken in response to a machine prediction (Heath, 2019).

2. METHODOLOGY

This study conducts a literature review on hyper-automation and its applicability on current companies' processes. With the goal of how hyper-automation technologies could affect the organizations and their performances the paper is structured into two parts. The first part assesses the state of knowledge concern to hyper-automation and their role in the process's transformation. It will be gathered relevant literature on the domain being analyzed for building a comprehensive body. In this sense, it is intended to collect information regarding hyper-automation technologies such as, AI, ML, RPA, and related subject relevant to the analysis.

The second part, it will be collected information from some Portuguese companies to understand their processes and how they would adjust with hyper-automation, reporting the benefits inherent to technological evolution, and which sector would experience a substantial impact with the introduction of hyper-automation. Furthermore, the compiled information will be analyzed to propose a strategy with the hyper-automation technologies available.

The above strategy can be synthetized in the below Figure 1.

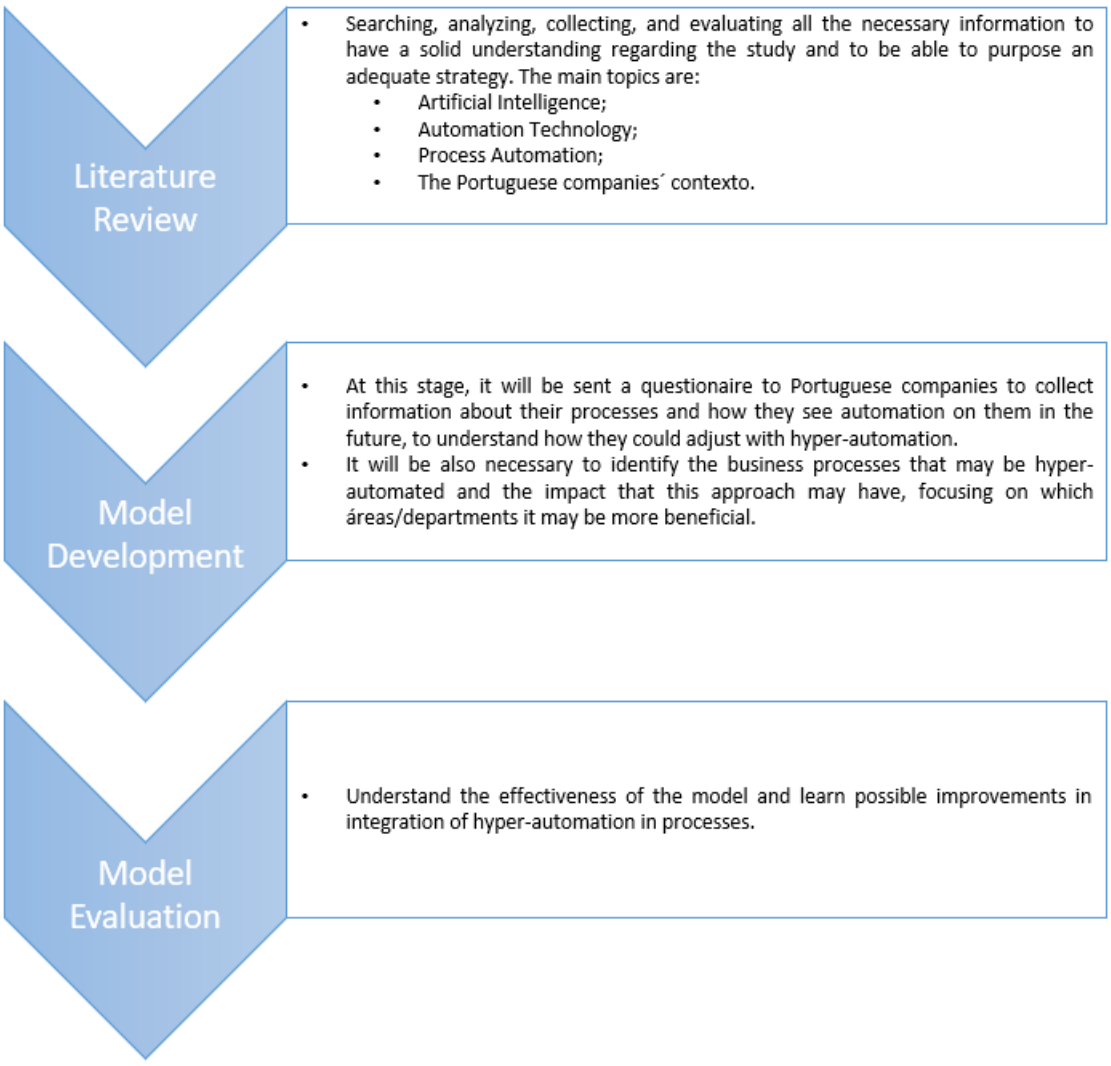

Figure 1 – Methodology throughout the study

2.1. LITERATURE REVIEW APPROACH

A literature review is a method of obtaining information with the goal of learning what has been investigated in a certain field and gaining knowledge of the subject. The reader, on the other hand, must be able to evaluate the articles critically; being able to connect their own research questions, findings, and debate to current literature is a crucial approach to establish the credibility and contribution of their work (Bryman, 2016).

The primary goal of the literature review is to determine what is already known about the issue under consideration and to determine which concepts and theories are pertinent to the dissertation's theme (Bryman, 2016).

The focus of the search, analysis, collection, and evaluation of the information to be studied in order to be able to purpose an adequate strategy were:

1) *AI:* understand the field of AI, how AI can be useful to automate processes, which areas of application is being used, and what subfields of AI are most known for performing automated task.

2) *Automation Technology:* where are industries leading to and how previous methodologies are being transformed.

3) *Process Automation:* how technology can be integrated into processes and enabled automation of complex business processes.

4) *The Portuguese companies' context:* how Portuguese companies are carrying out actions aligned with a strategic vision for the technological revolution and understand which sectors of activity are more prone to be affected by hyper-automation processes.

2.2. MODEL DEVELOPMENT

A questionnaire is a type of data collection tool that can be used in a survey. It is a research technique that consists of questions posed by the inquirer that are pertinent to the study and are intended to provide more information about the research issue.

The need to create questions with clear, concise, and accessible language was considered when developing the questionnaire, as well as the need to develop it in Portuguese, because the study's target audience is Portuguese companies, and the goal of the questionnaire was to assess the degree of acceptability and the need to complete changes in the processes of Portuguese companies to understand the viability to implement hyper-automation on their processes.

The questionnaire is split into four questions. It begins with a common denominator question in which the respondent is asked to identify the district in which the company is located. The second question serves to assess how many employees the company has, and thus it is intended to identify the size of the companies who answered the survey, according to a recommendation followed by the National Institute of Statistics (PORDATA, 2019). Furthermore, it is intended to understand the

company's activity sector, and finally, know which areas are likely to implement automation processes and what are the respective priorities.

Once data´s questionnaire is collected it will be important to analyze which areas/departments are more likely to introduce hyper-automation processes and what can be done in such areas through different periods of time.

2.3. MODEL EVALUATION

At this final stage, the objective is to understand the effectiveness of the model and learn possible improvements in integration of hyper-automation in processes. The procedure can be synthetized as the *Figure 2*.

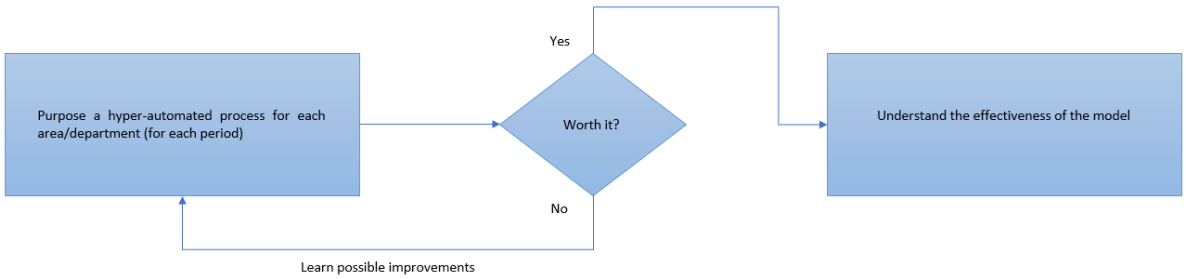

Figure 2 – Model Evaluation process

The first step of the model evaluation will be to analyze the data collect from the questionnaires, and with all the information searched throughout the literature review purpose an alternative hyper-automated process for a specific area/department. At the end of this study, it will be needed to understand the effectiveness of the model in such areas/departments that hyper-automated process will be implement. If it is worth it to the companies (pro vs cons) and if not, comprehend the why to learn and present changes to purposed hyper-automation processes.

3. LITERATURE REVIEW

In this chapter, the study will focus on collecting relevant information regarding different automation technologies. The goal is to collect and comprehend various technologies, what they bring, and all of the possibilities that come with them. Automation technologies are classified into three types: process automation, automation technology, and process analytics.

3.1. ARTIFICIAL INTELLIGENCE

There is no unique and commonly recognized definition of AI. It is normally referred to as the ability of a machine to learn from experience, adapt to new inputs and perform human-like tasks (Duan, Edwards, & Dwivedi, 2019a). In the field of computer science research defines AI as the study of "intelligent agents" which are devices that "identify their environment and take actions to maximize their chance of success at some goal" (Duan et al., 2019a).

During a conference at the Japan AI Experience in 2017, DataRobot CEO Jeremy Achin began addressing the crowd by offering the following definition of how AI is used today: "AI is a computer system that can do tasks that would normally need human intelligence... Many of these AI systems are based on machine learning, while others are based on deep learning and others are based on fairly mundane things like rules."

AI can be summarized as a science of training computed systems to mimic human tasks through learning and automation. Automation has always been used to increase productivity, increase safety and make better use of resources. Today, it is not only automating by augmenting human power with machine power – it has been automating by performing tasks and making decisions through algorithms derived from processing immense quantities of data (SAS, 2020).

3.1.1. Concept and Areas of application

The rise of AI in recent years has been made it an increasingly popular and growing field in computer science, as it has allowed to improve the quality of human life in many areas and facilitating their work. With the fast paced growth of Big Data technologies and AI in the past two decades, the working environment has seen significant adjustments in tasks and improvements in the performance of several fields, such as human resources, manufacturing and service systems (Duan, Edwards, & Dwivedi, 2019b). The application areas of AI are also having a major impact on various other topics in life, as the study and constant growth of AI technology is widely used today to solve more complex problems in various areas such as science, finance, engineering, medicine and others fields (Mittal & Sharma, 2021) where two decades ago people would seriously questioning the capability of technology to act in such complex and delicate processes.

Today, AI technology is being employed in several areas with many applications. The main areas are:

A) Language understanding – the ability of a machine to have a reading comprehension and respond to the natural language.

    a. Speech understanding;

    b. Questioning and Answering;

c. Language translation.

B) Learning and adapt to different systems – the ability of a machine to learn and adapt to different systems based on past experiences.

C) Problem solving – the ability of a machine to identify a situation, define the problem and propose several solutions.

   a. Automation of writing;

   b. Interactive Problem Solving;

   c. Heuristic problems.

D) Perception – the capability of a machine to interpret data in a manner similar to the way human uses their sense to translate the knowledge from the world.

   a. Pattern recognition.

E) Robots – a combination of the different abilities above described with the capability to move and shape objects.

   a. Military;

   b. Delivery;

   c. Security;

   d. Navigation;

   e. Exploration

   f. Other (mining, farms, etc.)

F) Games – the simplest way of AI application where a set of rules is explained to the machine and with these instructions it have the ability to problem solve the difficulties present by the opponents.

   a. Chess, Checkers, etc.

3.1.2. Machine Learning

ML has represented an instrumental role for the advance of both data analysis and AI (Chen & Liu, 2018). ML algorithms have been applied in almost all areas of computer science, natural science, engineering, social sciences, and beyond. The application of ML practices is even more disseminate and have been focused to solve problems where they can learn from data and enhance their results and accuracy over time without the need to be programmed (Law & Von Ahn, 2011). ML algorithms have enabled the creation and growth of many industries, and many of them would not have been created or flourished, e.g., Internet commerce and Web search.

ML algorithms can discover unexpected similarities between old and new data through “training”, aiding the computerization of tasks for which big data has newly become available (Brynjolfsson &

McAfee, 2011). A set of data are trained to find patterns to be reliable to feature in massive amounts of new data and to be able to predict and make decision upon that data. The better algorithm, the more accurate will be the predictions improving the results.

ML is everywhere and their practical application can be noticed every day. Here are a few examples of ML:

A) From digital assistants (Amazon Alexa, Apple Siri, Nio Nomi) with the capability to learn and solve natural language processing (NLP) problems such as processing text and voice data enabling the understanding of human speech;

B) Recommendations for users based on what they have search and viewed through deep learning technology;

C) Chatbots also use NLP with pattern recognition to decipher input text and handover the most convenient response;

D) Self-driving cars use machine learning and deep learning to constantly identify images around the car and predict the behaviors for all “road agents”.

3.1.3. Bots

The term bot is an abbreviation for robot and refers to software application that is programmed to perform certain tasks autonomously without a human operator. They execute tasks according to instructions given by humans. Bots are intended to replicate human behavior but with greater outcomes in performance, less errors and faster than a human employee could do (Gianvecchio, Xie, Wu, & Wang, 2008).

There are several types of bots, and each one with different applicability, goals, and tasks. Some examples include: 1) chatbot, which is a program that talk with users simulating a human conversation. 2) social bots, operates in social media platforms. 3) shop bots, which is a program that gather information on internet and give the best choices with the best prices for the searched product. 4) knowbot, collect knowledge for a user by automatically visit a site and retrieve information that meets a certain requirement predefined.

3.2. AUTOMATION TECHNOLOGY

Automation technology is the main industry on the way to Industry 4.0, which can be translated into the current automation of traditional manufacturing and industrial methods, using modern, intelligent, and innovative technology combined with the ability to connect different technologies in the completion of a process (Harmonic Drive SE, 2021). The term means intelligent and digitally interconnected systems that allow independent industrial production. In a smart factory, humans, products, and logistics are all interconnected through communication channels, an approach that is sometimes seen as the fourth industrial revolution (Jonathon, David, Chad, & David, 2014).

Automation technologies compile all work processes and equipment that allow plants and systems to function automatically and independently. Human intervention is minimal. The higher the degree of automation, the less intervention needs to be performed by humans to control and secure the process. AI, ML and RPA are some of the new automation technologies.

3.2.1. Workflow Automation

Workflow can be defined as structured activities or tasks that runs in typical business information systems. These sequential activities that processes a set of data, usually involve several database systems, user interfaces, and application programs and anytime data is moved between humans and/or systems, a workflow is created(Singh & Huhns, 1994). It can be summarized as a path describing how something goes from being incomplete to complete.

When automation technology its applied on those structured processes, machines support the groups of humans to perform the tasks involved in the workflow. In some cases, the processes can be fully automated and therefore machines will replace human activities, i.e., invoice extraction through RPA.

Nowadays there are already process-management software tools that allows users to initiate and track the status of workflow process in real time. It will manage the human users and robot's relationship and provide statistical data regarding the end-to-end process and the bottlenecks (Berruti, Nixon, Taglioni, & Whiteman, 2017). With workflow automation, companies will be able to reduce the amount of manual activities done by employees – reducing the risk of mistakes –, conclude more work in a shorter period of time and help companies achieve more consistent results.

3.2.2. Robotic Process Automation

A foundational question for many companies and business process owners is "What should be automated?". This question is not new and developments studies in ML, AI, data science force to revisit this question continuously (W. M. P. van der Aalst, Bichler, & Heinzl, 2018). RPA can be interpreted as the technological replica of a human employee with the goal of automating structured activities in a cost efficient and fast approach (Aguirre & Rodriguez, 2017).

Although the term "robot" can bring to the imagination of a humanoid creature with an appearance similar to human beings, it is important to understand that RPA is not a physical robot, it is a software based solution that is built to carry out repetitive and rules-based operational jobs used to be done by humans (M. C. Lacity & Willcocks, 2016).

3.2.3. Intelligent Process Automation

The term Intelligent Process Automation (IPA) is a combination of automation technologies with focus on a limited set of tasks, building on top of five different core technologies: RPA, Workflow Automation, ML, Natural-Language Generation and Cognitive Agents.

In simple terms, IPA "brings the robot out of human" by performing work previously made by humans but in a more effective and fastest form (Berruti & Taglioni, 2017). It is a collection of business process improvements and new technologies used to automate and optimized existing

tasks. Having ML as one of its core technologies allows IPA to learn the activities performed by humans and over time (and quantity of data processed) will execute them better due to its ability to learn from past behavior, and adapt to change to become more efficient (Laurent, Chollet, & Herzberg, 2015).

3.2.4. Industry 4.0

Industry 4.0 stands for the fourth industrial revolution which is the ongoing automation of historic manufacturing and industrial processes, using modern technologies such as IoT, Cloud based Manufacturing, Industrial Internet, and Smart Internet integrate the virtual world with the physical world.

In today´s industry, the manufactory industries are shaping towards a customization of products rather than mass production (Vaidya, Ambad, & Bhosle, 2018). To fulfill this demand of an increasingly individual customer need, companies are focusing on their process digitalization. The gathered data can be used to optimize companies' performance, or provide guidance regard the company environment and what companies can do to better approach their customers. Industry 4.0 intends to reduce human contact in the manufacturing process but values its knowledge input, in order to have continuous improvement and be able to focus on activities that can add value to the company and avoid losses (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014).

3.3. PROCESS AUTOMATION

The advancement of technology helps to find solutions to the basic needs of society and industries that until then were considered impossible to solve (M. Lacity, Willcocks, & Craig, 2015). This technological development allows companies to maintain their current competitive advantages and, in many ways, create new procedures to stay ahead comparing to direct competitors, while also improving prosperity, well-being and the ability to focus on more crucial decisions for the organization's success (M. Lacity et al., 2015).

With technological growth, the relevance and importance of process automation in companies has increased dramatically. Among information, communication and automation technologies, traditional interconnection barriers are, in the operational context, gradually disappearing. Currently, companies are more available to change their internal processes, giving more value to innovative systems that can now supervise and control increasingly complex work, guaranteeing accuracy and safety, and provide support for the implementation of inspection strategies. advanced. Organizations need to take a different and more comprehensive approach to issues of quality, cost and time, and automation engineering will play a central role in this change (Jämsä-Jounela, 2007).

In the case of the manufacturing industry, the implementation of an automatic process control ensures that workers can continue to operate regularly and always within the most profitable range, avoiding bottlenecks - the point of congestion in a production system -, leading to more consistent production in greater quantity, reliability, yield, and quality using less energy and in a shorter period

of time. This technology will increase efficiency, help to increase productivity, improve the quality of workers as they will have greater relief for the achievement of theirs and a reduction in costs (Lorenz & Schmidt, 1989). These consequences will allow companies to boost their profits (M. Lacity et al., 2015).

3.3.1. Business Process Management

The constant changes on economic environment have led to an increasing interest in improving organizational business processes to enhance performance and develop their inefficiency. One of the study fields dealing with these challenges is business process management (BPM).

The BPM discipline explore methods and techniques to form business processes in an efficient and effective manner (Mendling, Hull, Weber, & Hull, 2018). Any combination of methods used to conduct a company's business processes is BPM and a key idea is that it engages the improvement of business processes by redesigning information systems to best support the people who are working in the process.

Despite considerable investment in the area, most reviews report that the great majority of BPM initiatives having been unsuccessful (Abdolvand, Albadvi, & Ferdowsi, 2008). It is therefore not surprising that the industry is reluctant that a business process plan could bring positive changes and behavior throughout the companies or have significant impact tangible, and measurable benefits. Because these changes were ruled as risky and prone to fail, there was a gap need to be filled and to clarify, it was investigated what could be point as critical success factors (CSF). The most commonly CSFs for BPM included in literature are the following: top management support, project management, project champions, communication and inter-departmental cooperation, and end-user training (Ariyachandra & Frolick, 2008). Top management is often considered to be the most influential because it must initiate and support BPM efforts to be implemented and assure it is continued. Any isolated consideration of the previous cited aspects will yield suboptimal conclusions (Trkman, 2010).

The latest advancements around AI, ML, cryptography, and distributed systems have provided the foundations for new technologies, such as RPA, chatbots, self-driving cars, smart objects, blockchains, and the IoT. It is difficult to predict in which specific way they will shape BPM, but the rising upgrade of these technologies will likely influence how organizations design and execute business processes in the future.

3.3.2. Business Process Integration

According to the International Conference on e-Business, we can describe BPI as “a key procedure to support business interoperability. Focused and process-oriented organizations are continually integrating their processes, and the integration of internal and external processes is also the essential point for various types of business process reengineering or optimization tasks, as well as logistics planning efforts (Berente, Vandenbosch, & Aubert, 2009). BPI has the benefit of allowing the automation of business processes and the integration of different systems in various organizations (Aouachria, Gonzalez-Huerta, Javier Réda Ghomari, Abdessamed Hadaya, & Leshob, 2017). It is important to distinguish between integration in the context of a BPM platform - a function that allows software to combine data between other systems - and integration in the context of a BPI -

which occurs when several business processes interconnected in a vertical hierarchy work together to meet defined business objectives.

Businesses that want to connect systems and information efficiently must use BPI. As previously stated, BPI enables the automation of business processes, the integration of various systems and services, and the secure sharing of data across multiple platforms across the entire organization. Overcoming the challenges of integration allows organizations to connect systems internally and externally. Additionally, BPI also allows the automation of logistics, management, operational and support processes(MuleSoft, 2020). Today, software that enables the integration of business processes is not only available to large companies and this makes it possible for all companies to gain an advantage over competitors, because all the headaches caused by the challenges of integration, including time and energy to boost new business, they will be minimized by the option to acquire the necessary software to leverage the business.

3.3.3. Business Process Automation

A business process is the collaborative execution of business tasks in accordance with a set of business rules defined to achieve previously stated organizational goals. The process must specify only one input and one output. All factors that contribute to adding value to a given product or service (directly or indirectly) are called inputs. These conditions can be cataloged in the management, operational and support business processes. Several sectors, from consumer services to industrial companies, have applied efforts to restructure and reengineer their business processes to achieve cost reduction and improve efficiency. With the rapid growth of technology leading to an upgrade of today's computers and information technology, difficult business processes can now be automated, tasks that were traditionally performed manually and considered to be of a high degree of complexity are now potentially automated through of intelligent machines or systems. This brings many new challenges to the equation: 1) Business processes need to be easily created, mapped, implemented, and updated. 2) Business processes need to be developed in an interoperable way, so that different organizations and departments can integrate their business processes. 3) The correctness and security of a business process needs to be guaranteed. 4) Methodological tools are needed to facilitate the management and reuse of business processes (Bose et al., 2012).

3.3.4. Process Analytics

Process analysis is a new type of analysis that not only shows how processes are working and how well they are performing, but also what needs to be changed to help them perform better. With the help of RPA and other automation technologies, it will enhance the process efforts, its effectiveness and focus on important steps (Celonis, 2020).

3.3.4.1. Process Mining

To better comprehend what process mining is, an analogy with a X-ray can help to resolve to understand what it is about, where X-rays reveal how the process is carried out and can also be used to recognize problems (failures in process) and purpose treatment (changes to the process to improve). After consulting, it is possible to verify that process mining is considered an analytical method to recognize, monitor and develop real processes as they are, collecting knowledge of activities performed by people, machines and software (W. Van Der Aalst, 2012b). Process mining is

based on facts obtained through collected data, allowing to provide its users a greater understanding of its data, greater support in decision making and better analysis of business processes.

Even though the amount of data processed and stored by information systems in event logs is currently much greater than they ever were, and with exponential growth, managers continue to make their decisions based on graphs and tables, precluding analysis. more rigorous and careful information available (W. Van Der Aalst, 2012a). Process mining software allows organizations to capture information from business transaction systems and, thus, prepare more elaborate and detailed reports based on the data saved on how the main processes are being executed. Event logs are created when the task is finished - an order is received, a purchase is made, a payment is made - and the logs allow these steps to be saved (Davenport & Spanyi, 2019). Because the logs allow you to store these events, a post-process analysis allows you to study and understand it to create key process performance indicators. In this way, organizations will have the possibility to analyze the process, evaluate its performance and focus on the most important steps to continuously improve the execution of the process.

As process mining has been very important in assessing the processes of organizations, identifying areas for improvement, allowing them to improve and make them more efficient, and makes it an effective partner for tools such as AI, which can find the reasons for performance fluctuations or RPA, as it can first identify the best places to implement “bots” and, as a result, provide calculation methods on the impact of implementing RPA on processes.

It can be concluded that process mining represents an attractive view for managers, based on data obtained from the performance of the process. This will attract the interest of senior executives, who can easily visualize and identify where the problems and possible opportunities are. This will make it possible to reinforce an organization's dedication and objectives in decision making based on real, coherent, and reliable data, contributing to the improvement of deficient tasks, and increasing the importance of automation for these tasks.

3.3.5. Hyper-automation

The term "automation" today refers to the use of technology that allows you to perform tasks that were previously repetitive and highly manual or that required a significant amount of human effort without making a significant contribution to the organization. These types of tasks were perceived early on as a perfect opportunity for automation in general - and RPA in particular - since automating them helps to minimize repetitive and demotivating work for employees, save valuable time for employees and allow them to focus on higher value work initiatives, contributing to the organization's prosperity (Patrick, 2019).

Hyper-automation compiles different components of process automation, managing to integrate everything from tools to new technologies that enhance the ability to automate work. Hyper-automation has its origin in RPA technology and expands the automation capacity with new technologies in great growth such as AI, process mining, analysis, decision management and NLP, and other applications more advanced devices can later be used together in an end-to-end automation solution (Patrick, 2019).

When it comes to hyper-automation, one should avoid falling into the error of just considering a more advanced and sounder name for performing task automation. It is not just about implementing tools to manage tasks and make them simpler, faster, and more effective. It requires collaboration between humans as well. This is because it is humans who must make the fundamental decisions for the growth of organizations and the responsibility to use technology to interpret data (Patrick, 2019).

The idea is to automate more, and increasingly complex tasks, involve everyone in the organization to share their knowledge/input so that everyone is part of the transformation and disseminates it throughout the organization.

It is important to mention that despite both hyper-automation and IPA leverage AI and ML to enhance processes there is a significant difference between the two terms. While IPA intention is to automate and increase efficiency on existing tasks, hyper-automation it is a consolidate business strategy to create and optimize end-to-end processes aiming to innovate business premises (McHugh, 2021).

3.4. PORTUGUESE COMPANIES´ CONTEXT

On this section, it is presented facts regarding the actual economy surrounding Portuguese companies and several topics will be approach, such as the challenge of technological transformation, the distribution of Portuguese companies by sector of activity, the dimension of Portuguese companies, the geographical dispersion of Portuguese companies, and the characterization of sectors of activity with the potential to adopt hyper-automated processes.

According to the Confederação Empresarial de Portugal (CIP), Portugal should see the current technological revolution as a great opportunity. Digitization must be seen as the engine that will lead the national economy on a path of competitiveness and growth, due to the productivity gains that it can boost (Confederação Empresarial de Portugal, 2019). Companies must be prepared to carry out actions aligned with a strategic vision for the technological revolution to capitalize and be ahead of the upcoming changes throughout the work environment.

3.4.1. The challenge of technological transformation

Digital technology, automation and innovation are impacting all industry sectors by improving productivity and the consumer experience.

The study on “Automation and the Future of Work in Portugal”, promoted by CIP and prepared in partnership with the McKinsey Global Institute and NOVA School of Business and Economics, concludes precisely that automation can provide the necessary injection of productivity, being one of the main solutions to counter the trend of slowdown in GDP due to the decline demographic.

For this potential to be realized, it needs more investment, indispensable for incorporating technological innovation in products, services, and processes. Another critical factor in this technological transformation that the companies in Portugal must face and manage, on a large scale, is in the qualification and requalification of professionals. Requalify its assets and recruit new

employees who have an appropriate skills profile will be essential to the companies who want to have success in this change because it will require qualify professionals to know how to work and adapt to new processes and automated tasks.

3.4.1. Distribution of Portuguese companies by sector of activity

By the end of 2019, the Portuguese economy was represented by a total of 1.335.006 companies. Regarding the distribution of this companies by sector of activity, the most represented specific sector of activity is wholesale and retail trade with 16,4% of total enterprises, following by agriculture, farming of animals, hunting, and fishing with 9,8%, accommodation and food service activities with 8,8%, human health and social work activities with 7,6%, construction companies with 6,8%, manufacturing, mining, and quarrying with 5,2%, and education with 4,4%. Representing less than 8% (total of 103.642 companies) it is real state enterprise with 3,7%, transportation and storage companies with 2,3%, financial and insurance activities with 1,2% and the minority sector is respecting to electricity, gas, and water with 0,4%. Nevertheless, about a third of total companies works in a different sector of activity than the ones previously mentioned (PORDATA, 2019). On *Figure 3* represented on the below bar chart it is possible to visualize the representation of percentage of total Portuguese companies by sector of economic activity.

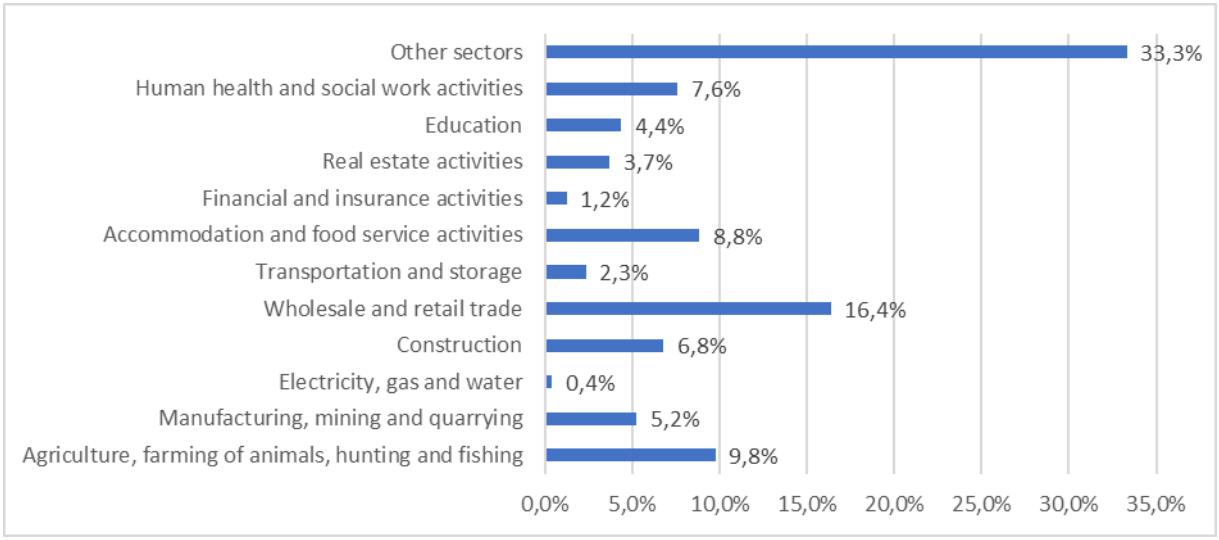

Figure 3 – Percentage of total Portuguese companies by sector of economic activity

3.4.2. Dimension of Portuguese companies

The National Institute of Statistics follows a recommendation of the European Commission of 6 May 2003 to distinguish the characteristics of a micro, small, medium, and big company (PORDATA, 2019).

- Micro company: employs less than 10 people and whose annual turnover or annual balance sheet does not exceed 2 million euros.
- Small company: employs less than 50 people and has an annual turnover or annual balance sheet that does not exceed 10 million euros.

- Medium company: employs less than 250 people and with an annual turnover that does not exceed 50 million euros or a total annual balance sheet that does not exceed 43 million euros.

- Big company: organizations with 250 or more persons employed or companies with a turnover exceeding 50 million euros and net assets exceeding 43 million euros.

According to PORDATA, the representation of Portuguese companies by its dimension is the following: 96,0% micro companies, 3,3% small companies, 0,5% medium companies and only 0,1% are considered big companies. In nominal values, the small and medium enterprises (SME) represent 99,9% of the total companies operating in Portugal which is 1.296.457 organizations. Meanwhile, there are only 1.357 big companies in Portugal. On *Figure 4 a)* it is possible to verify the previous statements. Nevertheless, the business volume generated by sales it is a different scenario. On *Figure 4 b)* it is easy to understand that despite the total of Portuguese companies are considered as big companies is only 0,1%, they generate almost half (43%) of sales between all organizations. It is followed by medium companies with 20% with the second highest percentage of total business volume, then small companies as 19% and finally the micro companies with 18% of total business volume.

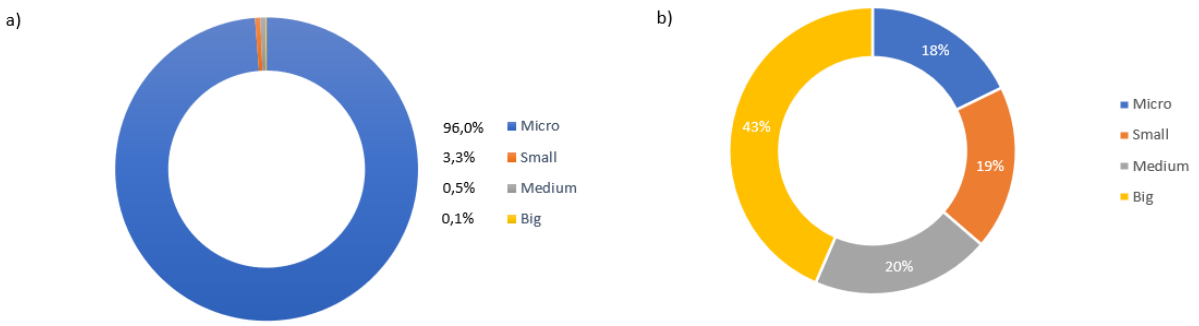

Figure 4 – a) Percentage of total Portuguese companies by dimension; b) Percentage of total business volume by dimension (PORDATA, 2019).

4. STRATEGY FOR THE INTEGRATION OF HYPER-AUTOMATION TECHNOLOGIES INTO THE CURRENT PORTUGUESE COMPANIES' PROCESSES

At this chapter it will be propose a strategy to implement hyper-automation technologies on different business processes, with different priorities, and evaluate the strategy proposed to understand the viability and benefits from it. The chapter is organized as follow: First is presented a description of the characteristics of the sample from the questionnaire's throughput and its discussion of the obtain results. After an analysis and discussion of the collected data is performed, and lastly it will be proposed a framework with different strategies and hyper-automation technologies, with different priorities, having in account their size and costs of implementation for these approaches.

4.1. DATA COLLECTION

To understand their processes and how they would adjust with hyper-automation, reporting the benefits inherent to technological evolution a survey was performed.

The survey had focus on the identification of the business processes that may be hyper-automated and the impact that this approach may have on, and measure in which areas/departments the managers believe hyper-automation will have a major influence in the short-term.

The aim of the survey was to understand which areas could be hyper-automated. In this sense, the target population of this survey were the 200 most lucrative companies in Portugal in 2019 acknowledging that they are the financially healthier companies and more open to invest in business process´s improvements due to its costs (McKinsey&Company, 2018). It was possible to contact through e-mail and LinkedIn 102 companies and collect 41 answers.

The collection of responses to the survey took place between the months of July and September 2021. As previously stated, responses were gathered via a questionnaire survey. It was said that the response would be confidential and anonymous. To arrange and summarize the data, descriptive statistics were employed as a method of data analysis to carry out the treatment. Tables, pie charts, and bar charts are used to portray the data received so that it can be read.

The survey structure is presented in Appendix 1**.** The survey questionnaire was built on the knowledge learned from the literature review using the following assumptions:

- Bigger companies are more likely to invest in new automation technologies.
- Process automation technologies allows companies to maintain their current competitive advantages and, in many ways, create new procedures to stay ahead comparing to direct competitors, while also improving prosperity, well-being and the ability to focus on more crucial decisions for the organization's success (M. Lacity et al., 2015).

4.2. DATA DISCUSSION

The survey outcome allows aggregate information from Portuguese companies that have focus on processes automation and understand which areas are more expected to be automated. As previously stated, it was gathered 41 answers of the 200 most lucrative companies in Portugal.

For the first question, the objective was to understand where the companies were located. Two thirds of the answers came from companies based in Lisbon, as shown in *Table 1*. Although most of the answers came from a specific district, this can be explained by the fact that from the 200 most lucrative companies in Portugal, 93 of them are located in Lisbon (46,5%).

Table 1- Companies´ location

District	Answers	%
Lisboa	27	66%
Setúbal	3	7%
Aveiro	3	7%
Braga	2	5%
Porto	2	5%
Faro	1	2%
Santarém	1	2%
Região Autónoma da Madeira	1	2%
Beja	1	2%
Total	**41**	**100%**

On the second question it was intended to comprehend the size of the companies that answered the questionnaire. It was given four options (Less than 10 employees, between 10 and 50 employees, between 50 and 250 employees, and more than 250 employees), and with the answers it is possible to understand if the companies are, micro, small, medium or large companies based on a recommendation followed by the National Institute of Statistics (PORDATA, 2019). From the 41 answers, it was only received answers from medium and large companies. Roughly three quarters were from large companies (30 out of 41), while the remaining 11 were from medium size companies. The *Figure 5* shows the graph illustrating the answers.

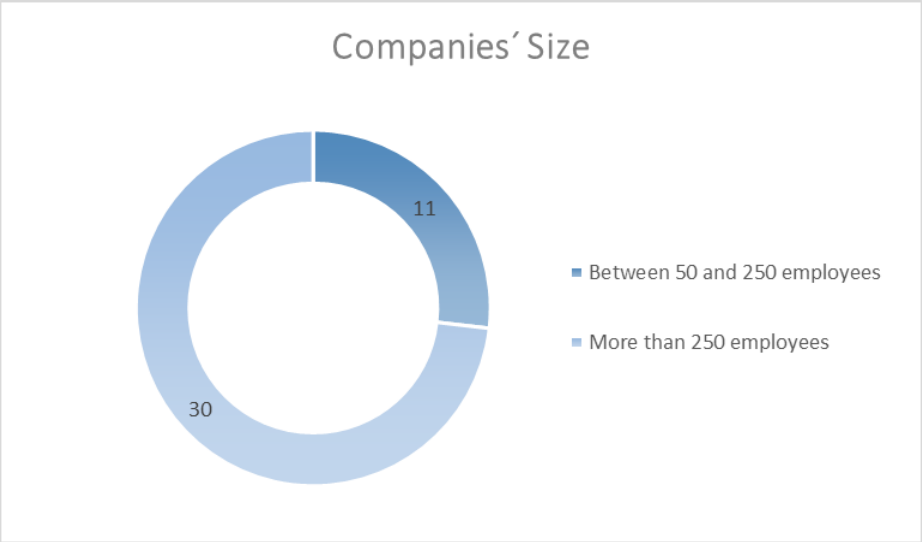

Figure 5 – Graph related to companies´ size.

The third question, and the last one regarding Portuguese companies´ context perspective, was about the sector that each company operates. The options given were taken from National Institute of Statistics. As it can be seen in *Figure 6*, there are three sectors than compile more than three thirds (68,3%) of the total sectors answered (28 out of 41), extractive or manufacturing services (11), wholesale and retail trade; motor vehicles and motorcycles (9), and consulting, scientific, technical and similar activities (8). There were also answers from transport and storage (3), information and communication activities (3), electricity, gas, steam, hot and cold water and cold air (2), human health and social support activities (1), agriculture, animal production, hunting, forestry, and fishing (1), and other service activities (1).

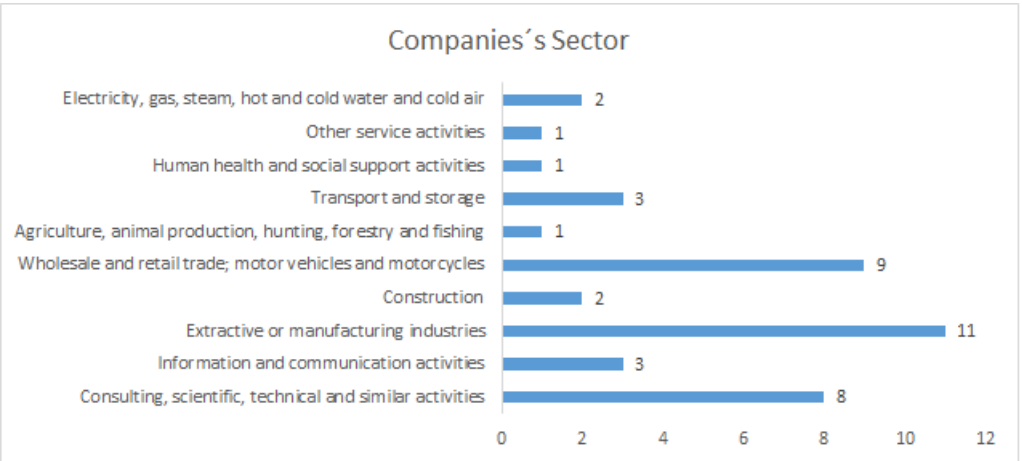

Figure 6 – Chart representing the companies´ sector

Regarding the fourth and last question, was a multiple-choice type and the main objective was to perceive from the company's perspective which areas/departments were more likely to be subject to automation process and understand how long it would take to introduce new process automation

technologies. The choices were between Financial, Human Resources, and Industrial. A fourth option were given as “Other Areas” followed by an open answer about which area the responder was mentioning. As it can be seen in *Figure 7*, for all three departments the most common answer was changes become effective in short-term (next 5 years). For the financial area the opportunity to introduce changes for the next 5 years collected 75% of the answers, followed by next 10 years with 21%, and one answer to only after 10 years. For the human resources, the option of next 5 years collected 56% of the answers, followed by the option of next 10 years with 32%, and only after 10 years with two answers, and one responder answered that is never expected processes to be automated. For the industrial area, 22 out of total 24 answers were regarding changes to be implemented in the next 5 years, while next 10 years and more than 10 years only received one answer each. To be noted that option “Other Area” received only 3 answers and all of them were about changes to be made in commercial area in the next 5 years.

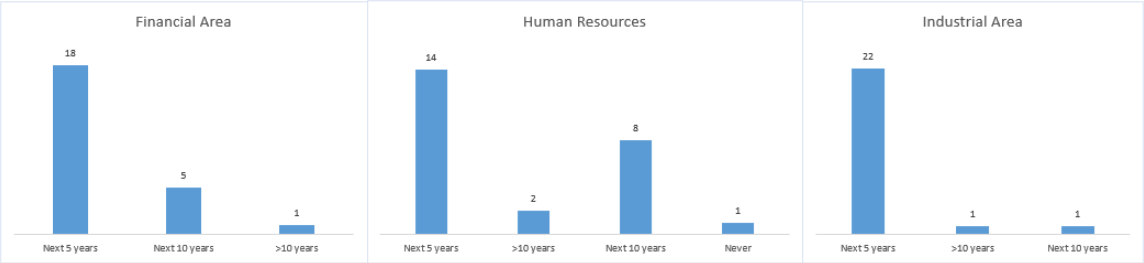

Figure 7 – Graphic bars representing the probability process automation for each sector

4.3. PROPOSED STRATEGY

Based on the literature review is possible to state the following assumptions regarding automation technologies and process automation setbacks:

Automation Technology setbacks:

1) *Workflow Automation:*

    a. The company must have their business information compiled in databases (the flow of the information within the company must be understood);

    b. In some cases, it can be necessary the implementation of a machine/robot to automate human task;

    c. Acquisition of a process-management software.

2) Robotic Process Automation:

    a. Requires a software able to replicate the activities performed by a human employee.

3) *Intelligent Process Automation:*

    a. It is needed a software to automate human task to improve their work (more efficient and faster);

    b. It is more expensive than RPA technology.

4) *Industry 4.0:*

    a. High cost of implementation (several modern technologies, such as IoT, Cloud based Manufacturing, Industrial Internet, and Smart Internet to be able to integrate the virtual world with the physical world;

    b. Only apply to industrial and manufacturing sectors (nevertheless we suggest a personalized sale approach for the commercial sector).

Process Automation setbacks:

1) *Business Process Management:*

    a. Although a considerable amount have been invested in the area, most reviews report that the great majority of BPM initiatives having been unsuccessful (Abdolvand, Albadvi, & Ferdowsi, 2008), and for this fact changes to be made are ruled as risky and prone to fail.

    b. It is fundamental top management of the company are supportive and initiate BPM efforts to be implemented and followed.

    c. To implement BPM it must have a design and execute of the processes to be introduced and managed.

2) Business Process Integration:

    a. There is a need to integrate their process internal and externally.

    b. It must be able to integrate different systems.

    c. Business processes interconnected in a vertical hierarchy.

    d. Overcome the challenges of the integration.

3) *Business Process Automation:*

    a. Business processes need to be easily created, mapped, implemented, and updated.

    b. Business processes need to be developed in an interoperable way.

4) Process Analytics:

    a. The cost associated to the implementation of the process analytics software such as Process Mining.

5) Hyper-Automation:

    a. Compilation of different components of process automation, managing to integrate everything from tools to new technologies.

    b. Carries a high cost to customers to implement this kind of technology.

Furthermore, concerning the survey outcome is possible to state the following assumptions:

- Roughly three quarters of the answers were made by big companies, and it´s expected that due to its bigger economy strength they are more prone to adopt the proposed strategies and likely to invest more capital into it.

The proposed strategy is divided in three different analyses: implementation on SME, implementation on Big Companies, and its cost/complexity. For each analysis, it will be given a score (inadequate, fairly adequate, adequate) for each company sector and respective evaluation for the introduction to automation technologies and process automation. The strategy can be easily adapted and implemented by any company.

First it will be presented a table regarding the implementation of such technologies and automation processes on SME. Afterwards it will be referring to Big Companies, and lastly it will be an analysis about the cost/complexity of those implementations. The score given will be evaluate regarding difficulty/complexity and the cost of the implementation for each technology, and the constrains are the same for SME or Big Companies, however it can be more relevant or less relevant depending for each company size.

As it can see below on *Table 2*, it is compiled information regarding SMEs where we can see the companies' sectors on columns and the automation technologies and process automation on rows. The analysis and score of the technologies will be the proposed as the following:

Automation Technology:

- *Workflow Automation* - mainly due cost of acquisition of a process-management software and the necessity to have an organized database with a full knowledge of the company we give a **score 2** (because of their usefulness) to financial and human resource sector, but a **score 1** to industrial and commercial because it would require more effort and complexity.

- *Robotic Process Automation* - considering a more standard automation technology product in the market, the acquisition and implementation of such software would be affordable to SME. However, we recognize that introduce this technology in the financial and human resource sector is easier to adapt than for industrial and commercial area. Considering the previous statements, we gave a **score 3** for financial and human resources, a **score 2** to industrial sector and a **score 1** to commercial sector (more rules needed equals to more complexity)

- *Intelligent Process Automation* - because the main difficulty to implement it is the fact that this technology is more expensive than RPA, we consider as **score 2** for financial and human resources sectors, and a **score 1** to industrial and commercial sectors. The reasons for the industrial and commercial sectors have a lower score than the others are similar to the ones for the implementation of RPA in these industries (more complex to adapt).

- *Industry 4.0* - For the reasons mentioned above regarding the considerations from the literature review, both financial and human resources departments aren´t considered for this automation technology, and we attribute a **score 1** to industrial and commercial because of the cost to implement those modern technologies in SME.

Process Automation:

- *Business Process Management* - The implementation *per se* doesn´t require a significant amount of money to be executable. The most constrains are time, effort, and predisposition. For this reason, we see attribute a **score 3** for this implementation to all sectors (except to industrial due to its complexity – **score 2**). For these BPM changes to be succeeded it is crucial that leaders acknowledge the importance of their role in these tasks to design, implement, and follow-up the process.

- *Business Process Integration* - The prerequisite of an integration of different systems in the company can be difficult and/or expensive for SME to accomplish. For this reason, but having in consideration the added value of such process we evaluate as a **score 2** to all sectors.

- *Business Process Automation* - For this strategy, there is a need to identify and create a flow of activities and make it interconnected through the company. We consider this approach simple enough to SMEs to implement but with a somewhat high price for them. Due to this reason, we considered a **score 2** to implement this strategy on all sectors.

- *Process Analytics* - The only barrier we have identified to introduce this strategy in SME is the cost associated to software´s acquisition. Nevertheless, the benefits of this technology where it can reveal how the process is carried out and can also be used to recognize problems (failures in process) and purpose treatment (changes to the process to improve) and because of this we classify it as a **score 3** to all sectors.

- *Hyper-Automation* - For this technology, once again the biggest impediment to all SME adopt hyper-automation is its high costs of implementation regarding integration of different tools, processes, and technologies. But the advantages that SME can take from the implementation are enormous. In this sense, we have attributed to all sectors **score 2** (fairly adequate).

Table 2 – Strategy implementation on SME

SME		Companies Sectors			
		Financial	Human Resources	Industrial	Commercial
Automation Technology	Workflow Automation	2	2	1	1
	Robotic Process Automation	3	3	2	1
	Intelligent Process Automation	2	2	1	1
	Industry 4.0	-	-	1	1
Process Automation	Business Process Management	3	3	2	3
	Business Process Integration	2	2	2	2
	Business Process Automation	2	2	2	2
	Process Analytics	3	3	3	3
	Hyper-automation	2	2	2	2

Score	Meaning
1	Inadequate
2	Fairly Adequate
3	Adequate

Following on *Table 3*, it is compiled information regarding Big Companies (over 250 employees) where we can see the companies' sectors on columns and the automation technologies and process automation on rows. The analysis of the technologies will be identical to the ones regarding SME, but with a different impact on score for those technologies.

Automation Technology:

- *Workflow Automation* – the main setback of this technology for SME were concerning to its cost of acquisition of a process-management software and the necessity to have an organized database. For big companies, we do not consider the costs as an obstacle for the implementation. Nevertheless, having an organized database relies on good management, but we also have considered that to a company become responsible for over 250 collaborators it requires these hurdles resolved. In this sense, we gave a **score 3** to all sectors (problem of money is solved).

- *Robotic Process Automation* – RPA is a technology presented in most of big companies, where it is used on financial area (i.e., invoices extraction), human resources (automate processes within existing digital HR systems, such as SAP, Workday), or in industrial sector (inventory reports), and for this reason we considered a **score 3**. Regarding commercial sectorial, due to its complexity we have gave a **score 1.**

- *Intelligent Process Automation* – for this technology on SME we have consider as **score 2** to both financial and human resources because it requires more investment than RPA. Considering that for big companies the budget and openness for investment should be higher than for SME, we have considered to all sectors a **score 3**, except commercial due to its complexity and we attributed a **score 2**.

- *Industry 4.0* – as previously stated, from literature review it can be noted that for this particular technology both financial and human resources aren´t considered for the introduction of this technology, therefore we didn´t attribute any score to them. Although the cost of implementing these modern technologies in SME were the biggest setback, we also consider that because they are new technologies it can be more difficult to implement these many changes at one time, we gave a **score 2** to industrial and commercial.

Process Automation:

- *Business Process Management* – as previously acknowledged, for BPM changes be succeeded it is necessary that companies´ leaders recognized their importance in implement and follow-up the new process changes. The design, implementation, and execution of the changes doesn´t require a significant amount of money. The most "valuable" resource to be dispended is time. And we realize that big companies´ leaders don´t have the same availability, and the follow-up stage would demand that availability. In this sense, we gave a **score 2** to all sectors.

- *Business Process Integration* – for this process, the main difficulty would be the cost of integrating different systems. We understand these costs wouldn´t be a meaningfully setback that big companies wouldn´t introduce in their processes, and we had attributed a **score 3** to all sectors.

- *Business Process Automation* –BPA requires an identification and creation of a flow of activities that interconnects processes through the company. We identify the financial and

commercial sectors as the ones with more complex workflow (regarding industrial sector, it is very rudimental a workflow process that recreates the industrial process). Because of this reason, we attribute a **score 2** to financial and commercial sector, and **score 3** to industrial and human resources.

- *Process Analytics* – the barrier identified to implement this strategy in SME were the costs associated to software´s acquisition. Having in consideration that the weight of software´s acquisition is significantly higher in SME than in Big Companies, we also gave a **score 3** to all sectors.

- *Hyper-Automation* – we can say that the main differences between SME and Big Companies are the number of employees under their payroll, revenue/costs/profit, management and business structure, difference in market niche, and know-how. And again, the main setback to not consider adequate to implement hyper-automation technology in SME was the high costs associated, and as mentioned above, big companies have another capability to invest money in their business, and for this reason we gave a **score 3** to all sectors.

Table 3 - Strategy implementation on Big Companies

Big Companies		Companies Sectors			
		Financial	Human Resources	Industrial	Commercial
Automation Technology	Workflow Automation	3	3	3	3
	Robotic Process Automation	3	3	3	1
	Intelligent Process Automation	3	3	3	2
	Industry 4.0	-	-	2	2
Process Automation	Business Process Management	2	2	2	2
	Business Process Integration	3	3	3	3
	Business Process Automation	2	3	3	2
	Process Analytics	3	3	3	3
	Hyper-automation	3	3	3	3

Score	**Meaning**
1	Inadequate
2	Fairly Adequate
3	Adequate

On *Table 4*, it is summarized the information regarding the cost/complexity to implement each automation technology and process automation, where we can see the companies' sectors on columns and the automation technologies and process automation on rows. The analysis of the technologies will be based on the literature review.

Automation Technology:

- *Workflow Automation*
    - Costs: reliable and organized databases.
    - Complexity: more complex to design and implement the workflow activities for industrial sector than for financial, human resources and commercial sectors.
    - **Score 3** to industrial sector, **score 2** to financial and human resources, **score 1** to commercial.
- *Robotic Process Automation*
    - Costs: software´s acquisition.
    - Complexity: more complex to introduce business rules in financial and commercial sectors.
    - **Score 2** to financial and commercial sector, and **score 1** to human resources and industrial.
- *Intelligent Process Automation*
    - Costs: more expensive than RPA technology.
    - Complexity: more complex to introduce business rules in financial and commercial sectors.
    - **Score 3** to all sectors.
- *Industry 4.0*
    - Costs: implementation costs.
    - Complexity: necessity to have implemented several new modern technologies.
    - **Score 3** to industrial and commercial sectors.

Process Automation:

- *Business Process Management*
    - Costs: insignificantly.
    - Complexity: the design, implementation, and execution of the changes doesn´t require a significant amount of money but it requires time.
    - **Score 1** to all sectors.

- *Business Process Integration*
    - Costs: a considerable amount of money to integrate different systems.
    - Complexity: interconnectivity of different systems.
    - **Score 3** to all sectors.
- *Business Process Automation*
    - Costs: not a significant amount of money to be dispended.
    - Complexity: identification and creation of a flow of activities that interconnects processes through the company.
    - **Score 2** to financial and commercial sectors, and **score 1** to human resources and industrial.
- *Process Analytics*
    - Costs: cost associated with software´s acquisition.
    - Complexity: low complexity to implement the software in the organization.
    - **Score 1** to all sectors.
- *Hyper-Automation*
    - Costs: high costs associated to this new technology.
    - Complexity: not significant.
    - **Score 3** to all sectors.

Table 4 – The cost/complexity of the proposed strategy implementation

Cost/Complexity		Companies Sectors			
		Financial	Human Resources	Industrial	Commercial
Automation Technology	Workflow Automation	2	2	3	1
	Robotic Process Automation	2	1	1	2
	Intelligent Process Automation	3	3	3	3
	Industry 4.0	-	-	3	3
Process Automation	Business Process Management	1	1	1	1
	Business Process Integration	3	3	3	3
	Business Process Automation	2	1	1	2
	Process Analytics	1	1	1	1
	Hyper-automation	3	3	3	3

Score	**Meaning**
1	Low Cost
2	Average Cost
3	High Cost

5. EVALUATION

The proposed framework of various technologies and automation processes for various sectors was evaluated in terms of company size, SME *vs* Big Companies, and cost/complexity. The framework's usefulness was evaluated, and suggestions for improvement and validation were made.

As a result, and in accordance with the methodology chosen, interviews were conducted with experts to ascertain technical and non-technical perceptions of the structure. The content of the questions asked during the interviews was based on the results of the literature review and can be found on *Table 5*. They were created online using an embedded video communications platform.

To validate the proposed frameworks, the followed specialists were selected: Alexandra Tenera (**AT**), assistant professor at UNL/FCT – teaching and researching with focus on Production and Operations Management and Project Management and also coordinator of the post-graduate program in Project Management of the FCT/UNL, Sandro Costa (**SC**), software consultant and co-founder of Peercare – a digital transformation startup focused on healthcare and the relationship between patients and families, and Sandra Pereira (**SP**) head director of logistic at ATLA Logistica SA, a former logistic company of Aviludo and now part of Metro Group.

Table 5 – Validation Questions

Q1	Do you consider the proposed framework as useful and why? If not, why do you believe it is not?
Q2	Do you have any recommendation or suggestions for further improvements of the proposed framework?

Furthermore, due to the interviewees' extensive contributions throughout the discussion, only the answers to the questions above were included in this section.

To avoid biased information, the transcription process began immediately following the conclusion of the interviews.

Q1 - Do you consider the proposed framework as useful and why? If not, why do you believe it is not?

AT: First and foremost, I would argue that the values assigned to each of the automation technologies and processes vary depending on the type of company, its area of expertise (which influences the priorities of each sector in different ways), and the nature of the work itself. However, because of the company's size and cost/complexity, I believe the frameworks have usefulness and exploitation benefit. Taking into account the preceding analysis, I consider the frameworks presented

to be useful, specifically as strand indicators/guides and the attempt to verify disparities and diversity between sectors, which I find interesting.

I also think it would be very relevant, and I'm not sure if you used it in the remaining interviews, to create an interview protocol to ensure that all interviewees ask the questions in the same way, even if the contents are different because each one has your vision.

SC: Despite not having access to the justifications for assigning scores, I believe the framework presented is useful. I believe that the framework can be perfectly presented to small, medium, and large companies to first assess where they are in the situation and what they can do first (ie how actions can have an impact) in order to understand what to extract in terms of cost/benefit. That is, a consultant could use this to understand what he can do in a 6 month or 1 year project to have the most impact and the greatest cost/benefit for a company, after evaluating with the parameters of the proposed framework, as long as the score presented for each of the technologies/automation processes also makes sense in the real world.

SP: I believe the framework is designed. Companies, on the other hand, seek to optimize and automate everything from the industrial part, that is, everything from industrial processes, factory floors, and field processes must be as automatic as possible with a lower degree of operationalization of people, so anything industrial is a priority. Regarding the same financial part, all people in the financial area want real-time information in order to understand the status of the process, so automation of financial-related processes becomes very important for administrators, CEO's, and CFO's to have access to real and reliable information for decision making to be the most informed.

In short, I understand the framework's importance and utility, given that the idea is to present the framework to companies in order to define the priorities of each company in order to show people who end up making the decisions where it is necessary to begin implementing. Looking at the framework presented, if it were a large company, I would begin with everything financial because the costs presented for the area are deemed affordable, in order to initiate changes and create added value for the company through process automation.

Finally, check to see if the assigned score has been maintained in light of the reflections made during all interviews based on the interviewees' perspectives.

Q2 - Do you have any recommendation or suggestions for further improvements of the proposed framework?

AT: To have greater precision in the valuation of the various components, I believe that a clear distinction and definition of the concepts of cost and complexity would be beneficial, or at least try to give an orientation of what is meant by cost and complexity, which aspect is to be evaluated, so that a person who is going to analyze the framework (and since it is a subjective analysis) can make a decision with all of the evaluation done on the same concept presented.

Another consideration is the precision of the scale used (level 1-3, odd system). I would consider implementing a pair system (level 1-4) as an asset in order to "force" the interviewees to make the

decision of adequate vs not adequate, because otherwise the natural tendency is for the person in doubt to opt for medium level, and because this 1-3 level scale can cause some central decision-making bias that would not exist if I used another system. However, it is also important to note that when using an even scale, I condition the assessment by "forcing" the respondent to make a more, or less, favorable decision.

Finally, I would say that the score could be consensual, which means that the score would be defined by the respondents themselves or by the organizations themselves and then consensual through an average value, which would then be used as a reference based on this analysis.

SC: Again, I emphasize that the ratings presented in the frameworks are fair, nevertheless I would increase the score on industrial sector due to the importance of those technologies and processes on industrial sector, and also I would attempted to create other frameworks identical to those presented based on the feedback from these interviews, interviewed more people to get more feedback on the ratings and whys of the ratings given, and from there, you would be able to extract more information from what you really want with the feedback given in the interviews for the development of the framework, in addition to being fair.

The ideal situation would be to be able to define an assessment framework so that company administrations can analyze the framework, act according to the framework with the implementation strategy, and then assess according to the framework to see the results of automation technologies and processes. As a result, I believe that the addition of this new framework would greatly benefit the implementation of the suggestions presented.

SP: Regarding to improvements to be made on the proposed frameworks I would give review scores and the addition of more departments to the framework, to emphasize a little of what was said in the first question. Drawing on my experience, I believe that incorporating the logistics sector makes perfect sense, because all companies have this department, whether residual or not, with a weight in the final product of around 10%, being one of the areas that must be optimized as much as possible and with a low level of human resources interference, because they are more likely to make mistakes than the systems.

So, in the future, I'm not sure if you'll include the logistics department in this version, but adding this sector to the framework would make it more inclusive and deeper in its analysis.

6. CONCLUSION

This chapter concludes the dissertation's developed work by reflecting on the most important conclusions, limitations, and future work. It also provides a global understanding of whether or not the specified objectives were met. As a result, and taking into account the feedback gathered during the evaluation stage, we can acknowledge that the initial objectives have been achieved, and the proposed frameworks can be useful to companies as they begin to evaluate their processes and implement technologies and process automation.

6.1. SYNTHESIS OF THE DEVELOPED WORK

The objective of the research was to propose a strategy for the integration of hyper-automation technologies into the current Portuguese companies' processes to increase the competitiveness of the Portuguese companies.

To reach this goal the thesis was divided into two distinct phases:

1. **Theorical:** at this stage the main objective was the comprehension of the subject in analysis and collect information related to hyper-automation processes and technologies, as well as the context of Portuguese companies.

2. **Practical:** collect real information about the applicability and necessity of automation into current Portuguese companies processes through a questionnaire. After gathered that information, it was designed proposed framework to be use and applied by Portuguese companies. And finally, the proposed frameworks were evaluated by specialists.

In conclusion, it can be affirmed that the proposed objectives at the beginning of the dissertation were achieved.

6.2. WORK LIMITATIONS

Despite the fact that the proposed objectives were fulfilled, this investigation had some limitations in terms of framework validation. Even though it was approved by three specialists, the number of participants could have been greater, resulting in a more credible, universal, and applicable framework and its validation. The availability of several participants was limited due to the pandemics' context that was active during the conduct of this investigation.

Additionally, if the deadline to deliver the dissertation were longer it would be very interesting to interview more specialists and professionals working in management in order to collect more practical feedback, rearrange the proposed frameworks with the collected information from all the interviews, create a new framework to evaluate the proposed frameworks, and tried to implement in a real context on a Portuguese company.

Nevertheless, efforts were made to have a higher number of responses to the questionnaire. The main difficulties throughout this process were the manual collection of the contact information for each company (through their website, and when not available the requests were made via LinkedIn). This stage had begun in July and ended in September, and the low percentage of responses can be understanded by the fact that this period is frequently used as holidays for the majority of people in Portugal.

6.3. FUTURE WORK

In terms of future work, the validation of the proposed frameworks could be improved by collecting more insights from a larger number of people, making the framework as universal and practical as possible. Different users should be interviewed in order to gather information from as many different backgrounds as possible in order to create a larger framework that can be applied to more sectors.

The collected feedback from the specialist suggests that the updated frameworks should have in consideration to averaging the score, to implement a pair score system (1 to 4) to “force” the interviewees to make the decision of adequate vs not adequate, otherwise the natural tendency is for the person in doubt to opt for the medium level and because of this it can cause some central decision-making bias, and the creation of an evaluation framework to be used after the implementation of those technologies and processes automation.

Finally, making this investigation available to the academic world, for example, through a publication, would make it more accessible to the public and allow for the emergence of other investigations.

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APPENDIX 1 - QUESTIONNAIRE

The goal of this study is to gain a better knowledge of how Portuguese organizations view the opportunity to integrate new automation technologies, as well as to understand the priority for each business department. The primary research question is: what can be addressed in the processes of Portuguese companies, and how can it be incorporated?

Portuguese companies´ context

1) What district is your company in? If more than one, which headquarters is located.

2) How many employees does your company have?

3) Which sector of activity does your company belong to?

Strategy

4) For each area listed below, indicate whether the implementation of process automation is expected and its priority. (*Figure 8* illustrates the example given in the questionnaire)

	Next 5 years	Next 10 years	>10 years	Never
Financial	☐	☐	☐	☐
Human Resources	☐	☐	☐	☐
Industrial	☐	☐	☐	☐
Other Area	☐	☐	☐	☐

Figure 8 – Example from the questionnaire regarding question 4)

5) If you indicated "Other Area", please indicate which.

APPENDIX 2 – SPECIALISTS INTERVIEWS

Interviews' transcription regarding the proposed frameworks' evaluation stage of the present dissertation. To strictly respect the original statements of the interviewees, the transcript text preserved the original language.

Specialists' interviews

1- Alexandra Tenera

Q1 – Considera a framework proposta útil? Porquê? Caso não a considere, qual a razão?

Em primeiro lugar eu diria que os valores atribuídos a cada uma das tecnologias e processos de automatização dependem do tipo de empresa, da sua área de especialização (que influencia de forma diferente as prioridades de cada setor), e dependem do próprio tipo de trabalho. No entanto, considerando as frameworks como uma proposta de estratégia generalizada pelo tamanho da empresa e custo/complexidade creio que tem a sua utilidade e benefício de exploração. Tendo em conta a análise anteriormente feita, eu considero as frameworks apresentadas como úteis, nomeadamente como indicadores/orientadores de vertentes e a tentativa de verificar disparidades e diversidade entre setores e na minha opinião vejo isso como algo interessante.

Também creio que seria muito relevante, e não sei se aplicaste isso nas restantes entrevistas, seria a criação de um protocolo de entrevista de forma a garantir que todos os entrevistados postos as questões da mesma maneira, embora os conteúdos sejam diferentes pois cada um tem a sua visão.

Q2- Que recomendações ou sugestões tem para melhorar as frameworks propostas?

Acho que para se ter uma maior precisão na valorização das várias componentes seria benéfica uma clara distinção e definição dos conceitos custo e complexidade, ou pelo menos tentar dar uma orientação do que se entende por custo e complexidade, qual a sua vertente que se encontra a ser avaliada, de modo a uma pessoa que vá analisar a framework (e uma vez que é uma análise subjetiva) que consiga tomar uma decisão com toda a avaliação feita sobre o mesmo conceito apresentado a todos os inquiridos.

Outro aspeto é o nível de precisão da escala utilizada (nível 1-3, sistema ímpar). Eu consideraria uma mais-valia a implementação de um sistema par (nível 1-4), de modo a "obrigar" a os entrevistados tomarem a decisão de adequado *vs* não adequado, porque caso contrário a tendência natural é a pessoa em dúvida opta pelo nível médio, e sendo esta escala de nível 1-3, pode provocar algum enviesamento de tomada de decisão central que na realidade não existe se eu adotasse um outro sistema. No entanto, também é importante realçar que no caso de uma escala par eu também condiciono a avaliação pois "obrigo" o entrevistado a tomar uma decisão mais, ou menos, favorável.

Também acharia interessante apresentar-se aos entrevistados uma síntese à priori dos conceitos abordados na framework (como foi o meu caso no início quando questionei o significado de hiper-automatização), porque uma pessoa não tendo completa noção de todos os conceitos teria assim uma resposta condicionada pela experiência e ao que entende pelo conceito. Em jeito de sumário, em termos de aplicabilidade futura seria definir o que se entende pelos conceitos, onde eles se posicionam com a framework.

O score podia ser consensualizado, isto é, o score seria definido pelos próprios inquiridos ou pelas próprias organizações e depois consensualizava-se através de um valor médio e a partir dessa análise utilizar-se esse valor como referência.

2- Sandro Costa

Q1 – Considera a framework proposta útil? Porquê? Caso não a considere, qual a razão?

Acho que a framework apresentada é útil, apesar de não ter acesso às justificações apresentadas para a atribuição dos scores.

Creio que a framework pode ser perfeitamente apresentada a pequenas, médias e grandes empresas para em primeiro lugar fazerem uma avaliação de como eles estão, ou seja, para perceberem em que ponto da situação é que se encontram e o que é que eles podem fazer primeiro (isto é, como é que as ações podem ter impacto) de modo a perceber o que extrair em termos de custo/benefício. Ou seja, um consultor poderia utilizar isto para perceber o que é que ele pode fazer num projeto a 6 meses, ou 1 ano, de o que é que terá mais impacto e o maior custo/benefício para uma empresa, depois de avaliar com os parâmetros da framework proposta, desde que o score apresentado para cada uma das tecnologias/processos de automatização façam sentido também no mundo real. Isto é, a framework apresentada parece bem desenhada, mas no mundo real procuraria obter mais feedback de producto owners, especialistas da área e verificar se a avaliação apresentada nestas frameworks e as suas justificações são plausíveis no mundo do trabalho. Para isso a criação de um guião que contenha as prioridades para diferentes estratégias, seria uma mais-valia no momento da apresentação das estratégias propostas nas frameworks.

Q2- Que recomendações ou sugestões tem para melhorar as frameworks propostas?

Uma vez mais, friso que as classificações apresentadas nas frameworks são justas, mas tentava criar outras frameworks idênticas às apresentadas consoante o feedback destas entrevistas, entrevistas mais pessoas para obter um maior número de feedback sobre as classificações e os porquês das classificações dadas, e a partir daí conseguiria extrair mais informação daquilo que realmente pretendes com o feedback dado nas entrevistas para a elaboração da framework, além que consegues "prová-la" no mercado com esses testemunhos de pessoas que acabam por implementar essas tecnologias e processos de automatização nas empresas.

Dito isto, acredito que tendo a oportunidade de entrevistar e falar com pessoas com larga experiência na indústria traria muita informação útil pegar, analisar, e fazer uma avaliação geral dos departamentos atribuindo uma classificação e a partir daí, perceber o que é que é preciso melhorar ou não, e utilizar a framework que está a ser desenvolvida para compreender qual seria a área de

determinada empresa com maior impacto e maior custo/benefício. O ideal seria conseguir definir uma framework de avaliação para as administrações das empresas terem a possibilidade de analisar a framework de avaliação, atuar consoante a framework com a estratégia de implementação e novamente, avaliar consoante a framework de avaliação para ver os resultados das tecnologias e processos de automatização. Assim, a adição desta nova framework creio que traria um grande benefício para a implementação das sugestões apresentadas.

3- Sandra Pereira

Q1 – Considera a framework proposta útil? Porquê? Caso não a considere, qual a razão?

Acho que a framework encontra-se bem formulada. No entanto as empresas procuram otimizar e automatizar tudo o que seja da parte industrial, ou seja tudo o que seja de processos industrias, chão de fábrica, tudo o que seja processos de terreno tem de ser o mais automático possível com menor grau de operacionalização das pessoas, pelo que consideraria tudo o que seja industrial como prioritário. Em relação à parte financeira igual, todas as pessoas da área do pelouro financeiro querem ter a informação em tempo real de modo a conseguir compreender o estado do processo, pelo que a automatização dos processos ligados à área financeira acaba por ser muito importante para os administradores, CEO´s, CFO´s terem acesso a informação real e fidedigna para a tomada de decisão ser a mais fundamentada.

Resumindo, consigo compreender a importância e utilidade da framework, pois considerando que a ideia é apresentar a framework às empresas para definir quais as prioridades de cada empresa com o objetivo de mostrar às pessoas que acabam por tomar as decisões por onde é necessário começas a implementar. Eu olhando para a framework apresentada, se fosse uma grande empresa, eu começaria por tudo o que fosse financeiro porque os custos apresentados para a área são considerados acessíveis, de modo a iniciar as alterações e criar mais valia para a empresa na automatização dos processos. Uma vez mais, na minha opinião eu creio estas implementações no setor da indústria constituem uma mais valia porque tudo é praticamente automatizável, e acaba por ser muito difícil para uma empresa cobrir as encomendas dos clientes se não tiver um chão de fábrica bastante automatizado, pelo que são muitas as empresas que se encontram a adotar medidas com essa visão de automatizar os seus processos industriais. Um dos primeiros passos na implementação de processos automáticos na empresa na área industrial é a interligação com a parte financeira, e tudo isto acaba por reduzir o número de pessoas nos recursos humanos necessários para uma empresa, menos burocracia, etc…

Por último, verificar se o score atribuído ainda se mantém dadas as reflexões feitas durantes todas as entrevistas com base nas visões dos entrevistados.

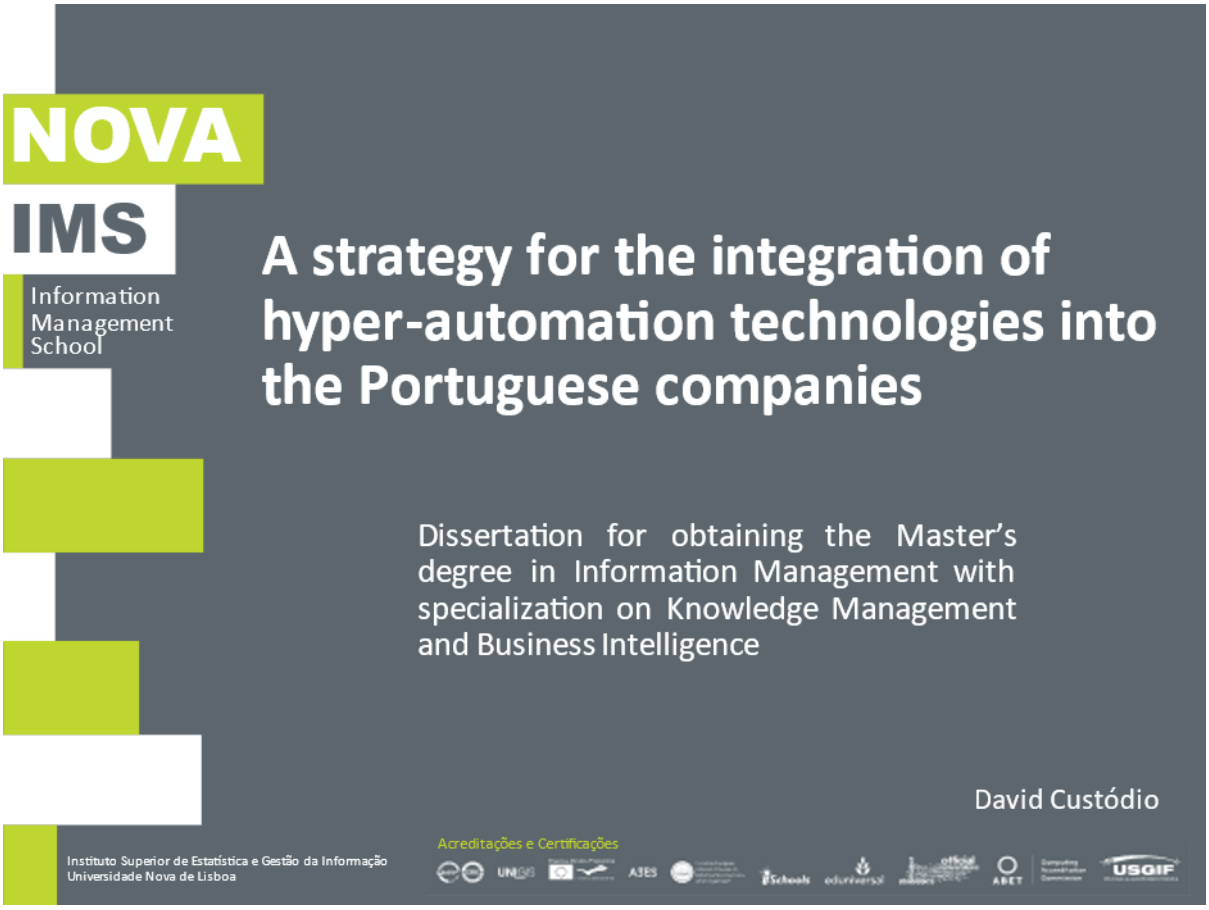
Q2- Que recomendações ou sugestões tem para melhorar as frameworks propostas?

Frisando um pouco do que foi dito na primeira pergunta, melhor/rever scores e adicionaria mais departamentos à framework. Puxando um pouco da minha experiência, creio que a incorporação do setor da Logística faz todo o sentido, porque todas as empresas têm este departamento, quer seja

residual ou não, tendo um peso no produto final de cerca de 10%, sendo uma das áreas que tem que estar o mais otimizado possível e com um nível de interferência de recursos humanos baixo, porque têm uma probabilidade de errar superior ao dos sistemas.

Por isso, no futuro, não sei se irás incorporar nesta versão o departamento de logística, uma adição deste setor à framework contribuiria para a mesma fosse mais inclusiva e profunda na análise.

APPENDIX 3 – FRAMEWORK PRESENTATION



Framework - Purpose

01

- Understanding the subject and relevance of hyper-automation processes.

02

- Collect information from Portuguese companies that have focus on processes automation - in order to understand their processes and how they would adjust with hyper-automation, reporting the benefits inherent to technological evolution.

03

- Identify the business processes that may be hyper-automated and the impact that this approach may have on, and measure in which areas/departments the managers believe hyper-automation will have a major influence in the short-term.

04

- Propose a strategy for the applying hyper-automation technologies in the Portuguese companies.

Framework – Small and Medium Enterprises

SME		Companies Sectors			
		Financial	Human Resources	Industrial	Commercial
Automation Technology	Workflow Automation	2	2	1	1
	Robotic Process Automation	3	3	2	1
	Intelligent Process Automation	2	2	1	1
	Industry 4.0	-	-	1	1
Process Automation	Business Process Management	3	3	2	3
	Business Process Integration	2	2	2	2
	Business Process Automation	2	2	2	2
	Process Analytics	3	3	3	3
	Hyper-automation	2	2	2	2

Score	Meaning
1	Inadequate
2	Fairly Adequate
3	Adequate

Framework – Big Companies

Big Companies		Companies Sectors			
		Financial	Human Resources	Industrial	Commercial
Automation Technology	Workflow Automation	3	3	3	3
	Robotic Process Automation	3	3	3	1
	Intelligent Process Automation	3	3	3	2
	Industry 4.0	-	-	2	2
Process Automation	Business Process Management	2	2	2	2
	Business Process Integration	3	3	3	3
	Business Process Automation	2	3	3	2
	Process Analytics	3	3	3	3
	Hyper-automation	3	3	3	3

Score	Meaning
1	Inadequate
2	Fairly Adequate
3	Adequate

Framework – Cost/Complexity

Cost/Complexity		Companies Sectors			
		Financial	Human Resources	Industrial	Commercial
Automation Technology	Workflow Automation	2	2	3	1
	Robotic Process Automation	1	1	2	1
	Intelligent Process Automation	2	2	3	2
	Industry 4.0	-	-	3	3
Process Automation	Business Process Management	1	1	1	1
	Business Process Integration	3	3	3	3
	Business Process Automation	2	1	2	1
	Process Analytics	1	1	1	1
	Hyper-automation	3	3	3	3

Score	Meaning
1	Low Cost
2	Average Cost
3	High Cost

Interview Questions

1) Do you consider the proposed framework as useful and why? If not, why do you believe it is not?
2) Do you have any recommendation or suggestions for further improvements of the proposed framework?

Thank you for your time and expertise!

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Acreditações e Certificações

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