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MASTER
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RESEARCH ON THE MATURITY OF PORTUGUESE COMPANIES IN THE ADOPTION OF ARTIFICIAL INTELLIGENCE APPLICATIONS

João Maria Castelo dos Santos Rebelo Duarte

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Dissertation
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Supervised by

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A master's degree is a long journey filled with countless challenges that make us more complete, capable, and qualified individuals and professionals in the end. A master's dissertation is the culmination of this arduous journey, putting all the capabilities acquired thus far to the test.

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I dedicate this work to my grandfather, hoping that one day I can be half as good as he was.

Statement of Integrity

I hereby confirm that the present thesis "Research on the maturity of Portuguese Companies in the adoption of Artificial Intelligence Applications" is solely my own work and that if any text passages or diagrams from books, papers, the Web, or other sources have been copied or in any other way used, all references – including those found in electronic media – have been acknowledged and fully cited.

I further declare that I know and have respected the Code of Ethical Conduct of the University of Porto.

Abstract

Artificial Intelligence and the applications it enables may be used in a wide range of fields, creating opportunities for a variety of businesses. However, there is few publicly available data on the use of Artificial Intelligence applications by Portuguese businesses in particular. The goal of this research is to give an analysis of the panorama of Portuguese enterprises regarding adoption of Artificial Intelligence applications, while also providing a comparison to what is done in other European countries.

Based on other research studies available at an European level, an in-depth survey was conducted with leading companies in Portugal followed by interviews with experts on the subject. Results suggest that, while Portugal is not a prominent country in terms of Artificial Intelligence research and development, it is exceptionally capable of adopting and developing applications that already use established Artificial Intelligence technologies.

Future research may investigate what types of policies could be put in place to make Portugal a more competitive country in Artificial Intelligence development, rather than just a consumer of derived applications.

Keywords: Artificial Intelligence, AI Technologies, Portuguese Companies, European Panorama

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List of Illustrations and Tables

List of Abbreviations

The following list describes the significance of abbreviations used throughout the manuscript, along with the page on which each one is defined or used for the first time.

Abbreviation	**Definition**	**Page**
AI	Artificial Intelligenec	1
PT	Portugal	1
AGISI	Artificial General Intelligence Sentinel Initiative	2
DL	Deep Learning	5
ML	Machine Learning	6
IBM	International Business Machines Corporation	6
ANNs	Artificial neural networks	6
SOA	State-of-the-art	9
EU	European Union	12
VC	Venture Capital	12
US	United States of America	12
TMT	Technology, Media, and Telecom	13
R&D	Research & Development	14
IT	Information Technology	14
SME	Small & Medium Enterprises	16
PSI-20	Portuguese Stock Exchange	17
SDR	Socially Desirable Responding	20
CEO	Chief Executive Officer	22
CAE	*Classificação Portuguesa das Actividades Económicas*	24
IoT	Internet-of.Things	26
SL	Supervised Learning	26
UL	Unsupervised Learning	26
RL	Reinforcement Learning	26

NLP	Natural Language Processing	26
KRR	Knowledge Representation and Reasoning	26
MP	Machine Perception	26
AP	Automated Planning	26
AS	Automated Scheduling	26
AA	Advanced Analytics	28
DM	Data Management	28
AIL	AI Leadership	28
OC	Open Culture	28
ET	Emerging Technology	28
AD	Agile Development	28
EA	External Alliances	28
EI	Emotional Intelligence	28
CPR	Consumer Products & Retail	30
SABI	Iberian Balance Sheet Analysis System	30
CRM	Customer Relationship Management	35
CC	Cloud Computing	35

1. Introduction

The use of technology in our daily lives and for work is evolving quickly. The same holds true for companies that continually look for ways to stay one step ahead of the competition and depend on technology for methods to retain consumers and attract new ones.

Artificial Intelligence (AI) is defined as the ability of systems to perceive and process data, efficiently converting it into relevant information for the users of its outputs.

Only Denmark is ahead of Portugal (PT) in terms of the percentage of businesses using at least one AI technology (Eurostat, 2021).

Which sectors benefit the most from AI applications? What value do Portuguese businesses place on these technologies? Which divisions are most affected? These are a few questions, among many others, that piqued curiosity.

The amount of studies in this field, specifically with relation to the Portuguese setting, is rather limited, as described later. The purpose of this dissertation is to specifically analyze the maturity of Portuguese enterprises in the use of technologies powered by AI to provide an answer regarding the state of AI in Portugal.

This work begins with a brief overview of AI and associated terms. Subsequently, a review of the state-of-the-art is carried out regarding studies on the adoption of AI by companies both in Europe and in Portugal.

Then, after finding a gap in the study of the adoption of AI by Portuguese companies, a survey was carried out with leading companies in different sectors of activity.

Finally, the main conclusions and insights from interviews with specialists on AI in Portugal are presented - one from the academia and the other from the business context.

2. Defining AI related concepts

Some AI topics that are important to understand this research are explained in this section of the dissertation.

Although the focus of this work is on AI technologies, it is important to first understand what Information and Communications Technologies (ICTs) are and how they relate to AI.

UNESCO Institute for Statistics (2009) defines ICTs as "…a diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the Internet (websites, blogs and emails), live broadcasting technologies (radio, television and webcasting), recorded broadcasting technologies (podcasting, audio and video players, and storage devices) …".

There are many definitions of AI by different authors that selecting the most suitable is a complicated task. There is even a constantly updated list published by the Artificial General Intelligence Sentinel Initiative (AGISI) (AGI Sentinel Initiative, 2020).

John McCarthy, a pioneer who created the term "Artificial Intelligence" in 1955, defines AI as "… the science and engineering of making intelligent machines "… "(where) intelligence is the computational part of the ability to achieve goals in the world", "… making a machine behave in ways that would be called intelligent if a human were so behaving" (McCarthy, 1955). Despite being the first, this previous definition may not be the easiest to understand. Thus, a clearer and more concrete definition may help the reader's understanding.

"Artificial intelligence is a type of technology that mimics the human thought, empowering machines to act on their own and to perform functions similar to human intelligence, such as the ability to perceive, learn, reason, and act." (Ribeiro, 2021). AI is a discipline that, in its most basic form, integrates computer science with substantial datasets to facilitate problem-solving (IBM, 2020).

The way ICTs relate to AI is not straightforward to explain. While ICTs are limited to storing and processing information and performing pre-programmed tasks, AI can perform a set of much more complex tasks, such as learning, adapting, performing, processing information. So, in a way, we can consider ICTs as ground level of AI, given that they are an important

component for the functioning of AI, but still performing very rudimentary tasks when compared to AI.

In the definition of AI applications, the categorization between Weak AI and Strong AI categories prevails.

Weak AI, also known as Narrow AI, where the vast majority of AI resides today, consists of modeling AI in order to perform specific tasks. Some examples of applications are Apple's Siri, autonomous vehicles and chatbots. Throughout this text, the reference will always be to this type of AI.

Strong AI is based on a theoretical form of AI, Artificial General Intelligence, which idealizes that a machine would have the same intelligence as a human. Thus, it is still a totally theoretical field in development (IBM, 2020).

For simplicity, we can divide AI into subcategories - Machine Learning and Deep Learning.

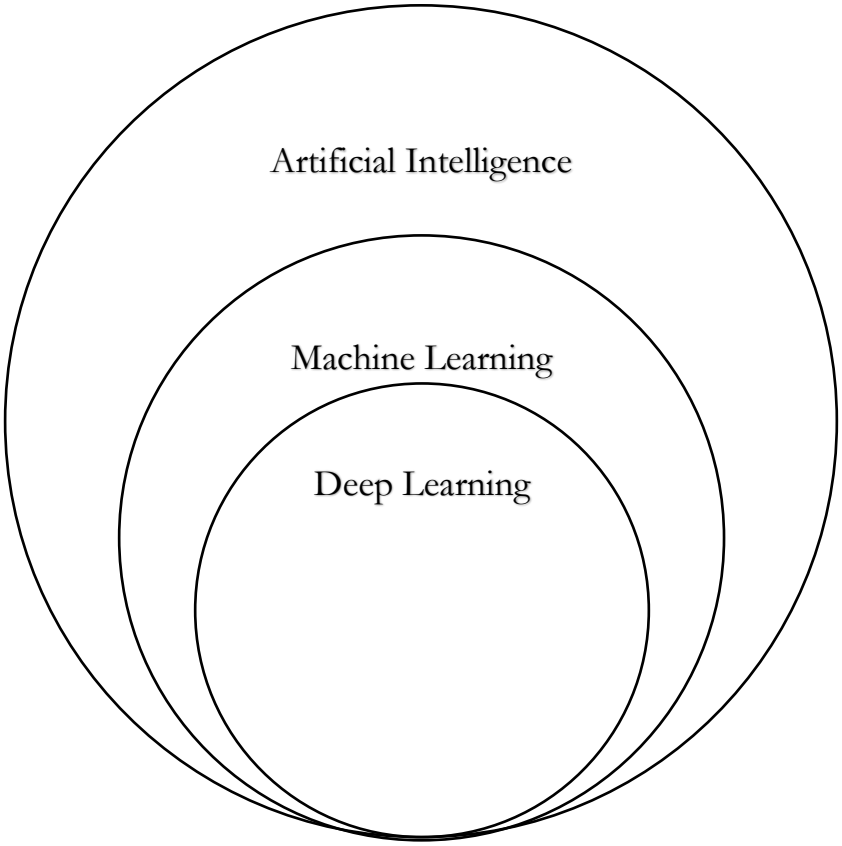

Figure 1 - Subcategories of AI.

The main difference between these two AI subcategories lies in the algorithm of their applications, especially in the way this algorithm learns.

Machine learning gives computers the ability to complete tasks autonomously by learning from previous data. By providing a machine a lot of data, computer scientists may "train" the system. The machine analyzes the data and makes conclusions using a set of guidelines known as an algorithm. The computer can grow more proficient at carrying out a task or reaching a judgment the more data it analyzes (Norvig, 2009).

Usually, 3 types of approaches are recognized:

- **Supervised learning**: algorithm's input and output are both given. The model receives input data and the desired output data – then, the algorithm carries out some optimization routine to minimize a loss or error function, becoming more accurate.
  Classification and regression problems are some of the most common – classification is when the algorithm returns a category output, such as "green" or "blue" while regression is when the output variable is a numerical value.
  A real-life example of the application of Supervised Learning is predicting house prices - information about numerous houses is gathered, such as their dimensions, number of rooms, etc. The cost of these houses (the labels) must then be known. We can now train a supervised machine learning model to estimate a new house's price based on the instances observed by the model by using data from thousands of houses, their attributes, and prices (Yagcioglu, 2020).
- **Unsupervised learning**: only algorithm's input data is given. Algorithms are left to their own: "Data points are used as references to find meaningful structure and patterns in the observations" (Yagcioglu, 2020).
  Clustering is a common approach used to analyze input data, which the objective is to identify natural groupings or clusters in a data set.
  A real-life example of Unsupervised Learning are e-commerce websites like Amazon, that use clustering algorithms to implement a user-specific recommendation system (Joy, 2020).
- **Reinforcement learning**: ability of a model to learn through trial and error using feedback from its actions. There is a sole similarity between Supervised learning and Reinforcement learning - both involve mapping between input and output, but that is it. In contrast, the feedback in supervised learning includes the appropriate course

of action for the agent (model) to take. There is no such answer key in Reinforcement learning. To complete the assignment successfully, the agent chooses what actions to take on its own (University of York, n.d.).

A real-life application is autonomous cars. Reinforcement learning agents are trained to optimize trajectories, motion planning, lane switching, parking, etc.

The figure below visually summarizes the different machine learning approaches.

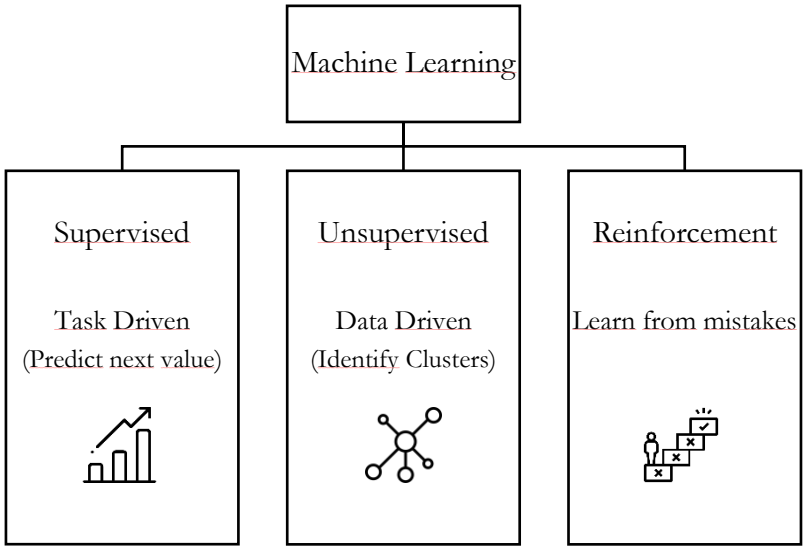

Figure 2 - Types of Machine Learning (Bhatt, 2018).

Deep Learning (DL) may be thought of as a subfield of machine learning. Technically speaking, it functions in a similar manner as machine learning, but with distinct capabilities and strategies. Often the term "neural networks" appears associated with DL given its intention to replicate human brain.

Neurons in our brain process information. They receive and analyze new information before sending electrical and chemical signals. Axons are the structures that link neurons together. Our brain is made up of a vast network of interconnected neurons and the connection and communication between them is what allows our body to respond to a stimulus (Dibble, 2020).

When we touch a hot pan, a stimulus triggers neurons that immediately send a signal to the body to drop the pan - let's think in a computational way. The stimulus received is the input, the synapses in the brain that process the information sent by the stimulus are the neural networks and the command to drop the pan is the output.

Thus, while a Machine Learning (ML) model may not need huge amounts of data to be a model with sufficient reliability - to the extent as it is trained, there is intervention until the output corresponds to the expected -, a DL model needs immense amounts of data, as it learns alone. In this way, if the model is provided with tiny amounts of data, the model will be shortly trained, while if massive amounts of data are given, it will have much more information that will allow it to be a significantly completer and more reliable model.

In its publicly available "Cloud Learn Hub", International Business Machines Corporation (IBM) explains how Artificial neural networks (ANNs) work as follows:

> ANNs are comprised of a node layers, containing an input layer, one or more hidden layers, and an output layer. Each node, or artificial neuron, connects to another and has an associated weight and threshold. If the output of any individual node is above the specified threshold value, that node is activated, sending data to the next layer of the network. Otherwise, no data is passed along to the next layer of the network.
>
> Each individual node as its own linear regression model, composed of input data, weights, a bias (or threshold), and an output. Once an input layer is determined, weights are assigned. These weights help determine the importance of any given variable, with larger ones contributing more significantly to the output compared to other inputs. All inputs are then multiplied by their respective weights and then summed. Afterward, the output is passed through an activation function, which determines the output. If that output exceeds a given threshold, it "fires" (or activates) the node, passing data to the next layer in the network. This results in the output of one node becoming in the input of the next node. This process of passing data from one layer to the next layer defines this neural network as a feedforward network (IBM Cloud Education, 2020).

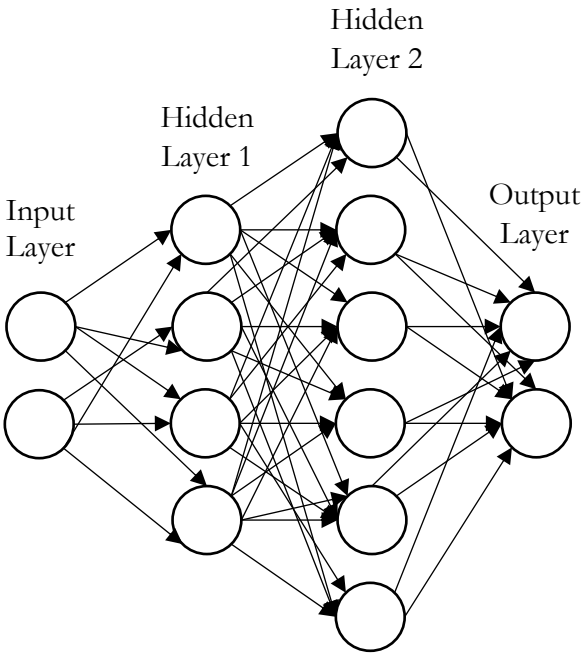

Figure 3 - Artificial Neural Networks.

These technologies, ML and DL, enable many other applications. These are some of the most common:

- **Natural Language Processing**: area within AI that is dedicated to developing the ability of technology to understand the language of human beings.
- **Robotics:** robots are programmable machines that are typically capable of performing a series of actions autonomously or semi-autonomously. AI robots are the bridge between robotics and AI. These are robots that are controlled by AI programs;

  AI robots differ from non-AI robots in that the latter are programmed to perform a limited number of tasks while the former reacts flexibly according to the environment to which they are exposed (different input data);
- **Knowledge Representation and Reasoning**: application dedicated to representing information about the world in a way that a computer system can use to solve complex tasks - reasoning. For example, "Amazon Alexa" uses encoded propositions (knowledge representation) to produce logically derived representations of new propositions (Bohnoff, 2019);

- **Machine Perception**: refers to the computer system's ability to interpret data similarly to the way humans use their senses to relate to the world around them;
- **Automated Planning**: it occurs when a machine is given a description of the present state, a list of potential actions, and a desired state and asked to come up with a series of activities or a plan;
- **Automated Scheduling**: considering a list of actions and a limited amount of resources, a machine must choose the most effective way to carry out each operation (create a schedule).

There are many other different applications derived from AI.

In this section, the key AI concepts and terms were supplied to help the reader comprehend this study.

3. State-of-the-art Review

3.1 Research Method

This section is the output of a state-of-the-art (SOA) review of the work carried out so far in the investigation of AI adoption by companies. It includes the appreciation of articles from scientific journals, master's dissertations, theses, books, and other documents available digitally.

In summary, the current research sought to identify and analyze worldwide surveys and studies that exclusively represented the Portuguese reality on AI.
The following actions were taken to complete the first section of the literature review:

1. Search for relevant literature:
    a) Keyword definitions;
    b) Manual review of references of identified articles;
    c) Articles suggested by experts in the area.
2. Identification of themes, debates, and gaps.
3. Findings and conclusions.

All studies were retrieved from three electronic databases: Web of Science, Google Scholar and Scopus. A list of keywords was established for the first section of the literature review, which examined worldwide surveys, in order to conduct an orderly and uniform search across the various sources:

- Artificial Intelligence **OR** Deep Learning **OR** Machine Learning **OR** Information Technology

  AND

- Survey

  AND

- Business **OR** Management

Only Open Access articles were considered to the literature review at this stage. The literature search was carried out from 2017 to 2022 and only English written studies were considered. The results found were the following:

Scopus query	Number of Papers	WoS query	Number of Papers	Google Scholar query	Number of Papers
(TITLE(artificial AND intelligence) OR TITLE(deep AND learning) OR TITLE(machine AND learning) OR TITLE(information AND technology) AND TITLE-ABS-KEY(survey) AND TITLE-ABS-KEY(adoption) OR TITLE-ABS-KEY(use) AND TITLE-ABS-KEY(business) OR TITLE-ABS-KEY(management)) AND PUBYEAR > 2016 AND (LIMIT-TO (OA,"all")) AND (LIMIT-TO (PUBYEAR,2022) OR LIMIT-TO (PUBYEAR,2021) OR LIMIT-TO (PUBYEAR,2020) OR LIMIT-TO (PUBYEAR,2019) OR LIMIT-TO (PUBYEAR,2018) OR LIMIT-TO (PUBYEAR,2017)) AND (LIMIT-TO (LANGUAGE,"English"))	34	(TI=(artifical intelligence) OR TI=(deep learning) OR TI=(machine learning) OR TI=(information technology)) AND TS=(survey) AND ((TI=adoption) OR (TI=use)) AND ((TS=business) OR (TI=management)) AND (2017 or 2018 or 2019 or 2020 or 2021 or 2022 (Publication Years)) AND English (Languages)	48	allintitle: survey use adoption artificial OR intelligence OR deep OR learning OR machine OR learning OR information OR technology OR business OR management	6

Figure 4 - State-of-the-art review queries.

As a result, 110 papers were found in these databases. The number of unique titles was 88. Thirty-four articles were identified in SCOPUS, 48 in Web of Science and 6 in Google Scholar. After removing duplicates and articles not of interest, 28 articles were considered for the purpose of the present review.

Another thirteen articles were considered, which, despite not having appeared in our research, were found through different web sources, recommendations from supervisors and manual search of references from selected articles.

For the second part of the literature review a similar work was carried out - keywords were defined to allow a consistent cross-platform search. This time, a review in Portuguese was carried out considering only surveys about the Portuguese reality.

However, due to the low number of results, a broader and more complementary search was carried out using the repositories available through the University of Porto and using open web search.

Thus, the goal of the literature review was to first gather the best practices and methodologies used in similar studies that were applied to other markets or nations, and then to look at the research done to assess the readiness of Portuguese businesses and economy to adopt AI applications.

Last but not least, this literature review was also crucial to enter and master a topic that is not the focus of the *Master in Management* - AI - and thus collect as much knowledge as possible on this matter in order to obtain the most reliable and highest quality results possible of the survey to be made.

3.2 State-of-the-art review

Most of the works found specialized in a particular field of study. The broader studies were mostly issued by institutions such as the University of Cambridge and Eurostat, or by companies such as Microsoft and McKinsey.

Thus, this review will be divided into two sections:

- An examination of the research on the European market, namely in terms of the overall landscape of AI;
- Examining work done in Portugal.

3.2.1 Research on the European market

AI and the technologies it upholds is seen as a tool capable of leading to change and better positioning economies that know how to take advantage from it.

The work carried out by the University of Cambridge, (Stix, 2019), has as its motto the study of the premise that, at the European level, the adoption of AI technologies is perceived, in a certain way, as delayed compared to other world regions and that European economies are rarely considered leaders in matters of adoption and development of AI technologies.

Effectively, and considering the work launched by Microsoft in its AI Outlook for 2019 (2018), of the 269 companies interviewed, from 15 different countries, only 4% consider to

be active users of AI technologies in their processes and decisions. On the other hand, most of the companies interviewed considered AI to be an important topic and even 61% already have related projects in initial development phases.

The study by the University of Cambridge (2021) begins with an overview of the European Union's (EU) strategy and vision regarding AI and its development plan. After framing the different agreements signed, the work focuses on EU's vision as a leader in the adoption of ethical AI.

Ethical AI, as defended by the EU, aligns with the intentions of maintaining the founding values of the Union, even based on the adoption of potentially disruptive technologies. The EU aims to be a leader in the adoption of AI as a tool for the benefit of people and societies. In this sense, some laws and projects have been launched, such as the General Data Protection Regulation (2018) which aims to give European citizens control over their data and protect it; and the Algo Awareness project which exhaustively studies how algorithmic decision-making can impact the lives of citizens.

The University of Cambridge' study is supported in four main topics, considered the foundation to develop an AI strategy at an European level.

The study establishes a financial comparison to support the reasons that may justify the lower speed of adoption of AI technologies by the EU. Thus, one of the drivers identified is Venture Capital (VC) investment and start-up funding. In 2016, the amount invested by VCs in Europe was more than seven times less than that invested in the United States of America (US). Seeking for a solution, in 2018 the EU launched a VC investment fundraising program and yet another one focused on investment in AI technologies.

In addition to funding, explored above, it also considers talent creation and collaboration.

The creation of talent has been one of the challenges of the EU, facing brain drain for markets with better salary conditions, combined with the difficulty of attracting talent to the EU. This study also explores the need for greater collaboration between member countries and their institutions to strengthen the EU's position and active projects in this regard.

And if the Cambridge University Study analyzes, in a macro way, the EU panorama and its main drivers, the Microsoft Study goes into detail, through interviews with several leading companies in fifteen countries. The purpose of this report is to establish a point between

reality versus hype in the adoption of AI technologies. For this, Microsoft, using the services of Ernst&Young, interviews executives from different sectors and sizes. It also uses other studies, benchmarks, and case studies.

The report begins by presenting the most used technologies, where ML, Smart Robotics and Natural language processing clearly stand out. Between Structured and Unstructured Data, the use of the first type clearly predominates. Subsequently, the report gives a picture of the investment of European countries under analysis – France stands out, with investments between 2008 and 2018 of around 1357M$, followed by Germany (520M$) and Denmark (330M$) for the same period. Portugal totals 3M$ in investments.

In line with the point established by the University of Cambridge' study, the sector with the highest investment is Technology, Media, and Telecom (TMT), supported by strong private investment and venture capital, as we will see below.

Microsoft's AI Outlook concludes that AI is relevant at an Executive Management level, integrating the C-suite agenda of 71% of the surveyed companies, further concluding that the more developed the company, the higher the level of hierarchy at which AI is discussed. When asked about the relevance of AI in relation to other technological priorities, the conclusion was that the priority would be similar.

In the different sectors, a discrepancy regarding the adoption of AI technologies is evident. Companies currently leading the way in terms of AI maturity are in TMT, Services & Hospitality, and Financial Services. Companies in those industries tend to categorize their AI maturity as "Released" (AI that is actively used, albeit sparingly or with less complex tasks) or "Advanced" (AI actively contributing to many processes and enabling advanced tasks). The maturity in TMT and Finance can be logically explained by their propensity to be more analytically astute and digitally advanced, favoring these organizations to proceed beyond piloting by having data science capabilities in place to evolve into more advanced AI stages.

In addition, the study also makes clear the main obstacles identified by companies – such as technological immaturity and lack of quality data – that has led many companies to position themselves as followers. Most of the businesses are already taking pilot projects but finding it challenging to integrate into daily operations.

A solid indicator of where businesses are placing their investments may be found by looking at the business functions that employ AI most frequently. According to the Microsoft

Outlook 2019*,* AI is employed often in Research & Development (R&D) activities in addition to an expected higher incidence within Information Technology (IT) departments. This mainly stems from three factors: engineers who work in R&D frequently have an excellent understanding of and appreciation for AI; the R&D operation is frequently already connected towards taking an exploratory, adaptive framework; and the R&D function frequently sits on large amounts of valuable data leading to high promising use-cases.

Due in part to increasing degrees of digitalization, customer-facing, commercial services like marketing, sales, and customer service make heavier use of AI. The abundance of data from growing usage of online channels is anticipated to make these services highly suitable for AI technologies in the future, even though AI adoption is often slower in customer-facing interactions than those in back-end operations. In a shell, the more information available, the easier the integration of AI tends to be.

It is interesting to note that, when asked, Portuguese businesses are the ones that anticipate big effects from AI technology the most in the next five years, i.e., a disruption that will lead to new goods, services, and business models.

Every year since 2017, McKinsey has released the report "The State of AI." The most current issue, which was released in December 2021, concludes that while AI use is growing, the advantages of the technology during the pandemic were more noticeable in terms of cost reductions than in terms of income creation.

Additionally, this survey notes that when asked why businesses are not mitigating all pertinent risks, respondents most frequently indicate that they lack the resources to manage the full spectrum of risks they face and had to prioritize. Cybersecurity and regulatory compliance continue to be the most acknowledged issues among interviewees. Geographically speaking, respondents in emerging markets seem to be more probable than others to say they are delaying risk mitigation until there are clearer regulations in place and are aware from assessment methods that risk mitigation is more expensive than the repercussions of a risk-related incident. Most investments in risk reduction are made by high-performing AI businesses, which makes sense given the approach presented above.

The "PwC AI Business Survey," on the other hand, is unique in that it focuses on understanding how the top AI businesses are performing. The results of the 2022 edition indicate that top organizations are choosing to implement a whole transformation plan,

which includes business transformation, enhanced decision-making, and modernized systems and processes, rather of concentrating on one goal before moving on to the next. This holistic strategy allows scaling and data exchange by gathering so many executives from throughout the company. It puts analytics teams, software developers, and data scientists together with AI professionals. By incorporating business expertise, it facilitates the alignment of outcomes with business aims, fostering organizational buy-in and resulting in initiatives that have a significant effect at a fair price.

According to the same report, AI leaders highlight improving decision-making and customer experience as well as increasing productivity through automation when asked about the company goals they have been working to achieve with AI initiatives.

3.2.2 Research on the Portuguese panorama

There is not many research available on AI adoption in Portugal. Many studies that examine the EU also research on Portugal, but not in the depth that this dissertation intends to.

Thus, the "Artificial Intelligence Pathways and Opportunities" by João Castro and Vasco Neves, published in September 2020, was one of the most pertinent studies.

The authors of this paper propose conducting a thorough investigation of the Portuguese environment and how AI interacts. First, one of the findings of the study's literature review is that health is the sector in Portugal with the greatest and most pertinent amount of published works, while the other sectors have fewer – as previously explained. The authors then list and explain Portugal's most prominent AI researchers.

The authors make the initial claim that there is a positive correlation between knowledge about AI and its adoption (Lautenschlager, 2020).

The report also identifies the most affected fields by typical biases in AI-powered tools. For instance, human resources have a few AI tools for a more agile examination of candidates but despite several iterations, gender bias is still pervasive in these technologies.

We attempted to comprehend the effects of biases on the adoption of AI technologies considering the author's exposition. Giusy Beneduce's article, "Artificial intelligence in recruitment: just because it's biased, does it mean it's bad?" found that the recruitment community's belief is that bias is already present and very challenging to extricate from their

processes. Moreover, it shows that the community is prepared to acknowledge some bias if these tools enable their jobs to perform in a more efficient and effective way.

The essay then turns specifically to the Portuguese market to comprehend how Portuguese businesses utilized AI technologies, having seen their research severely constrained due to the Covid-19 pandemic. Due to their need to prioritize the pandemic response, several of the firms intended to be interviewed had to refuse the invitation.

The research starts out by defining "Simple AI" and "Blackbox AI," where the first refers to the analysis of a lot of data and the latter to all other systems of more complex description. The first finding is that the majority of Portuguese businesses focus on utilizing or deploying "basic AI" tools - not because they are the simplest solution, but rather because they are the most widely available, represent a more pragmatic strategy, and are crucial for development.

The study's second finding is that organizations that employ "BlackBox AI" solutions have staff members who are more knowledgeable and experienced.

The report then moves to a sectoral presentation, suggesting that the businesses that create and gather the most data tend to be the pioneers in the adoption of AI technology. It uses the retail and insurance industries as examples to illustrate this point. On the other hand, the author adds that certain businesses, using the example of banking, adopt a stance of followers despite having access to a large collection of data without going into detail about why this position is taken.

The author then adds a brief comment regarding the size of businesses and their investment in AI, pointing out that Small & Medium Enterprises (SME) are finding it challenging to make AI investments in light of the pandemic context because this investment is no longer a top priority. On the other hand, there is evidence to suggest that recent businesses have been more aware of and willing to explore IA.

The author explains that several organizations stated that many of the top talents in Portugal are of world-class quality, but very difficult to keep in the country due to the restrictions of pay rates in Portugal, in an effort to investigate what has prevented companies from maximizing the value of AI. Moreover, Legislation takes longer to design and execute than innovations do, which restricts its use. By comparing the EU, the US and China, the study highlights the various circumstances in which data is controlled. They are noted to have

several drawbacks, two of which being data ownership issues and the absence of auditing of AI systems.

The paper by João Castro and Vasco Teles is one of the most pertinent to the topic of this dissertation. Although they do so in a primarily qualitative manner, the authors provide a broad and detailed review of AI technologies in Portugal as well as the key challenges. As a result, there is a chance for a more thorough and up-to-date quantitative analysis of how mature Portuguese businesses' use of AI is.

An investigation of the Portuguese government's stance on AI was also done to further this review. The study "AI Portugal 2030" was the most comprehensive and reliable source of information identified in this respect. This paper aims to describe Portugal's position regarding AI and offer recommendations for both public and private initiatives. The study then describes Portugal's 2030 goals, including producing major economic development, increasing the significance of Portuguese research, and greatly raising the workforce's qualifications, particularly in technology fields.

The approach to accomplish the stated goals is then presented in the study, which calls for attracting small businesses with a need for AI development to create a supportive atmosphere. In turn, the expected outcomes will create value, draw private funding, and encourage additional study in these fields, creating a synergy between private interest and Academia. Financing activities, the development of facilities, the issuance of vouchers for training and talent retention, the establishment of legal frameworks and standards for an ethical-by-design AI and raising public awareness of AI will all speed up this process.

Another relevant study, The use of Artificial Intelligence: the case of companies listed on the PSI-20, by Rita Matias (2021), intends to understand what AI projects are now being developed in Portuguese companies listed on the Portuguese Stock Exchange (PSI-20) and to study AI's influence in auditing activities.

For this assessment, the methodology employed was to analyze the reports of companies listed on the PSI-20, method which had already been adopted for the same purpose regarding different countries and stock exchanges, such as Spain (IBEX 35) and Finland (OMX Helsinki 25).

Throughout the investigation, the author specializes her analysis in the Audit area, nonetheless leaving pertinent conclusions on the state of AI in listed Portuguese companies.

According to data from 2019, twelve of the eighteen companies listed on the Portuguese Stock Exchange reflect in their annual reports activities related to the use of products and applications and the development of AI projects.

Compared with studies carried out in Spain and Finland, Portugal is the country that presents a lower disclosure of AI in the reports of listed companies. The fact that it is the only country to specify the risk category is noteworthy, though.

In a shell, it seems that there hasn't been much study done on the use of AI technology by Portuguese businesses when we try to precisely seize Portuguese reality. The literature currently available, especially for quantitative analysis, is even more limited; hence, this investigation's primary goal will be to fill up this information gap.

4. Methodology and Data Collection

After identifying the gap, it was necessary to decide how research might be conducted to address it. As a result, one option was to draw conclusions from existing research - which, as we have seen, would severely restrict the outcome of the research or, instead, to gather data that would enable a thorough examination of the issue at hand.

As an alternative, the use of a methodology described in one of the publications reviewed was explored. As a result, an online survey of leading companies was conducted, followed by an analysis of the data gathered. Interviews with AI professionals in Portugal were also conducted.

Given the insights collected from the SOA review, it was noted that conducting a survey offers difficulties, such as bias, that might have a big influence on the investigation's quality. That said, a review of other surveys, both related and unrelated to AI, was carried out to collect the best practices, preparing the most appropriate survey possible.

4.1 Practices and considerations for the elaboration of surveys

This section, as explained, consists on the study of other surveys to understand which practices may potentially best adapt to the purpose of this dissertation as well as learnings from other articles on considerations to be taken when carrying surveys, especially on how to address bias. Many studies that weren't just about AI were taken into consideration for this purpose.

The most frequent forms of bias found in survey research are listed below, along with some strategies for minimizing the likelihood that they may occur. The specific steps used to prepare the survey that was utilized to gather data for this research are then provided.

One of the most common forms of bias is *Biases Wording*, which refers to a question's bias in favor of or against a specific viewpoint, and *Biased Context*, which happens when questions are asked in a particular order such that the respondent already has preconceived notions based on earlier inquiries (Glasow, 2005). Some of the ways to limit the likelihood of *Biases Wording* is to have the content carefully reviewed, for example by Professors while to mitigate *Biased Context* the survey must be short and to the point to prevent interviewee fatigue.

Another frequent bias is sampling bias, which arises when only responses of a particular segment of the audience are gathered, disregarding all others. As we'll see later, this study will pay close attention to the top businesses in each industry, subjecting to this type of bias.

Response biases such as socially desirable responses, acquiescence, and extreme response bias, are also common among standardized surveys (Bogner, 2016). Socially Desirable Responding (SDR) refers to the propensity the interviewee must answer in way that believes to be more acceptable to the interviewer. some of the ways to prevent this type of bias are to carry out online and anonymously (Cleave, 2021).

Acquiescence refers to a respondent's predisposition to respond in a positive way to any question, regardless of its context (Bogner, (2016) - one of the key strategies to reduce this risk is to avoid using questions that are difficult to understand and to which the response consists in binary options, such as "Yes" or "No." (Chipeta, 2020).

Extreme response bias consists on the tendency of a respondent to select the extreme options (Bogner, 2016), and many times results from habituation bias, as respondents may routinely select the lowest or highest choice out of habit or exhaustion (Chipeta, 2020). To avoid this form of response bias, questions' form and variety is crucial.

The likelihood that the interviewees lacked the expertise essential to complete the survey, given the topic's specificity, was another of the major concerns noted.

Finally, another relevant consideration attained for the design of the survey was that when interviewing CEOs or other senior staff, we run the risk of them limiting their statements to what is formal communication, strategy, and the company's vision, whereas other employees would give more accurate and comprehensive insights (Castro, 2020).

4.2 Addressing Bias

As reviewed in the previous section, there are several biases that can potentially impact the quality of the research and its results. In this way, the main risks detected in the elaboration of the type of survey sought were considered and measures were taken to mitigate them.

	Bias	Action Taken
Biases Wording	Formulate the questions in such a way that they influence the interview response to some specific option.	The questions were reviewed by 3 different specialists, including professors and professionals in the field, who ensured the quality of the formulation of the questions and their neutrality as response options.
Biased Context	Order of questions suggest a context to the interviewee that influences their answers.	An attempt was made to reduce the number of standardized answer questions as much as possible. In addition, the survey only poses the essential questions for the analysis in order to prevent the interviewee from going into “automatic pilot”.
Sampling Bias	Collected sample does not effectively represent the intended population.	An in-depth analysis was made, exposed in the next section, on the extent of the study. In this analysis, two options were opposed: reducing the depth of the survey and obtaining a greater number of responses, or favoring a more complete analysis, but of a smaller number of companies.
SDR	Interviewees' propensity to respond in a way that they believe is more acceptable.	The survey was conducted online and anonymously.
Acquiescence	Respondent's propensity to respond affirmatively or positively.	It was avoided the use of questions that are difficult to understand and to which the response consists in binary options, such as "Yes" or "No".

	Bias	Action Taken
Lack of knowledge	Lack of knowledge of the interviewee in the matters to be questioned.	The response of employees in the IT department or with experience in the area has been privileged.
Restricted responding	Responses limited to what is the company's official vision.	We sought to interview employees in intermediate positions, that is, experienced employees, thus avoiding top-level positions.

Figure 5 - Actions taken to avoid the most frequent types of bias.

4.3 Outline of the survey

A list of issues that this dissertation sought to address was developed following a thorough examination of the literature and the identification of a gap in the field, as previously described. There is still significative shortage of publicly available data on the firms' vision and strategy in AI, which was the focus of the survey to be designed.

It should be mentioned that the survey only considered businesses with their founding and headquarters in Portugal.

As a result, our inquiry sought to provide answers to some of the following questions:

- What ICTs do Portuguese businesses employ most frequently?
- What prominent AI technologies are employed by Portuguese businesses?
- Where are ICTs and AI strategies defined? Board of Directors or Executive Management?
- Which departments are affected by these technologies the most?
- Does the Chief Executive Officer (CEO) profile affect how firms are positioned in regard to these technologies?
- Which area of the company is affected? Core Business or New Business Opportunities?
- Main challenges and opportunities.
- How are businesses positioned on the journey to the adoption of AI technologies?

During the survey's development, pertinent revisions were made. After 2 months of response gathering only 5 responses were collected after the first version of the survey. After looking into the reasons for the low number of responses, it was determined that the survey's complicity was too high for many companies to be able to participate.

Thus, a decision had to be made:

	1) Significantly reduce the survey depth and get a significant number of participations	**2) Maintain/increase the depth of the survey by obtaining the response from a small number of companies, but leaders in the sector that operate**
Pros	• Most representative macro sectorial analysis • More complete knowledge of reality, including companies of different sizes and stages of development"	• More availability and follow-up to support filling, mitigating the risk of bias • By getting the answer from leading companies, we will be closer to getting the best practices in the respective industries • Possibility to interview and study particularly relevant cases
Cons	• Less in-depth analysis • Less effective analysis regarding the response to the gap found • Greater exposure to sampling bias due to the impossibility of tracking all responses"	• Smallest sample • Reality portrait of only a limited number of companies"

Figure 6 - Pros and Cons of different approaches to the study.

Given the benefits, option two was chosen, and precedence was given to a microanalysis of the most pertinent businesses in each industry. Both solutions would be feasible and would

allow for different conclusions to be formed; nevertheless, option two was chosen because it was more appropriate according to the to the intended depth of the questions raised.

Thus, a survey was prepared with 45 questions divided into five sections. The first four of closed answer and the last one of open answer:

1. Identification and Characterization of the Company;
2. Identification and Characterization of the Interviewee;
3. How are the ICTs / AI present in the company;
4. Current status of the company;
5. Open Answer Questions.

The following sections provide information on the rationale for the questions included in each of the them and how those questions relate to an evaluation of the SOA.

4.3.1 Section 1 - Identification and Characterization of the Company

The aim of this survey section was to gather the fundamental data for a later classification of the responses for analysis.

As stated in the SOA for the Portuguese market, despite some analysis, albeit brief, having been done regarding the relationship between the capacity for investing in AI and the size of the businesses, it was found a gap when it comes to analyses in other dimensions that allow for cross comparisons regarding.

As a result, this section has been made as simple as possible, containing only two questions - the name of the company and the NIF (*Número de Identificação Fiscal,* standing for a company's Portuguese tax number). By using the available data bases and collecting this tax number, it is possible to gather an enormous amount of information such as the company's year of founding, the CAE classification code (*Classificação Portuguesa das Actividades Económicas*, standing for a code that allows each company to be assigned to a certain sector of activity - nomenclature established by the Portuguese National Institute of Statistics), as well as other relevant details, such as financials.

Please see Appendix A, figure "Appendix A 1", for the complete Section 1 of the survey, in the released format.

4.3.2 Section 2 - Identification and Characterization of the Interviewee

As suggested by João Castro and Vasco Neves, the position that the interviewee occupies within the company can influence the answers, thus generating potentially distorted data and results. In addition to the position within the company, there are several factors that may influence the interpretation of the questions and the answers.

Interviewing a homogeneous group of people who worked in the IT departments or had extensive training and expertise in the field was one of the measures applied to mitigate this risk.

Thus, this section of the survey sought to obtain the necessary data for a complete classification of the interviewee to detect potential biases or relationships between the profile of the interviewee and the responses obtained.

The data collected focused on the function within the company and the department to which they belong, academic qualifications and area of training, and even seniority in the company.

In this way, it should be possible to identify potential relationships between the interviewee and any potential bias detected in the responses obtained, as the ones exemplified in the SOA review.

Please see Appendix A, figure "Appendix A 2" to figure "Appendix A 4", for the complete Section 2 of the survey, in the released format.

4.3.3 Section 3 - How are the ICTs / AI present in the company

It was from this section of the survey that the questions specifically related to the topic and defined for the investigation started to be inquired.

The aim of this section was to obtain data to study the gap detected in Portugal, but also to apply some analyzes already carried out at an European level for an exclusively Portuguese context. On the other hand, this section also intended to understand the company's understanding of AI and how it positions itself accordingly.

The complexity of the questions grew. The first questions were intended to understand the main ICTs used by the company and what investment they represented.

Accordingly, to the abovementioned Eurostat study, "Digital economy and society statistics", which considers data collected in January 2022, Portugal typically ranks above

average when it comes to the use of social media for businesses. On the other hand, it fell short in the use of cloud computing and Internet-of-Things (IoT) devices.

Thus, and in order to obtain consistency in the comparisons with the results presented by Eurostat, the ICT options considered were similar:

- Online Store / Online Sales;
- Social Media presence;
- Cloud Computing;
- CRM;
- Internet of Things;
- ERP;
- Updated Website.

Regarding the use of AI technologies, according to the same study, Portugal ranks second. Thus, after the company's classification in terms of ICTs, questions were asked about the use of AI technologies, namely which technologies are most used, and the representativeness of investment in these technologies in the company's overall budget.

For the classification of the presence of AI in the business, the main technologies used in the area were considered, as suggested by the revised texts in the SOA:

- Machine Learning:
    - Supervised Learning (SL);
    - Unsupervised Learning (UL);
    - Reinforcement Learning (RL).
- Natural Language Processing (NLP).
- Robotics.
- Knowledge Representation and Reasoning (KRR).
- Machine Perception (MP).
- Automated Planning (AP).
- Automated Scheduling (AS).

As suggested in the SOA review presented, most Portuguese companies focused on launching "Simple AI" technologies – which technologies specifically? Is this the case when we target on leading businesses?

Undoubtedly, as already explained, using only a limited group of companies, a modeling can be considered biased, however, it makes it possible to deeply study the approach taken by the businesses that lead their respective industries.

Next, we tried to understand how the company's strategy was determined with regard to ICTs/AI, and what relevance was given to these investments in relation to the other made by the company.

At an European level, a mixed strategy prevails, that is, 45% of companies shape their strategy either based on what the market demands, or on initiative and internal research. On the other hand, these strategies tend to be defined in a top-down format, which is evident given the increasing relevance attributed to AI technologies, according to Microsoft's AI Outlook for 2019 (2018).

Subsequently, and in order to obtain a self-assessment of the company on how it is positioned in the market, the companies were asked how they classify themselves between "Pioneer", "Follower" and "Observer", and what is the maturity of the implementation of AI technologies - in development, testing or already implemented.

Then, in order to understand how AI impacts the business the most, companies were asked which are the main departments impacted and whether the adoption of AI technologies enhances gains in the core business, in adjacent business or new business, meaning:

- **Core Business**: primary areas of the company's current business;
- **Adjacent Business**: business areas on the edge of the company's core business;
- **New Business**: Business areas entirely new to the company.

Finally, we tried to understand where the vision for the future of companies goes, questioning what the main priorities are, as well as the dimension of the perceived risk in investing in this type of technologies.

Please see Appendix A, figure "Appendix A 5" to figure "Appendix A 11", for the complete Section 3 of the survey, in the released format.

4.3.4 Section 4 - Status of the company

This section of the survey sought to understand the state of maturity in which the company is positioned, in what are considered the main capabilities enhanced by AI. These capabilities were chosen based on the Microsoft abovementioned report, which identifies them as the main competencies needed to extract the maximum benefits from the technology while minimizing the associated risks.

Thus, the following capabilities were considered:

- **Advanced Analytics** (AA): obtain and develop data science expertise (data engineering, data architecture and data visualization), training employees, attracting talent or cooperating with external partners;
- **Data Management** (DM): collection, storage, treatment, and work of information in order to be applicable to ICTs or AI;
- **AI Leadership** (AIL): ability to implement an ICT or AI project from top to bottom, that is, defining clear and common objectives, aligned with company's strategy;
- **Open Culture** (OC): Development of a cooperative and comfortable culture towards ICTs and AI, with the ability to grow in the imminence of possible uncertainties and ambiguity;
- **Emerging Technology** (ET): the company's ability to continue to innovate, launch improved processes and develop solutions;
- **Agile Development** (AD): capacity of the company and its teams to work with each other in an iterative way, in cycles, in order to be able to progress in the implementation of ICTs and AI technologies;
- **External Alliances** (EA): development of partnerships with schools, consultants and other specialists in ICTs and AI in order to be able to evolve technically and implement the best practices in the market;
- **Emotional Intelligence** (EI): measure and work on the behavior of employees, in order to seek to improve human-machine relationships to make the most of the available technologies.

All these capabilities had the following rating scale:

1. Not competent
2. Not very competent
3. Competent
4. Quite competent
5. Very competent

And if the previous section allowed us to understand the positioning of AI technologies in the company's priorities, this section allowed us to go into detail about which capabilities are enhancing or delaying the company in the implementation of these technologies.

Please see Appendix A, figure "Appendix A 12" to figure "Appendix A 14", for the complete Section 4 of the survey, in the released format.

4.3.5 Section 5 - Open Answer Questions

This last section of the survey is the only open-response section.

At this point, it was intended to offer the interviewee some latitude to expand on some of the prior responses.

Only two questions were asked – the two most crucial for the purpose of the analysis. The questions asked were those whose answer by options would be limited and would hardly cover a complete range of possible answers.

Thus, the first question focuses on the risks inherent in implementing AI technologies. This question was intended to give the interviewee the freedom to develop about the main risks and reasons that might have kept companies away from a greater commitment to these technologies.

The second question addresses the impact of AI on the labor market. This question was intended to obtain a position of the company in relation to the potential of these technologies, whether in the way they hire employees, in their training or in the reduction or increase of personnel needs as a result of greater investment in AI.

Please see Appendix A, figure "Appendix A 15", for the complete Section 5 of the survey, in the released format.

4.4 Companies Selection to the study

The study covers a variety of companies from different sectors, having in common a position of significance in that sector or sub-sector in which they operate.

We sought to interview the leading companies of the different sectors identified to subsequently be able to establish a comparison with the EU panorama, the sectoral classification used in the Microsoft's AI Outlook (2018) report was used.

Thus, the results collected were categorized among the sectors below. However, for the research and selection of companies, a more complete classification was considered, similar to the one proposed by CAE, which was later synthesized in the list below:

- Science – Health, Pharmaceuticals, Biotechnology;
- Industry – Manufacturing, Materials, Equipment;
- Finance – Banking, Insurance, Investments;
- Services – Hospitality, Professional Services;
- CPR – Consumer Products & Retail;
- TMT – Technology, Media & Telecom;
- Infrastructure – Transportation, Energy, Construction.

Then, the selection of the leading companies was made using the "Iberian Balance Sheet Analysis System" (SABI) tool – this tool allows access to the most recent financial statements of all Portuguese and Spanish companies. Thus, for the purposes of consistency in the selection, we sought to interview the companies with the highest operating revenue in the different sectors identified. When, due to lack of capacity or availability, it was not possible to obtain a response from one of the selected companies, the next one was considered in the ranking.

Some businesses that don't fit into the above frame but have significant positions in their respective industries were also taken into consideration.

Companies were considered Portuguese if founded and headquartered in Portugal, or whose majority of operations are carried out in Portugal. This clarification is important as some of the companies considered are owned by international groups but continue with the bulk of their operations in Portugal.

As would be expected, collecting the answers was the most challenging of the entire investigation. Obtaining the availability of companies, and even more, the availability of employees within the companies with the adequate knowledge to respond to the survey was a task of enormous complexity. The main reason detected for the aversion to participation was that it was a survey for a master's thesis and not a study carried out by some competent and recognized entity.

Contacts were established with companies in different ways. Contact was made with connections, such as friends and colleagues, working in the selected companies; through the general contacts of the companies and, eventually, through *LinkedIn*, by sending messages to employees with the desired characteristics.

A frame on the survey and on the intentions of the study was previously given to the interviewee, and contacts were also made available to clarify any doubts that arose when filling in the form.

The tool used for the construction of the survey was "Microsoft Forms", as it is the open access tool adopted by the University of Porto.

5. Results

5.1 Participating companies and description of the sample

As previously said, businesses with relevant positions within their industry were interviewed. As a result, this study included the contributions of the following businesses, which were categorized in the following sectors:

Companies' Legal Name
DEFINEDCROWD CORPORATION, UNIPESSOAL, LDA
GALP ENERGIA, S.A.
NOS COMUNICAÇÕES, S.A.
ALTICE PORTUGAL, S.A.
INFRASPEAK, S.A.
SUPER BOCK BEBIDAS, S.A.
LACTOGAL - PRODUTOS ALIMENTARES, S.A.
CASA DE INVESTIMENTOS - GESTÃO DE PATRIMÓNIOS, S.A.
WORTEN - EQUIPAMENTOS PARA O LAR, S.A.
VILA GALÉ - SOCIEDADE DE EMPREENDIMENTOS TURÍSTICOS, S.A.
EDP COMERCIAL - COMERCIALIZAÇÃO DE ENERGIA, S.A.
A.N.O. - SISTEMAS DE INFORMÁTICA E SERVIÇOS, LDA
BANCO L. J. CARREGOSA, S.A.
SONAE - SGPS, S.A.
PORTO BUSINESS SCHOOL
G.T.S. - GRUPO TROFA SAÚDE, SGPS, S.A.
PLMJ ADVOGADOS, SP, RL
CORTICEIRA AMORIM, SGPS, S.A.

Figure 7 - Companies that participated in the study.

Eight other companies participated although decided to remain anonymous.

Responses from a total of 26 businesses were gathered, resulting in the subsequent distribution by sectors:

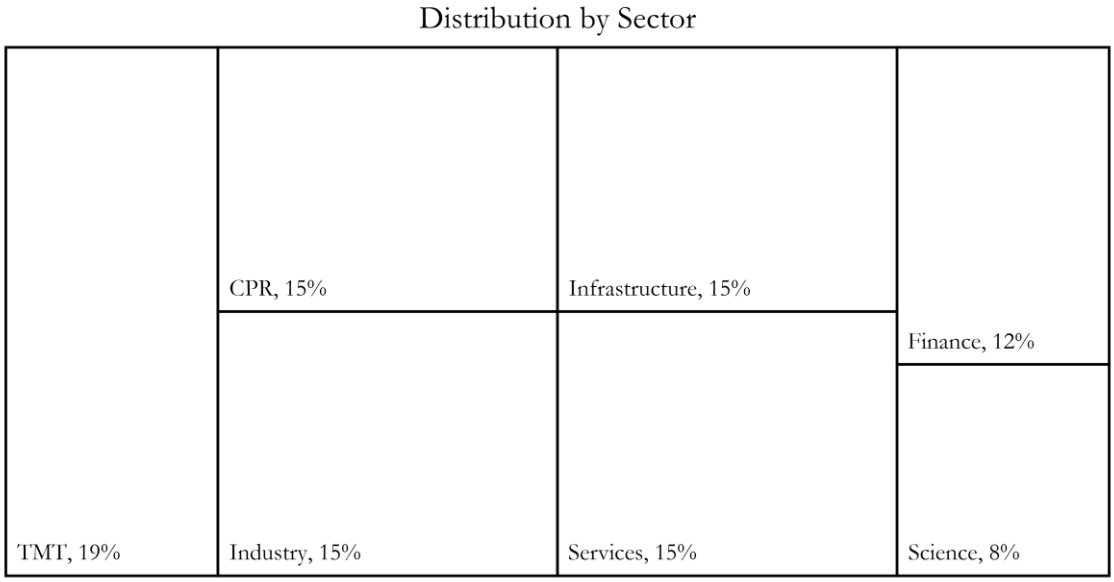

Figure 8 - Distribution of the answers by sector.

Sixty-five per cent of the respondents were part of the IT department of their respective company. Among the interviewees' specialization areas, Science, Mathematics, and IT prevailed, 35%, along with Social Sciences, Business and Law, also 35%. In terms of gender, males prevailed, accounting for 73% of the responses.

Regarding CEOs, only 4% have a PhD, 35% have an MBA, 8% a master's degree and 53% a bachelor's degree or a lower degree. In terms of specialization, management related areas of study prevail, accounting for 62% of the answers.

5.2 Findings

Throughout this section, the main conclusions drawn from the study and analysis of the data collected are presented.

In order to simplify the understanding by the reader, the analyzes were divided into subsections, according to their extent.

5.2.1 Overall use of ICTs and AI by Portuguese companies

Although the relationship between AI and ICT has not yet been explained, it may be relevant to the reader's understanding. ICTs, in a broad sense, can be defined as a set of technological resources, used in an integrated way to manage information. Thus, AI represents an area of ICTs, but which, given the greater potential and complexity of applications, is considered almost as an independent area.

First, we start with an analysis of the adoption of ICTs by Portuguese companies.

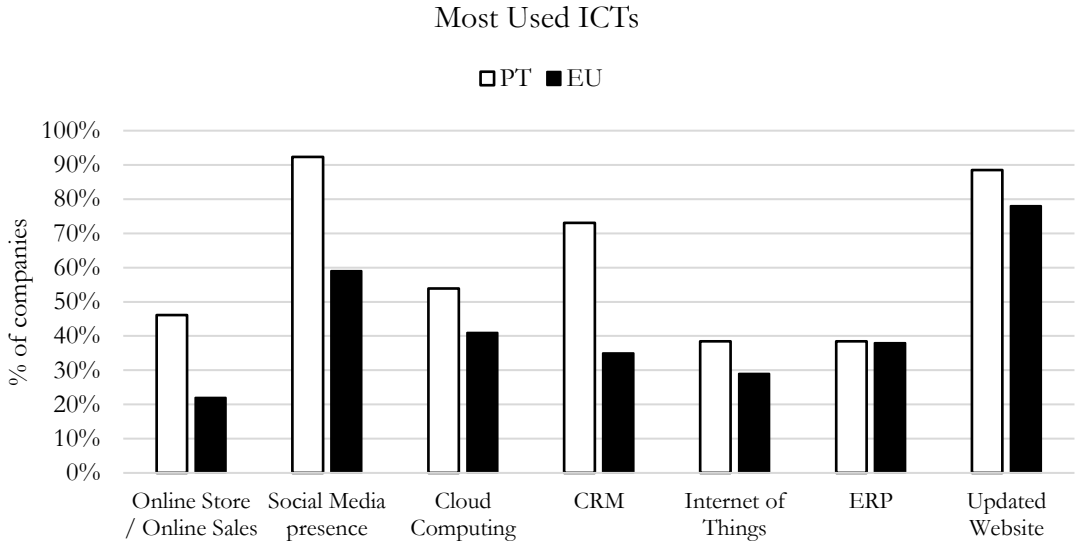

Figure 9 - Most Used ICTs.

Before proceeding with an analysis of the data presented above, it is evident that Portuguese companies have an adoption of all ICTs higher than the EU average. This Portuguese superiority must, however, be analyzed with caution, given that the values considered, provided by Eurostat (2021), bring together companies from several countries and of different sizes, while the data collected for the scope of this analysis cover typically leading companies. There are, however, some similarities between the ICTs most used by Portuguese companies and the average of EU companies.

The first conclusion is that all the companies interviewed make use of at least one type of ICT.

According to Eurostat, the most used ICTs by companies in the EU are having a website and social media presence. On the other hand, the least present are Customer Relationship Management (CRM) and Internet of Things.

As expected, the use of social media and a website are also the two most used ICTs by Portuguese companies, with a nuance – in Portugal, the presence in Social Media is superior to the use of a website. This is due to the accessibility of these ICTs and the extremely low cost of their implementation.

The use of CRM, software that stores all the company's interactions with potential customers is the third most used ICT by Portuguese companies, which makes sense, considering that all companies have customers and therefore, many of them need systems to manage them.

Then comes the use of Cloud Computing (CC), which allows remote access to software, files and data via internet connection. In conversation with some of the companies interviewed, the reinforcement of investment in CC, as well as online sales (which comes next), during the pandemic period was mentioned several times, information coherent with the requirements imposed by remote work.

Finally, there is the use of Enterprise Research Planning (ERP), software that manages the activities of finance, supply chain, operations, trade, reports, manufacturing and human resources, and IoT, which consists of a network of physical devices (things) through the internet, which allow data to be connected and shared. What these ICTs have in common, and which may be the reason for a lower adoption by companies is, on the one hand, the greater specificity of these technologies, which are possibly less suitable for certain types of companies and, on the other hand, high implementation costs.

How does this compare with the reality in the EU? The greatest divergence can be seen in the values of Online Sales and use of CRM, which can be justified by the fact that we are portraying leading companies with the capacity to implement these technologies that require high costs.

In the use of CC, IoT and ERP, Portugal is somewhat above the European average, slightly more optimistic conclusions compared to those presented in the Eurostat study.

Regarding the use of AI, 69% of the companies surveyed revealed that they use at least one of the technologies presented.

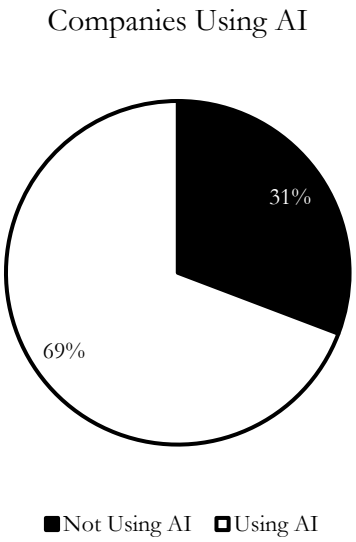

Figure 10 - Companies using AI.

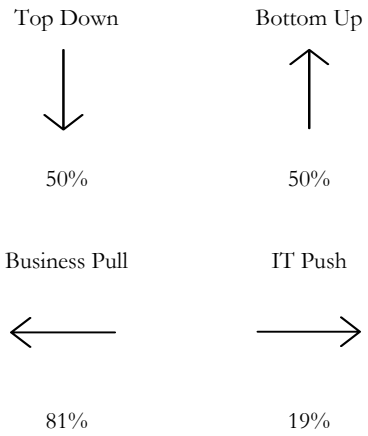

Figure 11 - How AI is deployed.

In the search to understand how AI emerges within companies, it was noticed that 50% of the companies have a top-down behavior, that is, having the decision center in the highest positions and 50% opt for a bottom-up strategy, that is, with decisions coming from the executive teams.

On the other hand, 81% of companies shape their strategy based on what the market and competition demand, while 19% on initiative and internal research.

Subsequently, and to obtain a self-assessment of the company on how it is positioned in the market, the companies were asked how they classify themselves between "Pioneer",

"Follower" and "Observer", and what is the maturity of the implementation of AI technologies - in development, testing or already implemented?

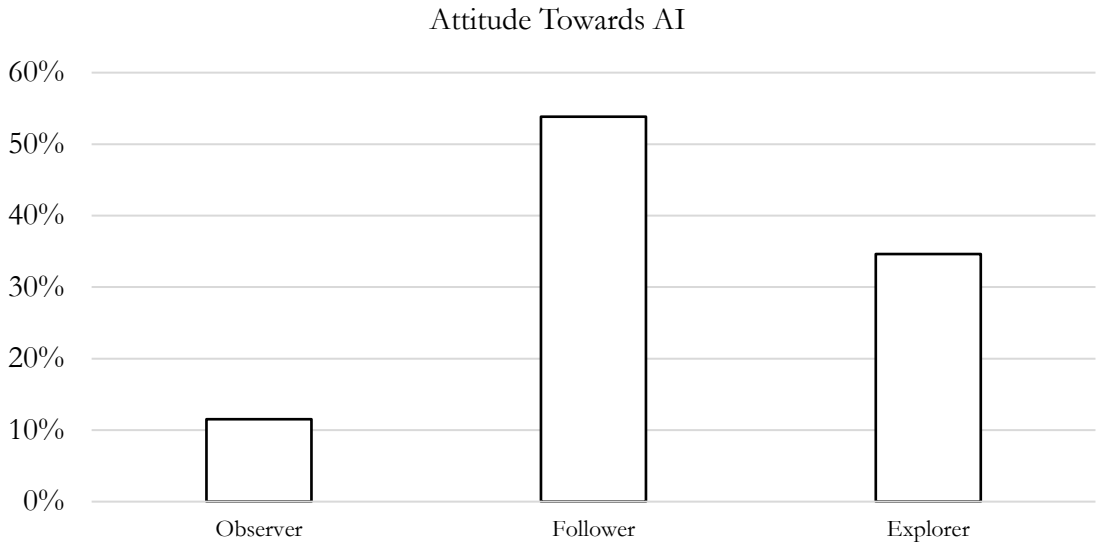

Figure 12 - Attitude Towards AI.

In line with the finding that most companies have a "Business Pull" motivation, we also noticed that most companies adopt a follower posture, that is, more than half of the companies choose to apply technologies already deployed in the market, while fewer companies invest in the application of pioneering solutions.

This relates to the risk/return ratio associated with investments in AI, which we will see next.

5.2.2 Deep into AI in Portuguese Companies

Apart from an institution, which was excluded from the chart presented below, all companies consider investments in digital transformation between relevant and very relevant when compared to other possible investments.

However, no relationship was noted between the degree of CEOs and the respective relevance attributed to investments in AI, as can be found in below.

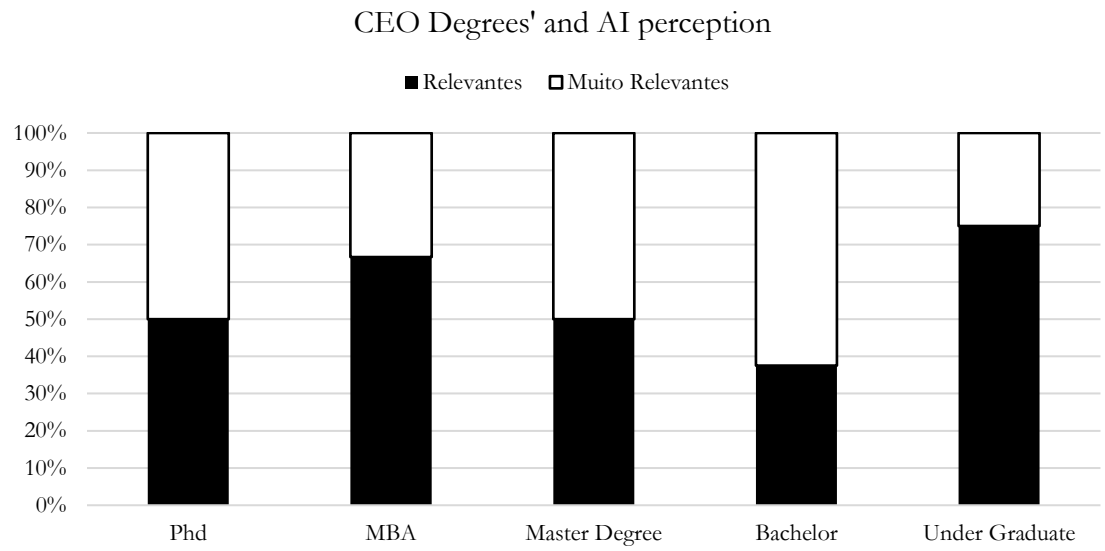

Figure 13 - CEO Degrees' and AI perception.

Companies also show a balance between moderate and high in terms of confidence in investments made in AI. 46% of companies say they can estimate the expected return on AI investments with a high degree of certainty, while 42% say they can do so with moderate confidence.

Although many companies have chosen not to disclose the amounts invested annually in AI, it was possible to determine that almost 50% of the companies surveyed invest more than thirty thousand euros a year in AI, of which practically 70% invest more than fifty thousand euros a year.

A comparison between the amounts invested by companies in macro terms would prove to be inconclusive, considering the numerous variables that distinguish EU economies, from the number of companies to the investment capacity. It was not possible to establish a comparison in terms of average investment per company, given the scarcity of information available in this regard.

It is, however, possible to compare the state of maturity in which Portuguese companies are compared to those in the EU.

As verified in the SOA carried out, the number of available publications was modest, indicating that research and investment in AI would also be scarce. However, this information does not invalidate, as already seen, the ability of Portuguese companies to take advantage of existing solutions available on the market that are enhanced by AI applications.

Now, the curves below represent just that. Companies were asked how they rate the maturity of their investments in AI applications and a comparison was made with the respective maturity calculated by the average of EU companies, based on the information available in Microsoft AI Outlook, which also considers major businesses.

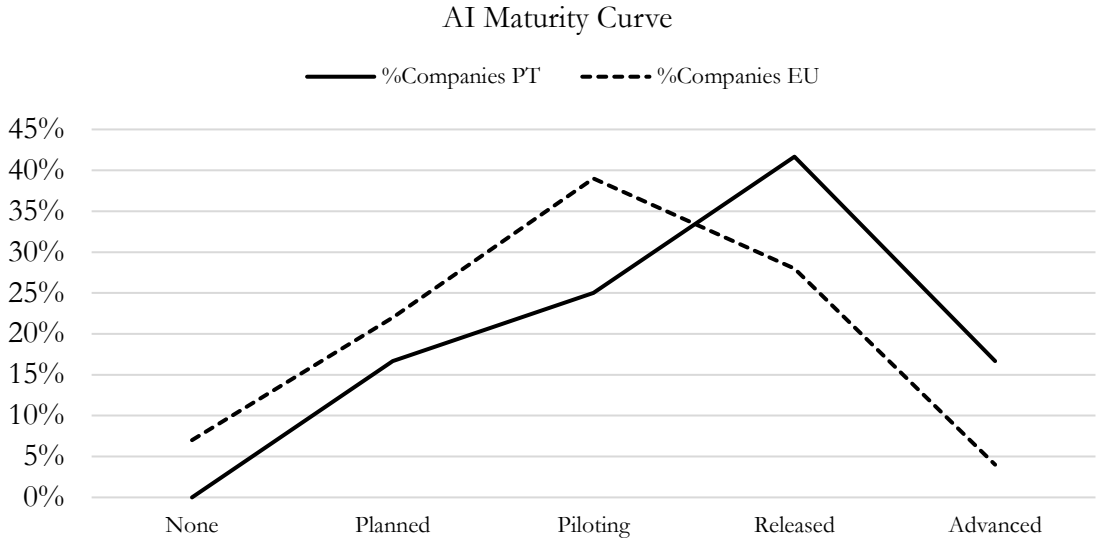

Figure 14 - AI Maturity Curve.

The curves present a very similar shape, revealing a great parallelism between the practices in the EU and in Portugal. There is, however, a key difference between them, which is their inflection point.

While, in the Portuguese reality, the largest share corresponds to the "Released" state, while in the EU, the largest share corresponds to the "Piloting" state. Therefore, we can see that the leading Portuguese companies are in a more advanced state of maturity than the average of EU companies.

On the other hand, and a relevant factor to consider, none of the Portuguese companies that responded that they did not currently have AI applications revealed that they intended to maintain this posture – all were in a "Planning" or "Piloting" phase. The opposite is true for EU companies, where 7% revealed that they had no intention of including AI on the agenda.

Another optimistic factor for Portuguese companies can be seen – a greater proportion of companies, compared to the EU average, are at an advanced stage of introducing AI applications.

AI has the particularity of being an area with very comprehensive and constantly evolving solutions. An application that does not exist today may be available for adoption by companies tomorrow.

In this sense, there are currently several business areas with pertinent applications that can affect companies' decision-making. The image below illustrates which business areas companies expect the impact of AI to be most significant.

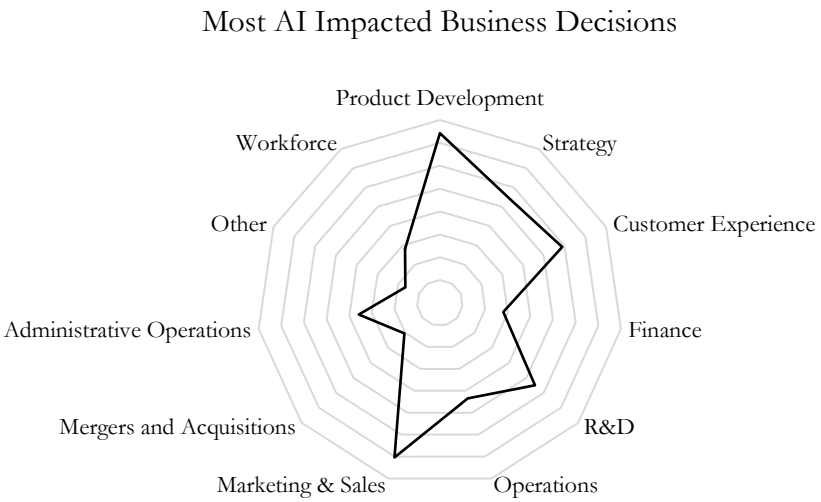

Figure 15 - Most Business Decisions impacted by AI.

There are clearly 4 business decisions significantly affected:

- **Product Development**: the features brought by AI impact various points of a product's production chain. In addition to quality procedures, through the development of algorithms capable of detecting production typos almost instantly, AI promotes more effective solutions in terms of planning, validating, and monitoring the development of new products (Syed, 2018).
- **Customer Experience**: AI not only impacts on the interpretation, through big data analysis, of the exact needs of consumers, but also enhances the development of more sophisticated, differentiating and more effective products in satisfying consumer needs.
- **Marketing & Sales**: AI applications can be both effective and discreet. From the development of consumer interaction solutions, such as chatbots, to personalization

and the best application of resources, which reflects, for example, in a greater conversion of pre-qualifying leads (Valdellon, 2022).

- **Research & Development**: either through the treatment of a high volume of information, the development of new solutions and the optimization of costs, AI has allowed research departments to work on innovative solutions.

Despite existing several applications powered by big data technologies, companies were asked about those that are considered most relevant and common (Bohnhoff, 2019).

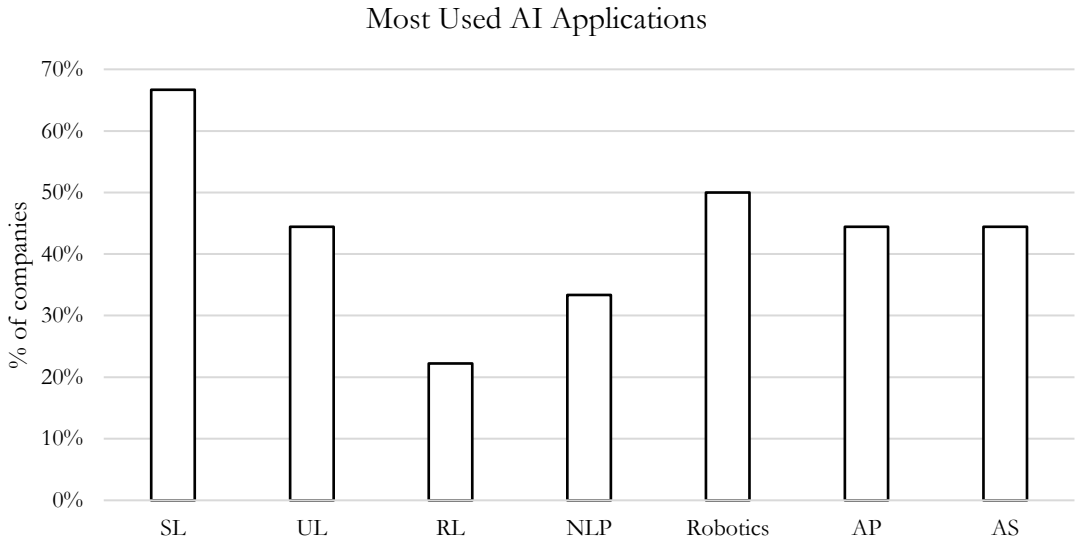

Figure 16 - Most Used AI Applications.

By analyzing the figure above, which considers only companies that currently make use of AI, we clearly see that there are two applications that stand out and three that share the third place on the podium.

The most adopted application is Supervised Learning which, to reiterate, is when a model receives input data and the desired output data, being, at the same time, one of the cheapest and fastest machine learning applications to implement.

As we will see in the next section, mindset towards AI is one of the main factors that still inhibits some companies from adopting AI applications.

Robotics is immediately next, taking the second position on the most used AI applications. As would be expected, the sectors that contributed the most were Industry, Science, TMT and Infrastructure. The application of Robotics is possible in a large number of industries and, unlike other big data technologies, and although less developed and intelligent, has been

present for several decades, making investments in smarter robots being easier to address and understand. On the other hand, the benefits from investments in robots are more immediate, reflected in a much shorter term with efficiencies.

Unsupervised Learning, Automated Planning and Automated Scheduling follow, sharing a similar adoption by companies, 44%. Unsupervised Learning is also one of the most famous applications of ML – unlike what happens with SL, this technology only receives the input and not the desired output, involving a more complex work for the algorithms, as they must find the right path without user assistance.

AP and AS allow the automation of a large number of processes, within several different industries. The immediate and easy-to-understand benefits of these applications make them two of the most attractive.

Reinforcement Learning and Natural Language Processing follow, being adopted by only 22% and 33%, respectively, of companies that adopt AI applications. Knowledge Reasoning and Representation is not currently adopted by any of the companies interviewed, so it was excluded from this analysis.

As can be understood, the adoption of AI applications involves, in nearly all companies, the implementation of processes, systems and even human capital, capable of cooperating and dealing with disruption.

Thus, Microsoft AI Outlook (2018) defines a set of pillars and capabilities, that companies must have in mind in order to enhance their adoption of AI technologies – already explained in the previous section.

The figure below considers the average, on a scale of 1 to 5, of Portuguese companies vs. 15 European markets considered.

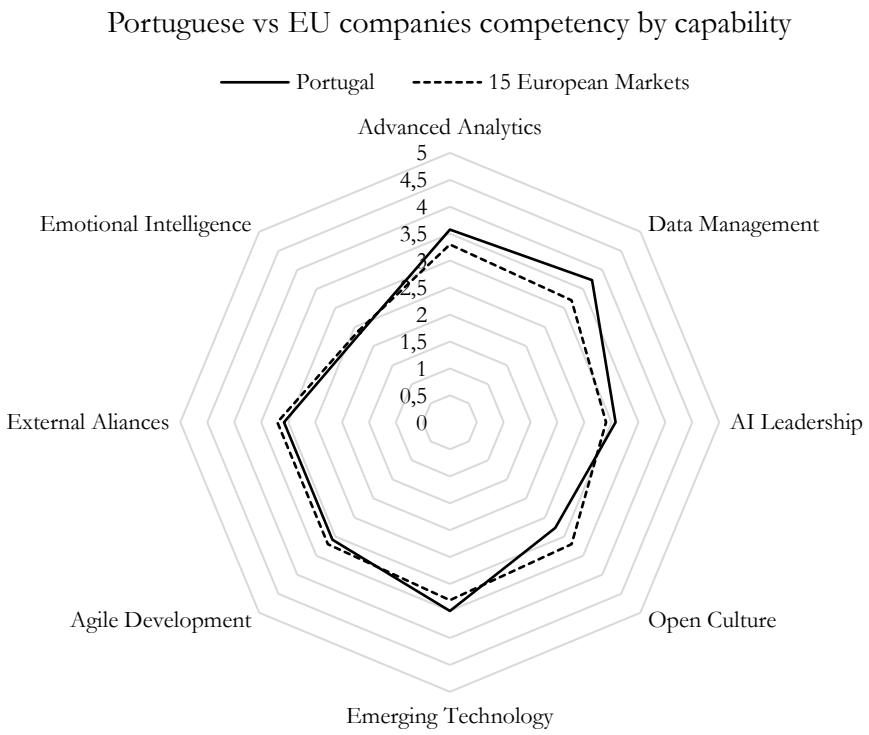

Figure 17 - Portuguese vs European companies' AI capabilities.

The shapes present a very similar layout to each other, which, once again, makes evident an approximation in the trends of Portuguese companies in relation to others in Europe.

The capability where companies feel most prepared is Data Management, which is understandable given that, even before the need for information management for AI application purposes, information management was crucial for business purposes. For this reason, it is understood that this is one of the areas in which companies feel more prepared. In this capability, Portugal is more capable than the average of the 15 European markets considered by Microsoft AI Outlook.

On the other hand, Emotional Intelligence, that is, the measure and work on the behavior of employees, seeking to improve human-machine relationships, is a competence in which companies, whether Portuguese or European companies show more strain – once again, it is evident that the human-machine relationship is still one of the main handicaps in the adoption of AI applications.

Culture, also relating to the previous capability, stands out as one of the points with the greatest opportunity for improvement – in several companies interviewed, where the

application of AI is already a reality, these projects are limited to the associated technological departments, creating a certain ambiguity and distrust in the remaining employees - in this competence Europe is in an advanced position versus Portugal.

In the Advanced Analytics, Emerging Technology, AI Leadership, Agile Development and External Alliances capabilities, Portugal presents median values, between 3 and 4, very much aligned with the average of the 15 European economies considered.

To find some trends by sector, the figures below are presented:

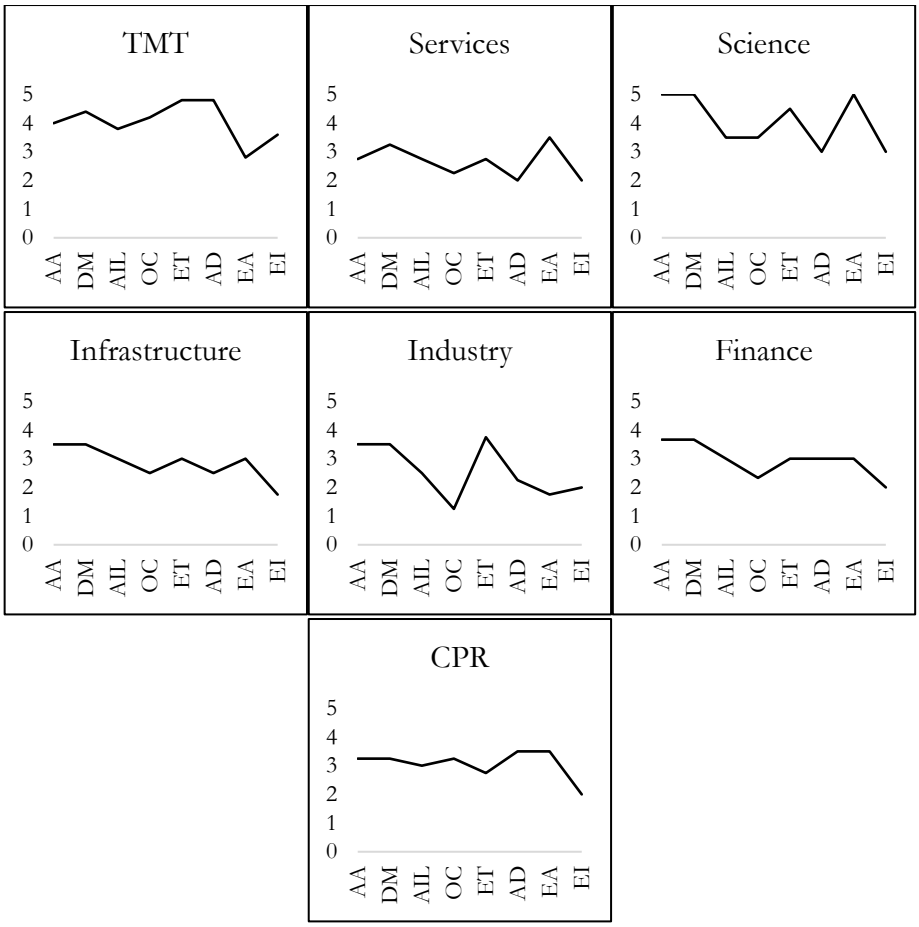

Figure 18 - AI capabilities per sector.

- **TMT**: is the most developed sector. It is an industry that produces a huge volume of data making it conducive to the development and application of AI. It is one of the sectors where Emotional Intelligence is best developed, which is in line with the nature of the industry and which has one of the lowest values for External Alliances, indicating that most of the work is internalized;

- **Services**: in this sector, the ability to establish External Alliances stands out. It is understandable, for example, that universities have a strong capacity to cooperate with each other and even with international institutions, as verified in the collected sample;
- **Science**: this is another sector that is significantly developed. In addition to being one of the sectors with the highest investment, it is a sector that has a lot of cooperation between entities. It is one of the sectors where Emerging Technologies are best led, which is understandable given the constant innovation;
- **Infrastructure**: no capability stands out either for the positive or the negative. It is also a sector with a lot of innovation and where companies face the biggest challenges in the management of Emotional Intelligence;
- **Industry**: developed sector, with the Emerging Technology capability highlighted. On the other hand, it is the sector where Open Culture has the lowest value, revealing that in some companies a more traditional culture might still exist;
- **Finance**: a sector with a behavior very similar to the Infrastructure one. This sector generates huge amounts of information and therefore, over the years, it has presented several successful cases in the implementation of AI, especially in the tools made available to consumers;
- **CPR**: this sector is above average in practically all capabilities. It is a sector that also generates a lot of data and where competition is fiercest across companies, which is proven by the fact that most companies in this sector recognize a Business Pull motivation.

Finally, companies were asked, in an open-ended question, which risks they identified as a barrier to the adoption of AI in their companies and what would be the impact of AI on the labor market.

Risks on AI Adoption	1. Data Privacy 2. People's resistance to change (the most mentioned) 3. Lack of cost and process control 4. Lack of knowledge from executive teams

Impact of AI in the labor market	1. AI will increasingly introduce automation of processes 2. An almost complete replacement of the human being at the time of decision making 3. High impact in terms of skills development, recruitment, on-the-job training 4. Complementarity of the workforce

Figure 19 - Results of open-ended questions.

5.2.3 Portuguese Case Studies

In this section, it is intended to briefly present two successful cases of AI application in Portugal.

The first case study is *Continente Labs*, which is a convenience store belonging to the *Continente* supermarket chain, owned by Sonae MC. The store presents itself as,

> Continente Labs is the first cashierless store in Europe by a European retailer. A store with no cashiers, no queues, no money and no papers. The cell phone is the key to enter. From there, just grab what we want, and leave.

AI makes this project possible, in this particular case ML and Machine Vision technologies, which comprises on a set of AI technologies that let a computer to quickly decide based on what it can "see" using sensors and cameras.

Open to the public since 2021, this store has been very well received by consumers, not only for the associated co-creation and discovery process, for the benefits once the process is assimilated, for the disruption introduced and for the gains in terms of marketing and communication (Varandas, 2021).

Another case study, with great success in Portugal, is the footwear sector, a sector that was completely revolutionized by Industry 4.0. Industry 4.0 is a term used to describe the organization of production processes based on technology and devices that communicate with each other autonomously along the production chain (Feetin 4.0, 2019).

According to the European Commission, in 2019, the Portuguese footwear industry was, in terms of value, the third largest European power. The main benefits presented by these technologies are related to efficiencies, through the automation of craft techniques and customization, which allows the creation of pieces with more added value and, of course, from ecommerce.

A company that has stood out for its investment in technology is AMF Shoes, a Portuguese technical footwear company with pioneering projects in this area, especially an insole with sensory technology that is adaptable to working conditions (CTCP, 2021).

5.2.4 Expert Perspective – Academia vs Corporations

In order to validate the findings presented and obtain a view of AI in Portugal, two experts in the field were interviewed – a Professor, representing the Academia, and a professional with experience in the area.

On the Academia side, Dr. Joao Gama, Professor at the Faculty of Economics of Porto and researcher and deputy director of The Laboratory of Artificial Intelligence and Decision Support (LIAAD, INESC TEC).

The professional interviewed was Dr. Christopher Shulby, PhD, Machine Learning Director at Defined.AI, with nearly 10 years of professional experience in AI.

The questions asked to both were similar to establish a comparison between the perspectives.

It was possible to perceive the surprise when confronted with Eurostat (2021) data that place Portugal in second place in the adoption of AI applications by companies. For both, the use of AI applications is something that, nowadays, is already relatively well disseminated, being relatively accessible for a company with some investment capacity to adopt them, explains Dr. João Gama.

The vision they both share is that, in research on innovation in AI, Portugal is a peripheral country, far from being able to assume a leading role in this regard. Both see Portugal as a very capable country in the development of innovative solutions using existing and available technologies, but not in the investigation of disruptive technologies regarding AI.

What has kept Portugal in this position is, according to Dr. João Gama, the investment capacity, recognizing that Portuguese companies are incapable of competing in this sense. Dr. Christopher Shulby sees location as a major element, both in terms of knowledge circulation, as Portugal is not a relevant Tech hub, and, akin to the Professor, owing to the Portuguese economy's lack of accessible capital.

Dr. João Gama identifies a growing trend in the number of AI-related courses available at Portuguese universities and that more and more specialized technicians are educated in

Portugal – Dr. Christopher Shulby adds, noting that these, particularly the brightest and most valuable, are drawn by other nations with more appealing wage and tax regimes.

Location is one of the main focuses of both. It is evident that having a presence in a technological center, such as San Francisco or Seattle or, in Europe, the Netherlands or Germany is fundamental for the development of AI – either through the dissemination and exchange of knowledge, either by universities or companies, and the ability to attract venture capital.

Asked what still prevents some Portuguese companies from adhering to AI applications, Dr. João Gama says that it is a question of mentality, exemplifying with some experiences he had where companies only invested in projects with guaranteed returns, often in the short term - he notes, however, a trend of improvement and a greater concern in investing in innovation.

Both anticipate for Portugal, over the next 5 years, a continuous growth and investment in AI. However, this, by itself, is not enough to differentiate Portugal. All countries currently have an AI agenda – Dr. Christopher Shulby raises the question of how Portugal will be able to stand out.

Dr. João Gama points out as a solution the reduction of bureaucracy in the relations between the bodies that work with AI, that is, having greater flexibility in the cooperation between faculties and between faculties and companies. On the other hand, Dr. Christopher Shulby, points the way to creating incentives to retain talent *made in Portugal* and attract international talent.

In short, the similarity between the academic and business perspectives is evident. Portugal, in terms of AI research, is not yet a country with international relevance, but it is very capable in the development of applications that use already available technologies. What has prevented Portugal from assuming a leading role is its lack of investment capacity and difficulty in retaining the talent it produces. The position of Portugal presented in the adoption of AI applications is considered plausible, considering the great diffusion of these applications recently and their easy access – findings much similar to the ones found in the SOA review.

6. Conclusions

The goal of this study was to investigate the maturity of Portuguese enterprises in the adoption of AI applications, as well as to compare it to the international reality, particularly at the European level.

There are several studies that place Portugal in prominent positions in the adoption of AI applications, a position that this research confirms and expands. Companies belonging to a more digital sector, such as Technology, Media & Telecom, demonstrate a greater aptitude for the introduction of these applications, although other sectors stand out, especially those that, within the scope of their activity, generate a high volume of information.

Even so, Portuguese companies position themselves mostly among observers or followers. In conversation with members of both Academia and companies, it became clear that Portugal excels in adapting existing technologies to innovative business solutions, but that there is an inability to compete with international players when it comes to R&D on AI technologies.

This study, which had the opportunity to collect feedback from leading companies in the main sectors of activity, places Portuguese companies at a more advanced stage in the incorporation of AI applications compared to companies in the main European markets.

The most frequent AI applications among Portuguese companies are Supervised Learning and Robotics and the areas where, in Portugal, AI has the most impact on companies' business is Business Development, Customer Experience and Marketing & Sales.

In relation to other European countries, Portugal stands out for its Data Management capacity, that is, in the treatment, storage and preparation of information to be available for AI applications, but it falls short in promoting a comfortable culture in relation to AI, presenting some challenges in mitigating the uncertainty caused by these applications.

In order to validate the results and seek an additional contribution, experts in the area were interviewed, where it was possible to detect several points to consider for the future of AI in Portugal.

Although the focus of this investigation is the adoption of AI applications and not the investigation of AI technologies, it became evident that Portugal, geographically, is a

peripheral country to the main world and European technological centers. This distance makes it difficult to spread knowledge and attract investment in order to encourage Portuguese companies to scale up to a point of international relevance when it comes to AI research. Measures for a greater attraction of talent, for greater interaction between bodies working on AI and more financial incentives are crucial for Portugal to sustainably become more relevant in this area.

For future research, there is an opportunity to explore which government mechanisms would be more effective in creating more favorable conditions for the development of Portugal as a relevant player in AI research.

Until recently, the attitude of Portuguese firms was one of the primary obstacles to the adoption of AI by businesses, a position that has been changing, with companies displaying a greater understanding of the potential of these investments in terms of differentiation and competitiveness gains.

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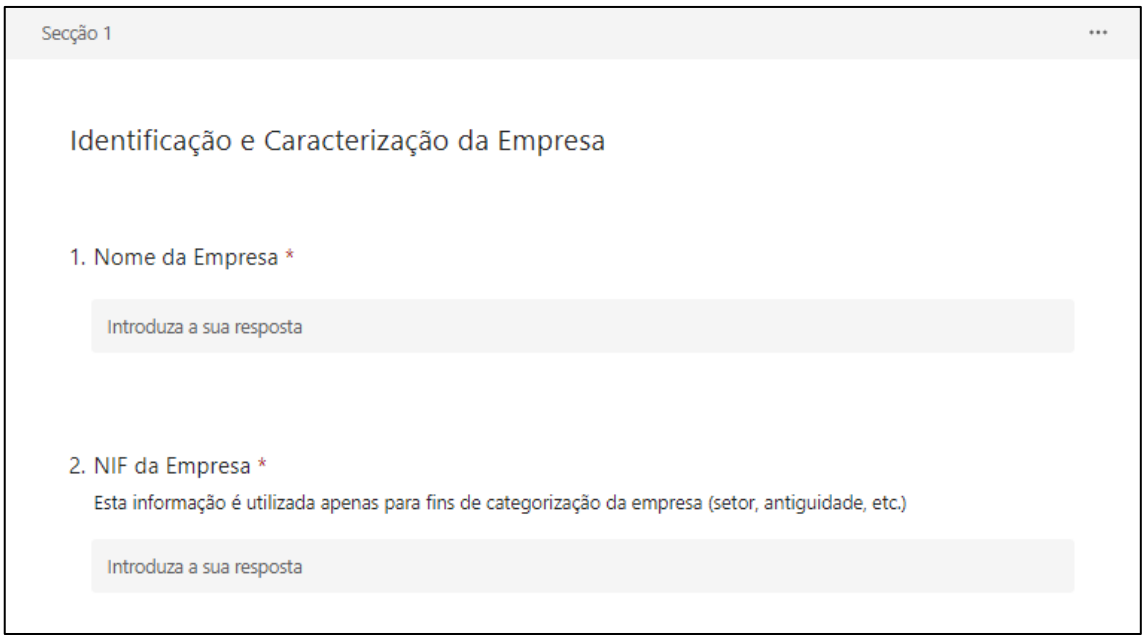
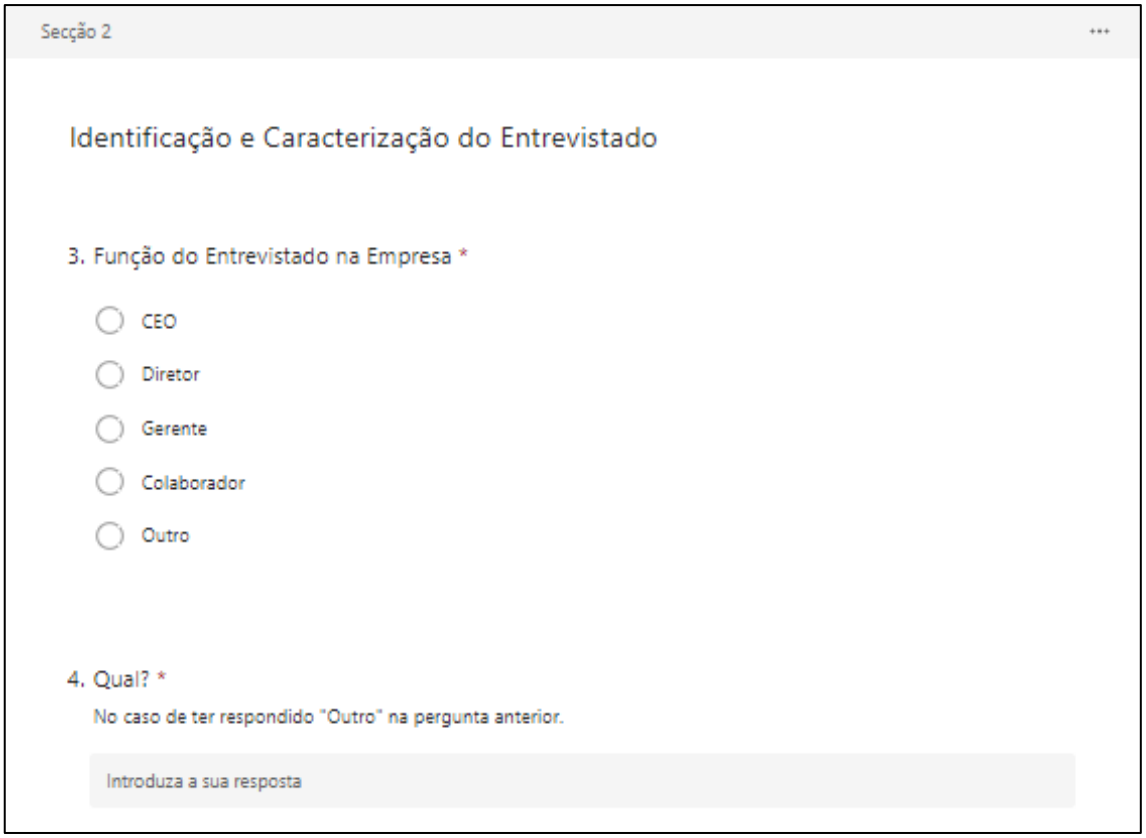
APPENDIX A

Complete Survey used for data collection.



Appendix A 1.



Appendix A 2.

5. Departamento do Entrevistado na Empresa *

- ◯ Administrativo
- ◯ Atendimento ao Cliente
- ◯ Comercial / Vendas
- ◯ Comunicação
- ◯ Contabilidade
- ◯ Qualidade
- ◯ Estratégia
- ◯ Legal / Jurídico
- ◯ Logístico / Operações
- ◯ Marketing
- ◯ Recursos Humanos
- ◯ IT
- ◯ Outro

6. Qual? *

No caso de ter respondido "Outro" na pergunta anterior.

Introduza a sua resposta

7. Habilitações Académicas do Entrevistado *

- ◯ Ensino Básico (até o 9º ano de escolaridade) ou inferior
- ◯ Ensino Secundário
- ◯ Licenciatura ou Bacharelato
- ◯ Mestrado
- ◯ Doutoramento

Appendix A 3.

8. Área de Formação do Entrevistado *

Conforme classificação em Diário da República, portaria nº256/2005, nº53 de 16 de março de 2005

- ◯ Programas Gerais
- ◯ Educação
- ◯ Artes e Humanidades
- ◯ Ciências Sociais, Comércio e Direito
- ◯ Ciências, matemática e informática
- ◯ Engenharia, Indústrias Transformadoras e Construção
- ◯ Agricultura
- ◯ Saúde e Proteção Social
- ◯ Serviços
- ◯ Outro

9. Qual? *

No caso de ter respondido "Outro" na pergunta anterior. Caso não tenha respondido "Outro", coloque "NA".

Introduza a sua resposta

10. Área de Especialização do Entrevistado *

Introduzir o nome do curso do grau mais elevado. Por exemplo, se o grau mais elevado que tem é o doutoramento e o mesmo foi em economia, inserir Doutoramento em Economia

Introduza a sua resposta

11. Ano de Nascimento *

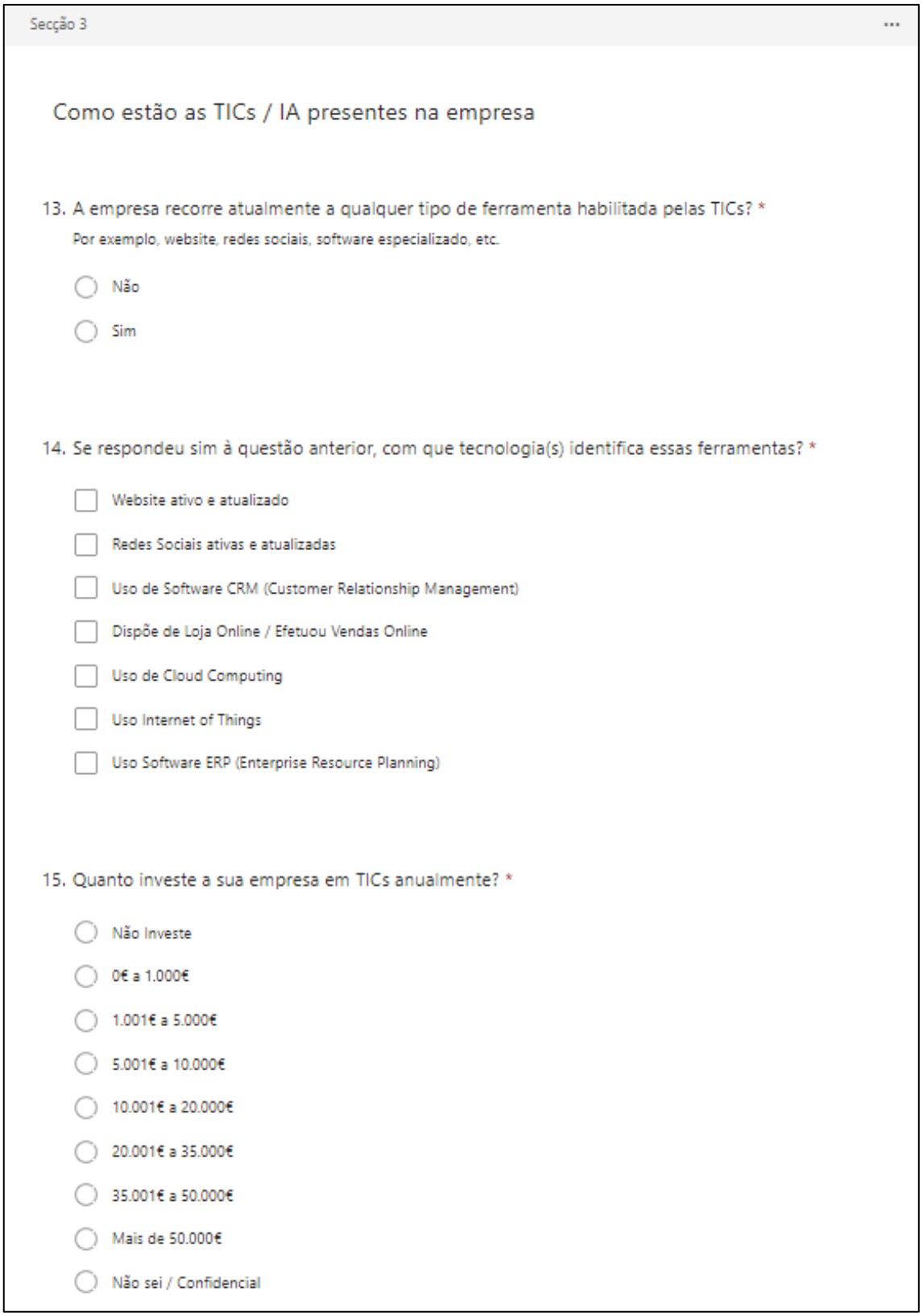
Em algarismos. Por exemplo, no caso de mil novecentos e oitenta, inserir 1980

Introduza a sua resposta

12. Género *

- ◯ Masculino
- ◯ Feminino
- ◯ Outro

Appendix A 4.


Secção 3

Como estão as TICs / IA presentes na empresa

13. A empresa recorre atualmente a qualquer tipo de ferramenta habilitada pelas TICs? *

Por exemplo, website, redes sociais, software especializado, etc.

- ◯ Não
- ◯ Sim

14. Se respondeu sim à questão anterior, com que tecnologia(s) identifica essas ferramentas? *

- ☐ Website ativo e atualizado
- ☐ Redes Sociais ativas e atualizadas
- ☐ Uso de Software CRM (Customer Relationship Management)
- ☐ Dispõe de Loja Online / Efetuou Vendas Online
- ☐ Uso de Cloud Computing
- ☐ Uso Internet of Things
- ☐ Uso Software ERP (Enterprise Resource Planning)

15. Quanto investe a sua empresa em TICs anualmente? *

- ◯ Não Investe
- ◯ 0€ a 1.000€
- ◯ 1.001€ a 5.000€
- ◯ 5.001€ a 10.000€
- ◯ 10.001€ a 20.000€
- ◯ 20.001€ a 35.000€
- ◯ 35.001€ a 50.000€
- ◯ Mais de 50.000€
- ◯ Não sei / Confidencial

Appendix A 5.

16. A empresa recorre atualmente a qualquer tipo de ferramenta habilitada pela IA (Inteligência Artificial)? *

- ◯ Sim
- ◯ Não

17. Se respondeu sim à questão anterior, com que tecnologia(s) identifica essas ferramentas? *

- ☐ Machine Learning | Supervised Learning
- ☐ Machine Learning | Unspervised Learning
- ☐ Machine Learning | Reinforcement Learning
- ☐ Natural Language Processing
- ☐ Robotics
- ☐ Knowledge Representation and Reasoning
- ☐ Machine Perception
- ☐ Automated Planning
- ☐ Automated Scheduling

18. Quanto investe a sua empresa em IA anualmente? *

- ◯ Não Investe
- ◯ 0€ a 1.000€
- ◯ 1.001€ a 5.000€
- ◯ 5.001€ a 10.000€
- ◯ 10.001€ a 20.000€
- ◯ 20.001€ a 35.000€
- ◯ 35.001€ a 50.000€
- ◯ Mais de 50.000€
- ◯ Não sei / Confidencial

19. Qual a quota (%) do orçamento anual (TICs + IA)?

Por exemplo, no caso de 10 porcento, inserir 10

Introduza a sua resposta

Appendix A 6.

20. Em que nível na hierarquia são debatidas e tomadas as decisões quanto à estratégia das TICs / IA da empresa? *

- ◯ CEO e Direção
- ◯ Direção Executiva
- ◯ Equipas Executivas

21. Considerando os outros investimentos em Inovação e Desenvolvimento, que importância relativa atribui àqueles que contemplam as TIC? *

- ◯ Nada Relevantes
- ◯ Pouco Relevantes
- ◯ Relevantes
- ◯ Muito Relevantes

22. Como classificaria a motivação para o desenvolvimento de projetos das TICs / IA? Em termos de origem no organograma empresarial: *

As necessidades são levantadas pelos colaboradores despertando a direção ou, alternativamente, a direção define estratégia e colaboradores adaptam-se à mesma? Selecione a opção mais relacionada.

- ◯ Top Down
- ◯ Bottom Up

23. Como classificaria a motivação para o desenvolvimento de projetos de TICs / IA? Em termos de origem interna ou externa: *

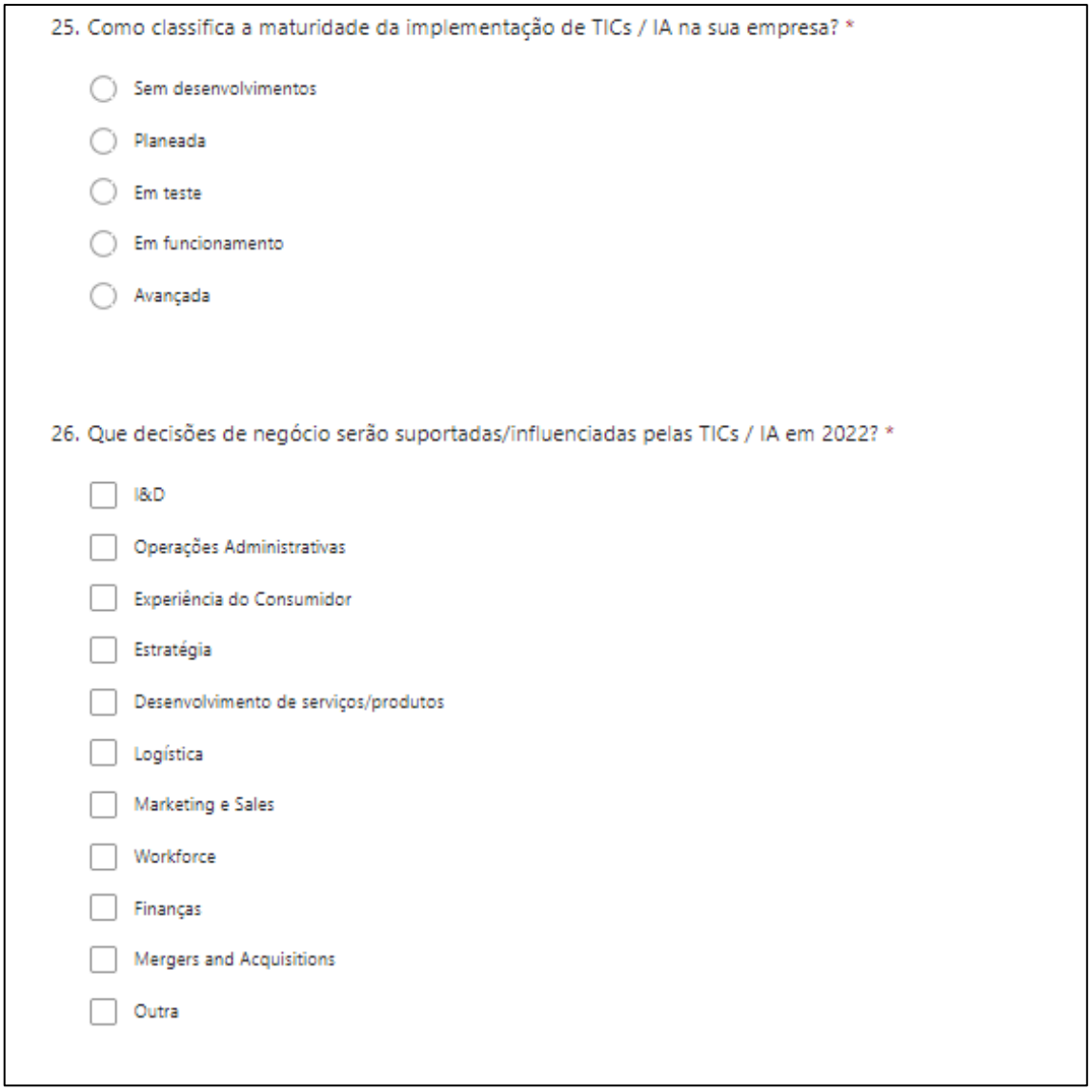
É a indústria e o evoluir da concorrência que exigem atualização ou é de origem interna a necessidade de trabalhar projetos relacionados com TICs / IA? Selecione a opção mais relacionada.

- ◯ Business Pull
- ◯ IT Push

24. Como posicionaria a sua empresa face às restantes do mesmo setor em relação à adoção de TICs / IA? *

- ◯ Pioneira
- ◯ Seguidora
- ◯ Observadora

Appendix A 7.


25. Como classifica a maturidade da implementação de TICs / IA na sua empresa? *
Sem desenvolvimentos
Planeada
Em teste
Em funcionamento
Avançada
26. Que decisões de negócio serão suportadas/influenciadas pelas TICs / IA em 2022? *
I&D
Operações Administrativas
Experiência do Consumidor
Estratégia
Desenvolvimento de serviços/produtos
Logística
Marketing e Sales
Workforce
Finanças
Mergers and Acquisitions
Outra

Appendix A 8.

27. Que departamentos mais utilizam as TICs / IA? *

- [ ] Administrativo
- [ ] Atendimento ao Cliente
- [ ] Comercial / Vendas
- [ ] Comunicação
- [ ] Contabilidade
- [ ] Qualidade
- [ ] Estratégia
- [ ] Legal / Jurídico
- [ ] Logístico / Operações
- [ ] Marketing
- [ ] Recursos Humanos
- [ ] IT
- [ ] Não sei precisar

28. Quem recebe formação relativamente às TICs /IA? *

- ◯ Nenhum colaborador
- ◯ Todos os colaboradores
- ◯ Apenas colaboradores de departamentos relacionados
- ◯ Apenas colaboradores que demonstrem interesse

29. Que impacto terão as TICs / IA nas seguintes áreas de negócio? | Core Business *

Com esta questão pretende-se entender em que magnitude é esperado o impacto das TICs / IA nas atividades primárias, principais, da empresa.

- ◯ Sem impacto
- ◯ Pouco impacto
- ◯ Bastante Impacto
- ◯ Muito Impacto
- ◯ Não sei precisar

Appendix A 9.

30. Que impacto terão as TICs / IA nas seguintes áreas de negócio? | Negócio Adjacente *

Com esta questão pretende-se entender em que magnitude é esperado o impacto das TICs / IA nas atividades que apesar de não serem primárias / principais, continuam a integrar o core business da empresa. São atividades "na fronteira" da divisão entre core business e new business (áreas de todo ainda não exploradas pela empresa).

- ◯ Sem impacto
- ◯ Pouco impacto
- ◯ Bastante Impacto
- ◯ Muito Impacto
- ◯ Não sei precisar

31. Que impacto terão as TICs / IA nas seguintes áreas de negócio? | Negócio Incremental *

Com esta questão pretende-se entender em que magnitude é esperado o impacto das TICs / IA nas áreas de negócio / atividades incrementais à atividade principal da empresa. Por outras palavras, qual o impacto esperado em new business, áreas de negócio ainda não exploradas, de todo, pela empresa.

- ◯ Sem impacto
- ◯ Pouco impacto
- ◯ Bastante Impacto
- ◯ Muito Impacto
- ◯ Não sei precisar

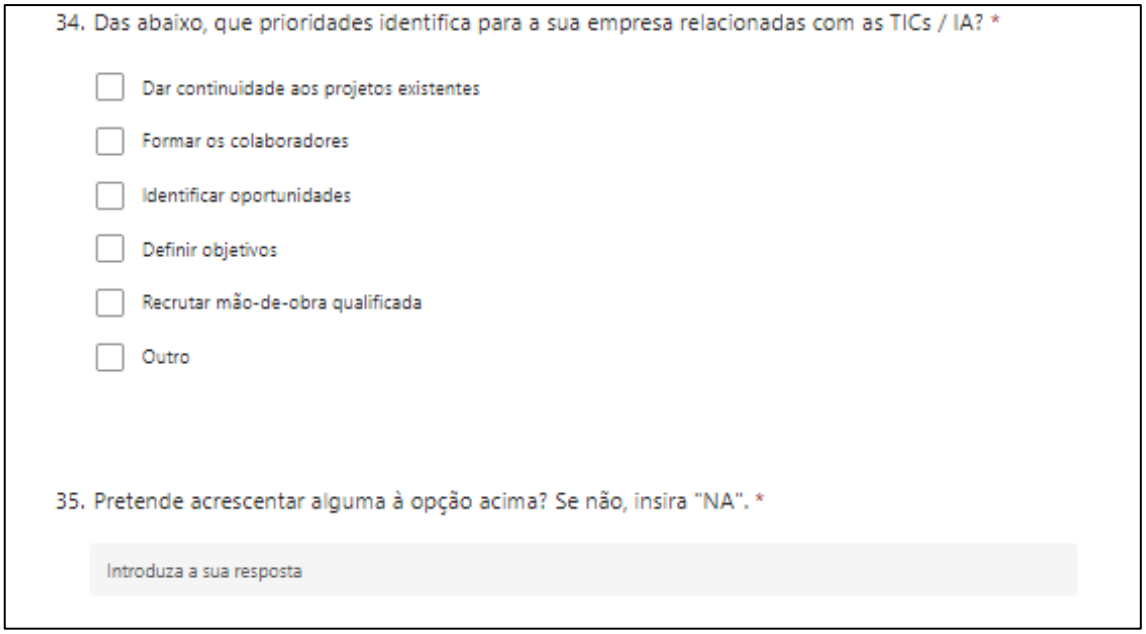
32. Que funcionalidades a sua empresa mais relaciona com as TICs / IA? *

- ◯ Previsão e Planeamento
- ◯ Automatização
- ◯ Análise de Informação
- ◯ Personalização

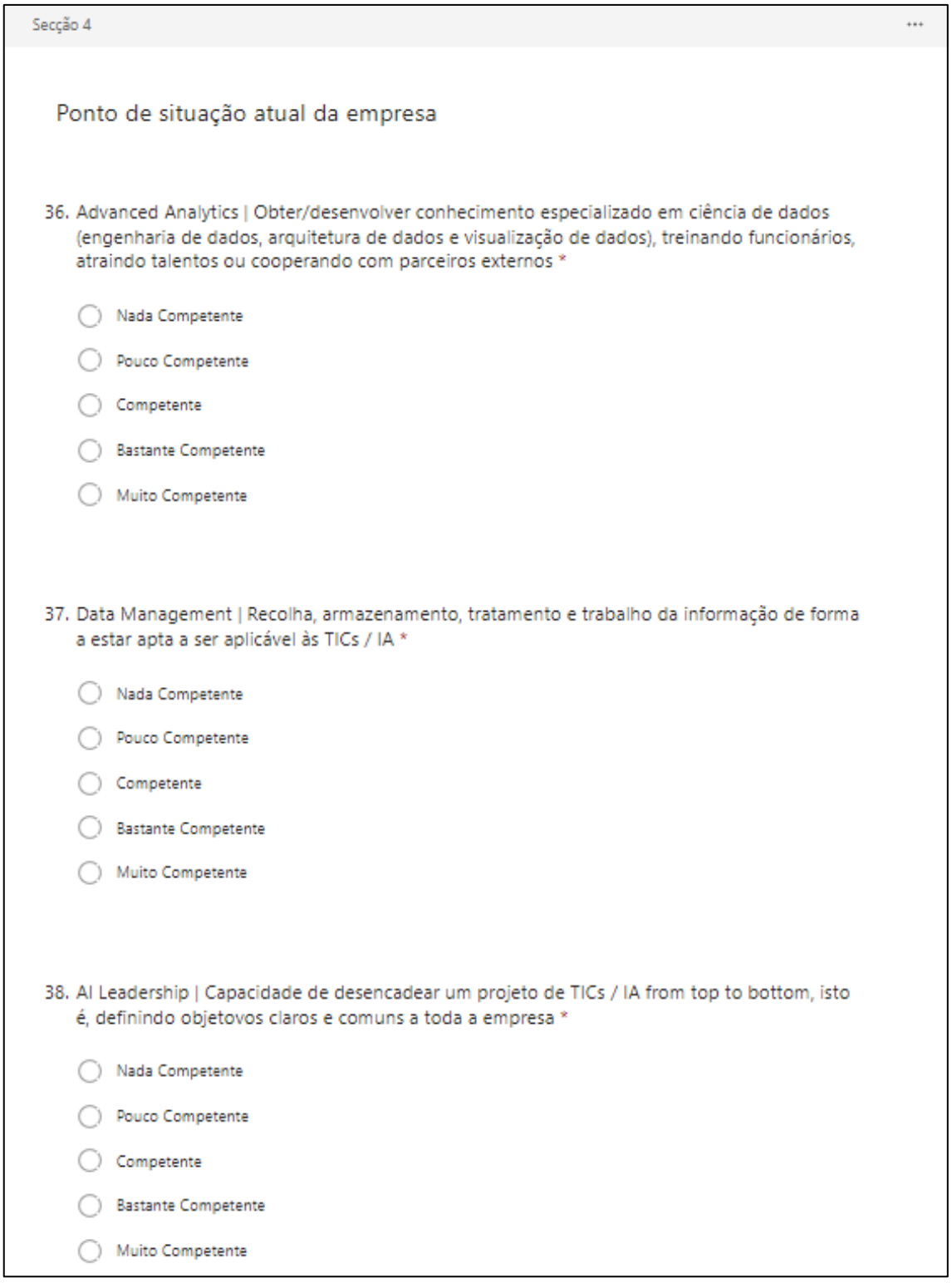
33. Que grau de certeza considera ter sobre o cáculo do retorno sobre os investimentos realizados em iniciativas relacionadas com as TICs / IA? *

- ☐ Baixo
- ☐ Médio
- ☐ Elevado

Appendix A 10.



Appendix A 11.


Secção 4

Ponto de situação atual da empresa

36. Advanced Analytics | Obter/desenvolver conhecimento especializado em ciência de dados (engenharia de dados, arquitetura de dados e visualização de dados), treinando funcionários, atraindo talentos ou cooperando com parceiros externos *

- Nada Competente
- Pouco Competente
- Competente
- Bastante Competente
- Muito Competente

37. Data Management | Recolha, armazenamento, tratamento e trabalho da informação de forma a estar apta a ser aplicável às TICs / IA *

- Nada Competente
- Pouco Competente
- Competente
- Bastante Competente
- Muito Competente

38. AI Leadership | Capacidade de desencadear um projeto de TICs / IA from top to bottom, isto é, definindo objetovos claros e comuns a toda a empresa *

- Nada Competente
- Pouco Competente
- Competente
- Bastante Competente
- Muito Competente

Appendix A 12.

39. Open Culture | Desenvolvimento de uma cultura cooperante e confortável para com as TICs / IA, com capacidade de crescer perante possíveis incertezas/ambiguidade *

- ◯ Nada Competente
- ◯ Pouco Competente
- ◯ Competente
- ◯ Bastante Competente
- ◯ Muito Competente

40. Emerging Technology | Capacidade da empresa continuar a inovar, lançar processos melhorados e desenvolver soluções *

- ◯ Nada Competente
- ◯ Pouco Competente
- ◯ Competente
- ◯ Bastante Competente
- ◯ Muito Competente

41. Agile Development | Capacidade da empresa e das suas equipas trabalharem entre si de forma iterativa, por ciclos, de forma a conseguir proguedir na implementação das TICs / IA *

- ◯ Nada Competente
- ◯ Pouco Competente
- ◯ Competente
- ◯ Bastante Competente
- ◯ Muito Competente

Appendix A 13.

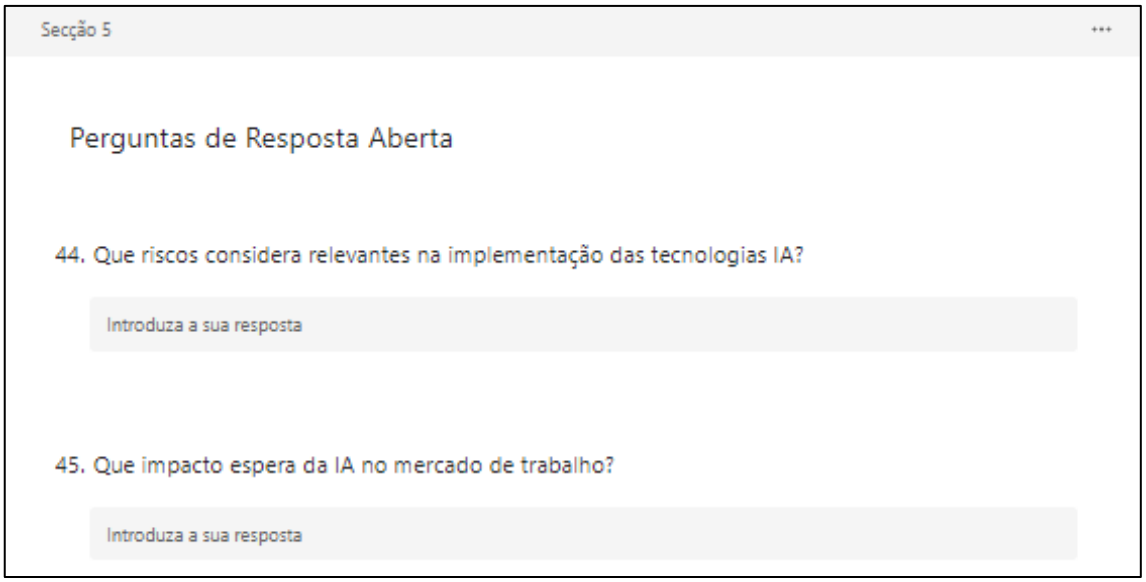
42. External Alliances | Desenvolvimento de parcerias com escolas, consultoras e outros especialistas em TICs / IA de forma a conseguir evoluir tecnincamente e implementar as melhores práticas do mercado *

- ◯ Nada Competente
- ◯ Pouco Competente
- ◯ Competente
- ◯ Bastante Competente
- ◯ Muito Competente

43. Emotional Intelligence | Medir e trabalhar o comportamento dos colaboradores, de forma a procurar melhorar as relações Homem-máquina para tirar o máximo partido das TICs / IA *

- ◯ Nada Competente
- ◯ Pouco Competente
- ◯ Competente
- ◯ Bastante Competente
- ◯ Muito Competente

Appendix A 14.



Appendix A 15.

APPENDIX B

Full interview with Dr. João Gama, PhD, Professor at the Faculty of Economics of Porto and researcher and deputy director of The Laboratory of Artificial Intelligence and Decision Support (LIAAD, INESC TEC).

The interview was conducted in Portuguese on August 29, 2022 by video call.

João Maria Duarte (JMD): Eurostat places Portugal in 2nd place in the adoption of AI technologies. The conclusions of the current investigation so far corroborate this advanced state of Portugal in the adoption of AI applications by its companies.

Despite this, most companies position themselves as followers in the adoption of AI technologies. How do you see the positioning of Portuguese companies regarding the adoption of AI applications?

João Gama (JG): Eurostat positioning Portugal in 2nd position, for me, is a good surprise. Portugal has several startups that work in the field of AI with great success and that typically, throughout their growth, end up being bought by either German or American companies.

Portugal, in European terms, was very well positioned in eGovernment, that is, in the use of information technologies at the government level and in the service sectors. There are very successful companies that use AI techniques in Portugal – for example, we have the case of Veniam, a Portuguese startup recently bought by a Israeli company. This type of case is always a sign that the market pays attention to what is done in Portugal.

In any case, I will have to investigate that Eurostat study, and check the criteria considered – for all intents and purposes this is good news.

When the adoption of big data technologies accelerated, with the greater availability of investment in this sense, Portugal began to be interested in these technologies. It was a strong investment stream that started in the USA and where European economies, such as Portugal, were driven to join.

JMD: Portugal, in macro terms, is a country that follows what is done abroad, but with success in replicating and exploring this previously explored path, where more successful

initiatives end up being consumed by other economies. Is this a good way to summarize your words?

JG: Portugal has innovative ideas. In terms of innovation, we have what is needed to innovate. However, to make the leap to relevant research capacity at European level, a lot of investment is needed. These companies thus must resort to risky investment, which end up being more available abroad – examples such as Feedzai, Farfetch or Veniam.

JMD: In relation to other EU countries, where does Portugal have room to evolve? What barriers does Portugal face in exploring AI applications by companies?

JG: For a company to have a European market, it must have professional and highly supported human capital, with a great investment capacity in order to scale at European level.

Portuguese companies that develop AI solutions and achieve some success typically end up being bought. Worldwide, of the most relevant companies in big data technologies, none are European – they are typically American, Chinese or Japanese. For example, there was a German company, with worldwide projection, which ended up being bought.

New Portuguese companies that want to explore AI applications end up setting up their offices in international headquarters other than Portugal, such as Madrid or Luxembourg. In terms of investment capacity, Portugal is a peripheral country at European level.

JMD: Certainly, companies in the German economy would have the capacity for significant investment to assume positions of relevance in world terms. Why are European economies not intentionally moving in this direction?

JG: The European market is free, which cannot prevent this type of acquisitions from happening. China, for example, has a more protectionist posture, in order to protect its AI and Big Data companies, providing the necessary support for them to grow without the pressure of international competition.

JMD: Portugal defined the AI strategy for the coming years through the Incode2030 program. Do you consider that Portugal, in terms of what is the AI environment in Portugal – legislation and education – is on the right path to promote the development of AI?

How does government's enhance the development of AI?

JG: Portugal has taken very positive steps, namely in the training of highly competent technicians in information technologies, with the emergence of more and more courses in data science in different parts of the country.

5 years ago, there was only one master's degree in data science in Portugal. At the moment, only in Porto, we have at least 4. There are alredy degrees available in Porto, Lisbon, Coimbra and Minho. The foundations are being built for technicians of excellence in these areas.

Portugal has always been at the forefront of AI technologies, but only through a small number of elements. We are currently developing numerous experts and thus solid foundations.

On the other hand, there have been incentives from the government to finance various projects, namely in the application of AI solutions in public services.

All this promotes the creation of an ecosystem that allows the development of a critical mass of knowledge in this area – Portugal, as well as most EU countries, have developed an AI agenda, which are very aligned with each other.

JMD: Summing up your words, Portugal in terms of strategy and the capacity of its workforce is in line with the EU average, with the biggest disparity related to the available investment capacity.

JG: Portugal is a peripheral country. At very short distances we have examples where the culture is quite distinct.

In the Netherlands and other EU countries, legal mechanisms are more favorable to the development of AI. There is a greater promotion of interaction between faculties, companies and public administration. This transfer of knowledge between these ecosystems is fundamental and that faculties have an active voice in solving challenges and problems raised by companies and by the public service itself.

On the other hand, the legislation in Portugal somewhat limits this interaction of knowledge – there is a distance between these three bodies. Universities are one world, companies and administration another two, isolated from each other. This exchange of knowledge is very relevant and Portugal should seek to move in this direction.

JMD: However, I think I understand why you were surprised to hear the position in which Eurostat places Portugal. So far, we have been talking about researching and exploring AI solutions in Portugal.

Now, the scope of my study is the adoption of applications, probably most of them already available on the market, by Portuguese companies. That is, the adoption of AI by companies that do not have at their core the exploration of AI solutions.

JG: This movement, namely in the telecommunications, services and banking sectors, is happening across Europe.

From the moment a company develops its online presence, it immediately creates the need to manage data - and several applications have been developed, in an accessible way, in this sense – applications to customize its offer to customers, recommend products, etc.

JMD: In the survey I developed, more than 50% of companies had medium to low confidence in their estimates of return on AI investments. Other risks, such as legal, were also mentioned.

Despite the growing adoption of AI applications by companies, what factors do you consider to be a barrier for more companies to integrate this movement?

JG: The main factor, I believe, is a question of mentality. I remember that when I started to collaborate with companies, I had several cases in which the first question was how much would a company earn with that investment, that is, from the companies' perspective, there was no interest in investing in AI applications without a guaranteed return expectation.

This mindset is changing. Companies are beginning to have the ability to understand that there are certain investments in which the return is not necessarily immediate. They

understand that these investments may not present direct returns in the short term, but that they make them more competitive and at the forefront in terms of innovation.

JMD: Isn't the absolute cost per se of implementing AI applications a barrier? That is, at the moment, most companies have the capacity to adopt AI applications, but not the mindset to do so?

JG: The biggest companies in the world are companies that exhaustively use AI technologies, and Portuguese companies know that. Markets are increasingly interconnected and demanding and companies must be able to innovate.

A few years ago, a doctorate in Portugal could almost be understood as overqualified. Nowadays, employing a PhD in Portugal is a huge advantage, because they are people capable of introducing innovation in companies.

A concrete case is the footwear industry in Portugal, which had a significant shift with technological innovation in the sector, placing Portugal with a leading role in this industry at European level.

JMD: How does the academy in Portugal compare with that of the EU and the world?

JG: Portugal has good universities and growing in terms of research. However, the legislation of Portuguese universities proves to be very restrictive, and very bureaucratic. As mentioned, the interaction between universities and companies is very limited.

Another factor that enhances the development of research in AI is the interaction between faculties. I have several foreign colleagues allocated to more than one university, thus having the possibility of interacting and stimulating the exchange of knowledge – which is a critical development factor. However, in Portugal, this does not happen – I am allocated exclusively to the Faculty of Economics of Porto and I am not aware of any colleague who is allocated to more than one university in Portugal.

JMD: Does the academy in Portugal already have a significant dimension? And are the funds available for research sufficient?

JG: The opening of research and doctoral scholarships has been increasingly, as well as a growing opening of career progression, but until recently this was not quite the reality.

More and more European projects begin to exist, and with the participation of a greater number of Portuguese teams involved in European projects.

JMD: To conclude, and in a very general way, what does the future hold for Portugal, in the next 5 years, in AI?

JG: Portugal is clearly expanding. The growing opening of courses proves this, and this will allow Portugal to create a considerable number of technicians which gives sustainability to innovation in this area, that we obviously hope will have an impact on services and public administration.

We are not standing still and Portugal is on the right path.

APPENDIX C

Full interview with Dr. Christopher Shulby, PhD, Machine Learning Director at Defined.AI, with nearly 10 years of professional experience in AI.

The interview was conducted in Portuguese on September 08, 2022 by video call.

JMD: Eurostat places Portugal in second place in the adoption of AI applications by companies. The work carried out within the scope of this investigation confirms this prominent position on the part of Portuguese companies. Do you share this insight?

Christoper Shulby (CS): In general, I consider Portugal a slightly behind in AI, but I have to read the study and check what Eurostat is considering as an AI application. In terms of the development of AI, there are few relevant companies, in relation to the application of AI I am not sure.

From my perspective, in Portugal, we don't have significant AI research, per se. In Portugal, companies stand out mainly for the development of AI applications. In Portugal we use technologies that are already 10 to 15 years old and where we differentiate ourselves is in the development of innovative solutions using these technologies.

Portugal has some recognized companies, such as Unbabel, which stands out for its quality in Machine Translation, or OutSystems, which is investing in low-code development. Still, like these there are several companies in the US that are much more advanced, or even in Europe, for example in Germany.

Portugal lacks in terms of company size and investment capacity in order to have a more expressive bet on AI - we do not see firms in Portugal with the capacity to be pioneers in this field.

Universities are also a relevant driver. Portugal has good universities, like the University of Lisbon and Porto, but they are in no way similar to Cambridge, Berlin or Paris. It is difficult for Portuguese Universities to retain talent – the best of the best typically receive irresistible offers to teach in other countries.

JMD: What has prevented Portugal from achieving the extra mile in the adoption of AI applications?

CS: I always like to set a comparison between Silicon Valley and Hollywood. Hollywood is a location– you don't need to live in Hollywood to be a good actor, but you probably won't have a career as good as you could. How many Hollywood actors are really from Hollywood?

How does this compare to Silicon Valley? Today, more than 60% of Silicon Valley CEOs are non-American. In other words, geography, in terms of attracting investment and disseminating knowledge, makes all the difference.

The US has a huge capacity to attract talent and that is why it is able to bring together the best American and international talent, even attracting startups.

This is not the case in Portugal. Some incentives were recently created, such as the Tax Regime for non-habitual residents, and efforts are being made to seek to adopt measures in this sense.

There has been a wave of emigration by American talent to Lisbon, given the quality of life at much more inviting prices than in San Francisco. The opposite happens with Portuguese talent, who see that the salary and tax conditions in Portugal are much lower when compared to other markets and end up having to go abroad.

I believe that Portugal, as a peripheral country, should think in this sense. Firstly, to be able to retain Portuguese talent and, secondly, to be able to attract the best minds from abroad, following, for example, some measures adopted in Barcelona.

JMD: What effect does the government's attitude have on the progress of AI in Portugal?

CS: A move by several government companies towards AI is clear. There are more and more government projects in this area, largely supported by funding through the "EU bazooka". However, this investment is only happening because this funding was available, otherwise and using local funds, we would not see this movement.

Even so, in the long run, it is very difficult to maintain these companies. These incentives exist at an early stage of projects, but in the long term there is no significant government support to maintain a sustainable development. The Portuguese government values

innovation and likes to approach the subject, but sometimes projects are short term and the construction of a robust knowledge structure is neglected – perhaps this is related to the duration of the mandates in which these investments are made.

JMD: Do you think there is a solid business community in Portugal, or for example, associations like Portuguese Association for Artificial Intelligence (APPIA), which offer startups and projects that want to develop a safe harbor to do so?

CS: Europe in general, and Portugal much less, do not favor fundraising operations. One of the first things that business schools teach is that to develop a project, typically, you don't use your own money. You must sell your idea to those who want to invest and this is how Venture Capitalists make money.

There are good incubators in Portugal that help you to gain structure at an early stage, but the funding available is always very limited, perhaps maybe just enough for the first year. In order to really leverage a company, it takes a considerable level of investment, an investment that is not available in Portugal. Here, we come back to the same – location is important.

This is the reason why Defined.AI has its Headquarters in Seattle, to be close to the technological hubs where this money is available.

JMD: In the next five years, what can we expect from IA in Portugal?

CS: The government is becoming more interested in IA, and I anticipate that Portugal will continue to grow and that more incentives will be created, but will this be enough?

Today, every country has an IA agenda - no country views IA as a bad investment. As a result, the question is, how can Portugal differentiate itself? Portugal must increase its investment capacity and become more appealing in comparison to other countries in order to continue to grow in IA.

SCHOOL OF **ECONOMICS AND MANAGEMENT** OF THE UNIVERSITY OF PORTO