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Artificial Intelligence as a driver of development and growth in organizations - A case applied to small and medium-sized enterprises (SMEs) in Portugal.

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Master in Management

Supervisor:

PhD, Rui Alexandre Henriques Gonçalves, Invited Assistant Professor

ISCTE - Instituto Universitário de Lisboa

September, 2025

BUSINESS SCHOOL

Department of Marketing, Operations and General Management

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Resumo

É impensável nos dias de hoje , que a existência da Inteligência Artificial se constitui como algo que veio para transformar a sociedade apenas, mas também algo que irá transformar e capacitar melhor as empresas.

Atualmente, as pequenas e médias empresas, dos diferentes setores de atividade procuram sempre inovar os seus negócios de forma a crescerem de forma sustentável sendo que a utilização da Inteligência Artificial representa uma nova abordagem. É imprescindível que as organizações compreendam o panorama global e as dinâmicas acerca da Inteligência Artificial de forma que seja possível fomentar o retorno da utilização desta nova tecnologia para o seu benefício.

O objetivo deste estudo pretende perceber tendo em conta, as características, vantagens e desvantagens, qual é o papel da Inteligência Artificial no futuro das pequenas e médias empresas em Portugal, como um novo facilitador de crescimento e desenvolvimento.

Com base na revisão de literatura foi construído um questionário online que foi distribuído a um conjunto de pequenas e médias empresas portuguesas.Com base na análise dos dados recolhidos, foi possível chegar à conclusão que a Inteligência Artificial possui um impacto positivo enquanto facilitador tendo sido provado que é visto como inovador na melhoria do processo de tomada de decisões sendo que é necessário referir que os riscos e a conformidade legal e regulatória poderão condicionar a implementação por parte das pequenas e médias empresas em Portugal.

Palavras-Chave : Inteligência Artificial, pequenas e médias empresas, apoio na tomada de decisão.

Classificação JEL :

M10 - General

O32 - Management of Technological Innovation and R&D

Abstract

It is unthinkable nowadays that the existence of Artificial Intelligence is something that has come to transform society only, but also something that will transform and better empower companies.

Currently, small and medium-sized companies from different sectors of activity are always looking to innovate their businesses in order to grow in a sustainable way, and the use of Artificial Intelligence represents a new approach. It is essential that organizations understand the global landscape and the dynamics around Artificial Intelligence so that it is possible to foster the return on the use of this new technology for their benefit.

The objective of this study aims to understand, considering the characteristics, advantages and disadvantages, what is the role of Artificial Intelligence in the future of small and medium-sized enterprises in Portugal, as a new enabler of growth and development.

Based on the literature review, an online questionnaire was built that was distributed to a group of small and medium-sized companies based on Portugal. With analysis of the data collected, it was possible to reach the conclusion that Artificial Intelligence has a positive impact as an enabler, having been proven that it is seen as innovative in improving the decision-making process, and it is necessary to mention that risks and legal and regulatory compliance may be condition the implementation by small and medium-sized enterprises in Portugal.

Keywords : Artificial Intelligence, small and medium enterprises, support in decision making.

JEL Classification :

M10 - General

O32 - Management of Technological Innovation and R&D

Index

Index of Tables

Index of illustrations

Index of Annexes

List of acronyms

SMEs – Small and Medium Sized Enterprises

AI - Artificial Intelligence

EU – European Union

IBM - International Business Machines Corporation

DARPA - Defense Advanced Research Projects Agency of the United States of America

ISO - International Organization for Standardization

OCR – Optical Character Recognition

LLM - Large language models

NLP - Natural Language Processing

XML - Extensible Markup Language

JSON - JavaScript Object Notation

BSON – Binary encoded JavaScript Object Notation

SIFT - Scale-invariant feature transform

HOG - Histogram of oriented gradients

DNN – Deep neural networks

CNN – Convolutional neural networks

RNN – Recurrent neural network

MLP - Multi-layer perceptron

AE – Autoencoder

RBM - Restricted Boltzmann Machine

DBN - Deep belief network

MDP - Markov decision process

DTP - Decision-Theoretic Planning

NPD – New Product Development

CRM – Customer relationship management

GDPR – General Data Protection Regulation

AI Act - EU Artificial Intelligence Act

EC – European Commission

EUR – Euro

TOE - Technological-Organization-Environment

OECD - Organisation for Economic Co-operation and Development

R&D – Research and Development

PRR - Recovery and Resilience Plan

AIGO - OECD Working Party on AI Governance

INE - Instituto Nacional de Estatística (National Institute of Statistic)

BPM - Business Process Management

IT – Information Technology

(α) - Cronbach's Alpha

(ρ) - Spearman Rho

CHAID – Chi-squared automatic interaction detection

QUEST – Quick, Unbiased, Efficient, Statistical Tree

ROI - Return of Investment

1.Introduction

Artificial intelligence as concept is still relatively new but growing at significant pace in the last few years with occurring changes in society, economy and other effects that affects a change of paradigm in today's world and the shift actions of what artificial intelligence could potentially lead to.

Companies, particularly SMEs, are starting to become aware of the tremendous potential of leveraging artificial intelligence into their businesses, however, not all companies are in the same level in terms of implementing how artificial intelligence can shape their businesses in the present and future, as well of facing other obstacles that significantly limit their planning and action. As stated by Perifanis and Kitsios (2023), "AI should be viewed as a dynamic computational frontier, governance should therefore go beyond just the content and also encompass its analysis" (Perifanis & Kitsios,2023), meaning that is not simply to be used as tool by companies since the use of artificial intelligence solutions has presented and shown signs that its full potential can be devastating in terms of transformation, so therefore it is needed to assure a proper monitoring in order to create the right environment to thrive and be put to good use.

To contextualize the choice of this theme, it's important to clarify the role of artificial intelligence that is more and more present in our daily lives, with substantial investment from larger companies in this field in recent years, that serves a purpose of creating value by optimizing the work that's being developed and create new development in products and services for the future. The creation of value, as stated by Climent et al. (2024), "refers to situations where an actor, such as a firm, provides a value proposition to another actor" (Climent et al., 2024), where artificial intelligence can be impactful to a company value proposition, by having an internal and external function. According to Enholm et al. (2021) , "internal functions involve using AI for improving internal business processes, such as decision-making, or for streamlining internal business processes", as for external functions comprise "using AI in products and services that are in direct contact with customers"(Enholm et al., 2021).

Furthermore, small and medium-sized enterprises (SMEs) face challenges in the adoption of artificial intelligence due to causes such as the unique environment and scope, which leads to obstructing the participation in this new trend. According to the European Union[1], small and medium-sized enterprises (SMEs) represent 99 % of all businesses in the EU, which "provide two thirds of jobs in the private sector in the EU and are deeply embedded in local communities, in particular in rural

[1] EUR-Lex - 32003H0361, http://data.europa.eu/eli/reco/2003/361/oj

areas". They also accounted[2] for "more than half of value added in the EU's non-financial business sector and are Europe's breeding ground for innovation, diversity and equality"(EU,2023). In short summary, SMEs in Europe are the backbone of the modern economy and particularly important in terms of long-term success and prosperity.

The main goal of this study is to contribute with new information and insights for the scientific community, whose main objective is to correlate the relationship between artificial intelligence as potential enabler for growth and development in SMEs in Portugal.

In order to fulfil with the presented goal, two objectives were defined, being the following: Assessing the extent to which the applicability of artificial intelligence solutions influences the perceived improvement by small and medium-sized enterprises in terms of quality of their decision-making and assess the level on which the risks related to AI regulation can affect the willingness to adopt AI solutions by small and medium-sized enterprises.

[2] SME Relief Package,https://single-market-economy.ec.europa.eu/document/download/8b64cc33-b9d9-4a73-b470-8fae8a59dba5_en?filename=COM_2023_535_1_EN_ACT_part1_v12.pdf

2. Literature Review

2.1 Background

2.1.1 History of Artificial Intelligence

The foundational roots of what we call artificial intelligence nowadays can be traced back to early 1950's when IBM firstly developed and designed the IBM 701, the world's first commercial computer, that had a primary focus for scientific and research development with a clear target in being able to offer the ability to tackle unsolved engineering problems and a range of scientific challenges for a set of operations.

A fascinating instance of the early days of artificial intelligence was the Turing Test, that was created by British mathematician Alan Turing during the 2nd World War. The Turing Test was featured in the article "Computing Machinery and Intelligence" (Turing,1950) that presented the following question "Can machines think?". The argument that supported the thesis if machines actually could think is based on a so called "Imitation Game", which contained three agents , a man (M) , a woman(W) and lastly an interrogator (I).

The method used by Alan Touring had a clear objective in hand, which was to provide a method in order to access if machines could think or not, based on a fictional scenario that each one of the agents played a certain role for each to be able to reach the desired outcome for the question originally proposed. The role of the interrogator was to be able determine which of the other two agents is in fact the woman while the roles of the other agents such as the man and the woman were to convince the interrogator that respectively one in fact is the woman and the other is not as seen in the picture below.

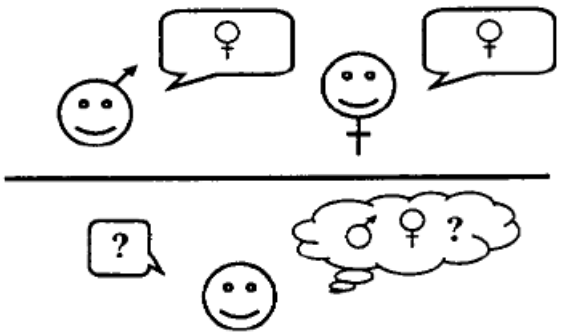

Fig 2.1 - Source: The Imitation Game: Stage 1. (Turing Test: 50 Years Later)

Both agents (M and W) communicate with the interrogator (I) using messages in a state of natural language, with deception of both agents being a key role of trying the imitate the behaviour of each other causing the machine to promptly try to think as a human being. The main goal of the Turing Test is to assess if the machine cannot successfully identify the agents in a correct way, then is considered to be successful test.

The conceptualization of term “artificial intelligence” into an actual research field of what we as society know, were first established in the summer of 1955 in the famous Dartmouth Summer Research Project, that brought together the most intelligent minds in the area at that particular time period, with names such as John McCarthy, alongside with Marvin Minsky, Nathaniel Rochester and Claude Shannon, which are to be considered as the founding fathers of artificial intelligence.

In today’s world, the Dartmouth Summer Research Project is seen as milestone that helped shaped the subject of artificial intelligence as whole , with the objective of the research project being about establishing “that every aspect of learning or any feature of intelligence can in principle be so precisely described that a machine can be made to simulate it”(McCarthy et al., 1955).

The established problem of artificial intelligence in the research project contained seven important views such as automatic computers, programming a computer to use a language, neuron nets, the theory of the size of a calculation, self-improvement across time, abstractions and lastly randomness and creativity that were discussed in greater detail during the summer of 1956 and coined a series of future contributions for artificial intelligence by entering a new era of prosperity following that summer.

The success of the Dartmouth Summer Research Project gained traction across the world with the optimism of creating and fulfilling the full potential of with the following years after that particular summer of 1956, leading to new creations and significant investments in the new world of artificial intelligence.

DARPA were one of the first government agencies in the world, to be involved in the new era of development in area of artificial intelligence specially in the development of emerging technologies for use by the military of United States of America. Founded in 1958, DARPA has a clear response to the Soviet launching of Sputnik 1 in 1957 with the constitution of clear vision and objectives of funding and collaborate projects in the academic world, industry, and other government partners by expanding the frontiers of both technologic and science level in order to be ahead in the military race of arms.

As seen before, governments such as the United States of America, Great Britain or Japan increased the overall funding for projects with the likes of cases like DARPA that had “promises of direct military applications, and rested on the assumption that existing approaches to expert systems, natural

language understanding, and vision were ready for large-scale application"(Haigh,2024). But the breakthrough during this period, was made possible with the invention of new type of AI called "expert systems".

Expert systems are defined as "a computer system that comprises computerized knowledge of an expert in a particular subject domain in order to provide fast and easily accessible knowledge in a useful and practical manner"(Tan & Kher,2012) and are characterised by having three distinct characteristics, utility, performance and transparency (Buchanan,1982). These 3 characteristics ensured that an expert system must be able to ensure importance to task proposed, a high performance by requiring expertise while answering a question and being transparent when providing a desirable output.

In 1986, after the growth of expert systems dominating the era until the unfolding events of AI Winter , the return and comeback of neural networks prompted a surge in its popularity with the publication of the paper "Learning representations by back-propagating errors"(Rumelhart et al., 1986) that introduced a new discovery of a new procedure that was essential to the optimization of neural networks. The discovery was backpropagation which consisted on "repeatedly adjusts the weights of the connections in the network so as to minimize a measure of the difference between the actual output vector of the net and the desired output vector"(Rumelhart et al.,1986), which resulted on finding hidden units in the middle part of the connection that had an important role and feature during task development that ultimately affect the prediction accuracy.

2.1.2 Artificial Intelligence (Concept and Definition)

The concept behind Artificial Intelligence is a direct result of a junction of two powerful words, artificial and intelligence, both having different meanings between them when the process of splitting them happens. Just as the definition of artificial intelligence that later on will be accessed on, it can be considered quite difficult to properly define as a universal definition for both artificial and intelligence. The complexity of what is actually intelligence, as per Neisser et al. (1996), can be first defined as "A individuals differ from one another in their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought" (Neisser et al., 1996), promptly launching and reinforcing the idea that intelligence is quite complex to define while also being considered quite reasoning of what is the general role of artificial intelligence as of today´s world. Regarding what can be defined as artificial, since the term is quite vague of explaining its purpose, mainly due to fact that it can be interpreted in different forms. For Solum (2014), the word "artificial" is directly linked to communication and its intention, since he considers that "communication succeeds because the other driver recognizes your

communicative intention"(Solum,2014), or in other words, recognizes a given context to be able to acknowledge a certain event or situation, similar to what happens with AI solutions nowadays.

In the present day, the definition of Artificial Intelligence (AI), is not accepted as a universally definition that can be used to define in general what is really artificial intelligence. However, multiples authors and organizations have established definitions over the course of the years in a way that the definition in certain time period may feel completely different of an actual definition in today's world.

Currently, artificial intelligence can be defined as a "technical and scientific field devoted to the engineered system that generates outputs such as content, forecasts, recommendations or decisions for a given set of human-defined objectives"(ISO[3]/IEC 22989:2022) at a more operational level. This definition embodies the technical aspect of what an artificial intelligence solution can do for a certain type of businesses, but for the average individual it does not provide a common and accepted definition.

At a more human level, artificial intelligence can be described as " the science and engineering of making intelligent machines"(McCarthy et al., 1955) or also as a "system's ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation"(Kaplan & Haenlien,2019).

For my thesis, since the availability of the multiple definitions what is AI, is considered to be wide in terms of range, in present day, Kaplan and Haenlien (2019) definition is the one I'm adopting, since in mine personal perspective, fully captures and embodies the capability of what an AI solution must do in order to successfully succeed at a moment's while being aware of its mission.

2.1.3 Big data and Large Language Models

Since the 1990's until the present day, AI development grew slow and steady in the first years after the surge of expert systems and the famous "AI Winter" that significantly caused setbacks on the research field.

The first major development after those events was the appearance of term that nowadays is known as Big Data in 2001 by Douglas Laney, however the subsequent development and growth of the topic leaded to more definitions in recent years making it case that there is not a universally accepted definition and it can be defined in different forms , such as "developing enormous informational indexes that incorporate heterogeneous configurations, i.e., organized, unorganized, and semi-organized information"(Abdalla,2012). Some authors such as Boyd and Crawford (2012) agreed that the definition of what is Big Data is a "cultural, technological, and scholarly phenomenon that rests on the interplay

[3] International Organization for Standardization

of technology, analysis and mythology "(Boyd & Crawford,2012) thus creating a dilemma of a clear definition of what Big Data really is and its scope.

In contrast, in order to properly access what is actually Big Data, it's needed to address the unique characteristics such as known as the 5V of Big Data, which are Volume, Velocity, Variety, Veracity and Value.

Without these five key elements, it´s impossible to describe what Big Data is all about, so each one of these elements hold significant importance towards the definition of term. The first element ,volume can be described as a high amount of data that is processed due to a significant high quantity of information , as for velocity refers to the speed at which the data is being generated and the movement along the process. Variety refers to the multiple types of data that can be present in a dataset or other sources such as unstructured data to structured data or even from images by using software like OCR, as for veracity stands for, having quality in data represented, by having a certain satisfactory threshold to achieve a good accuracy. The last element, value is described as the most important element since it represents the final use of what is possible to achieve with Big Data with a goal of being efficient and continuous improvement.

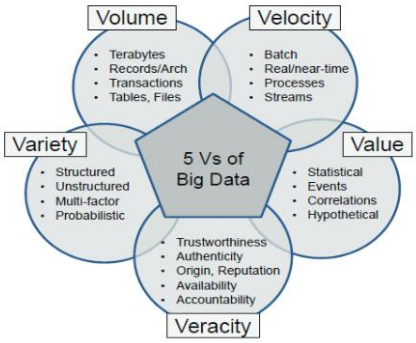

Fig.2.2 – The 5V of Big Data (Source: Big Data Tools-An Overview by Rabie Ramadan)

In recent years, the development of new advancements such as large language models (LLM) have grown significantly rapid to a point where the technology is drastically changing course in society but also on enterprises and how they act to potential clients and markets.

Regarding Large Language Models, the origins can be tracked back to a term called NLP (Natural Language Processing) first introduced by Noam Chomsky in 1957, on which we can define NLP as the process that enables the recognition , understanding and generation of text and speech for computers. The first successful attempts on creating solutions around this term revolved around the idea that a

machine followed a set of rules in order to guess correctly the meaning of a certain given phrase until the appearance of statistical language modelling in the early 1990's that aimed to estimate the probability distribution of words, sentences and documents with a purpose of helping on speech recognition, machine translation and other forms. The popularity around LLM's was caused by a major occurrence in language modelling, with the appearance of neural language models that can be defined as "mathematical models addressing contextually relevant properties of natural language from a probabilistic statistical perspective"(Wang et al., 2025).

Authors such as Hadi et al.(2023) described large language models as a "type of AI that can mimic human intelligence" on which the main objective is to "enable machines to understand human commands and adherence to human values" (Hadi et al., 2023) through factors such as changes and upgrades in terms of computers and their continuous evolution, diversity in data sources and innovation in algorithms.

2.1.4 Machine Learning

The concept of machine learning was first introduced in 1986 by Pat Langley who defined machine learning as a "field of inquiry concerned with the processes by which intelligent systems improve their performance over time"(Langley,1986). For Langley (1986), was apparent that the definition of what was machine learning was difficult to submit to a general and universal definition as whole, so argued that researchers of the field should "describe the central tendency of the field, a tendency that may itself change as the field develops"(Langley,1986).

Furthermore, it's important to establish the connection between data being collected and the machine learning solution, as for the importance of data impacts directly the efficiency and actual effectiveness of the proposed solution with the chosen technique and algorithm used.

Data can be classified in three different forms, structured, semi-structured and unstructured data. According to Sarker (2021), structured data presents a "well-defined structure, conforms to a data model following a standard order, which is highly organized and easily accessed, and used by an entity or a computer program"(Sarker,2021), on which examples of structured data include names, dates, geolocation or addresses.

Semi-structured data according to Hamouda and Abdelrahman (2024) can be presented as " flexible alternative to structured data, accommodating various data types without formal structures and commonly stored in formats like XML, JSON, and BSON"(Hamouda & Abdelrahman,2024), making it easier to examine in a machine learning solution. As for unstructured data, Sarker (2011) classifies as

not having a “pre-defined format or organization for unstructured data, making it much more difficult to capture, process, and analyze, mostly containing text and multimedia material”(Sarker,2021).

Machine learning techniques can be divided into four different categories, with supervised learning, semi-supervised learning, unsupervised learning and reinforced learning.

Supervised learning can be defined as task-driven approach that a machine “learn a function that maps an input to an output based on sample input-output pairs (Sarker,2021), meaning that occurs a prediction based on correct results that are already known and labelled. Unsupervised learning ,according to Russell and Norvig (2020) occurs when “the agent learns patterns in the input without any explicit feedback”(Russell & Norvig,2020), meaning there is not a right or wrong output and is primarily used to understand and extract features from unlabelled data that can be used to represent a specific pattern of provided inputs without any human interference.

Semi-supervised learning represents a mix between supervised learning and unsupervised learning, where this particular technique takes advantage of both methods. Taye (2023) describes semi-supervised learning as it “uses a huge quantity of input data, some of which are labelled, while the rest are not, and lies between supervised and unsupervised learning”(Taye,2023).

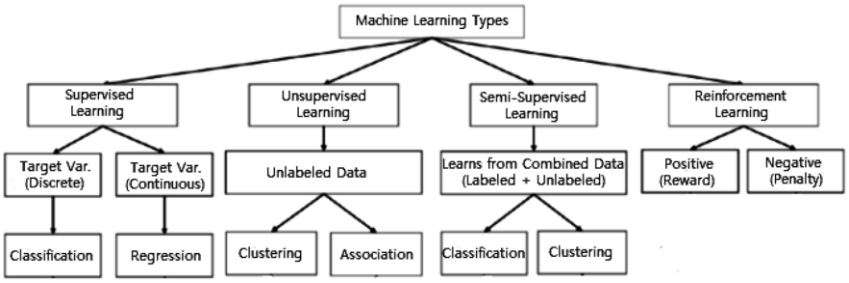

Fig 2.3 –Machine Learning Techniques. Source: Machine Learning: Algorithms, Real-World Applications and Research Directions by Iqbal Sarker

Last of all, reinforcement learning can be classified as an environment-driven approach, due to the fact that this technique assists machines “automatically evaluate the optimal behavior in a particular context or environment to improve its efficiency”(Sarker,2021), by utilizing a reward/punishment system that dictates whether the machine receives a reward or punishment caused by its behaviour.

2.1.5 Intelligent systems

Before referring to the various artificial intelligence techniques and how each one of them addresses and utilizes their specific set, it’s important to establish and explain what an intelligent system is. Defining what is an intelligent system proves to be quite challenging to this day, since it’s

hard to qualify the criteria what is an acceptable definition between researchers, due to the mainly the context and environment that one of these systems operates at his total capacity.

According to Russell and Norvig (2020), agents can be described as “anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators”(Russell & Norvig,2020).

Other authors like Sulich & Pelc (2024) approach intelligent systems as “an advanced computer system that can collect, analyze, and respond to data gathered from its environment”(Sulich & Pelc,2024), while others such as Molina (2022) argues that an intelligent system “is an artificial system that (1) operates as an agent, i.e., the system perceives its environment, acts in the environment and interacts with other agents, and (2) exhibits rational behavior, i.e., the system acts rationally (to maximize the success of its tasks) and shows rational thinking (justifies beliefs through reasoning)”(Molina,2022).

Although the existence of a universally accepted definition still does not appear until the present day, it’s possible to argue the role of central idea of what is an intelligent system is achievable around certain characteristics that predominantly tend to exist. The characteristics that an intelligent system possesses are based of reactions of external observers, which are interactions with the environment, interactions with other agents, rational behaviour and learning from over time.

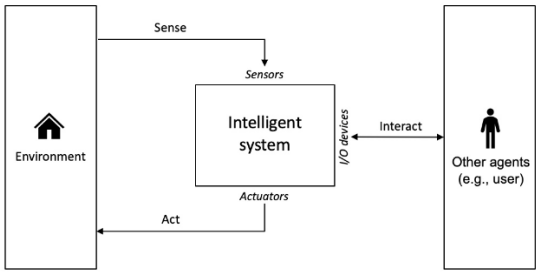

Fig 2.4-Intelligent System (Source: What is an intelligent system? By Martin Molina)

An intelligent system acts as an agent when interacting with a certain environment or other agents, that can be human or other machine-based agents, through the use of sensors and actuators which helps establish separation between the intelligent system and those that are part of a certain environment or classified as other agents, on which this process is called embodiment (Molina,2022). While interacting with another agent, intelligent systems can play two different roles, the delegate role and the advisor role.

The delegate role consists of when a certain task is given to the intelligent system by a human user, as described earlier on, on which the intelligent system acts independently in a certain environment with no help from other users, by making decisions at his own.

The advisor role, on the other hand, provides suggestions from the inputs given at the start of process by the user in order to enable their decisions based of the information provided by the intelligent system.

Furthermore, rational behaviour in intelligent systems can be presented as "performance measure" according to authors such as Russell and Norvig (2020) and Molina (2022), that concludes that machines "acts rationally if it consistently takes actions that successfully optimize the performance measure"(Molina,2022) of a certain given task, as for Russell and Norvig (2020), a "rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has"(Russell & Norvig,2020). Lastly, learning is not just a characteristic associated with an intelligent system and rationality, but primarily a need for the continuous improvement of intelligent systems, as quoted by Russell and Norvig that a "rational agent not only to gather information but also to learn as much as possible from what it perceives"(Russell & Norvig,2020), on which it's possible to conclude that learning over time based of perceiving the environment and other agents, supports adapting to occurring changes in the environment.

2.1.6 Computer Vision

The theorical foundation of the concept of computer vision dates into the early 1960's, in specific, to the year of 1963 when Lawrence Gilman Roberts submitted a paper for his thesis with the name "Machine perception of three-dimensional solids" regarding his PhD. This groundbreaking thesis established the foundational work of what nowadays is called computer vision mainly due the objective of the paper being able to extract 3-D geometric data from 2-D views that also contributed for the acceptance of Lawrence Roberts as the pioneer and father of computer vision.

Roberts and his thesis named "Machine perception of three-dimensional solids" established a future groundwork for further developments, on which to this day it´s still considered as reference. The concept of computer vision can be viewed as dual concept since it's referring to two different perspectives. One perspective, viewed as human level definition, refers computer vision as "discipline that intersects machine learning and image processing and provides sophisticated image recognition and classification capabilities"(Li & Zhang,2024) while the second perspective according to other authors such as Lasky (2024) , occurs at a more technical aspect that can be defined as "the ability of a computer to recognize and interpret the content of an image" (Lasky,2024).

In recent years with development of deep learning, a subclass of machine learning and a topic that's going to be addressed later on, with the further development and advancement of hardware capabilities of computers, has prompted a radical evolution not only the data that is being currently analysed[4], but primally on the number of algorithms and applications being developed as present.

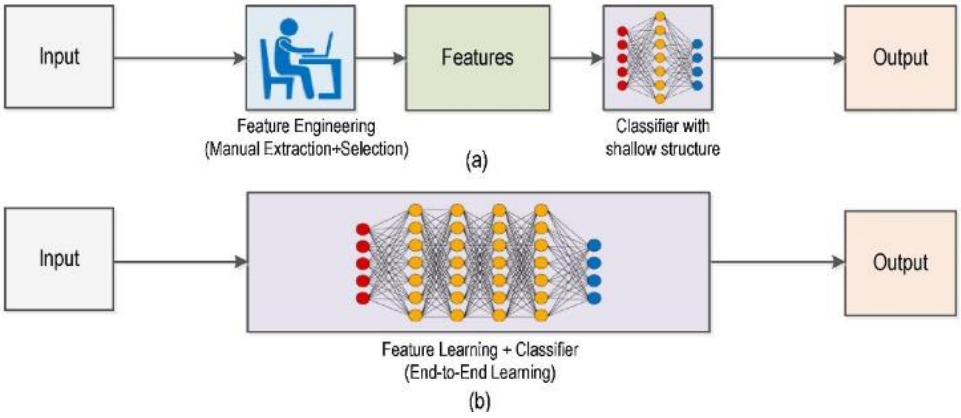

Fig 2.5 – (a) Traditional Computer Vision workflow vs. (b) Deep Learning workflow
Source : Deep Learning vs. Traditional Computer Vision (O'Mahony et.al.,2020)

The most relevant algorithms associated with computer vision are image classification, image segmentation and object detection. Image classification derives from classification models, which are models that can handle a large quantity of information for the purpose of use of making assumptions or classify data based on parameters previously defined. In the last years with the help of deep learning, a major leap was achieved with the creation of "ImageNet", a large-scale image dataset that was created with the purpose of providing researchers large quantities of data composed of multiple words or word phrases called "synonym set" or "synset", for training and testing of better machine learning methods[5] in order to foster the further development of topic of computer vision.

Image segmentation can be defined as a "pixel-level classification, which aims at dividing an image into meaningful regions by classifying each pixel into a specific entity"(Feng et al.,2019). In the present day, image segmentation, can be divided into two separate parts due to topic of deep learning once again, on which the first part is semantic segmentation that has the role of promptly "assign each pixel in an image to a semantic object class"(Feng et al.,2019) and the second part being instance segmentation that has the role of predicting "different labels for different object instances as a further improvement" to the first part.

[4] Big Data
[5] https://www.image-net.org/about.php

Object detection can be regarded as “general term for detecting, classifying and localizing objects in arbitrary scenes”(Rasche,2019) where it’s possible to detect multiple object classes simultaneously rather than only detecting one object class at time. The main goal of object detection is to detect in any type of scene by collecting images “containing the targets for each class type we wish to discriminate and we provide information where those targets are located in the image” (Rasche,2019).

Before the advancement of deep learning methods, object detection was based on computer algorithms such as SIFT and HOG, that at the time, were seen as the reference point, but when compared with deep learning, very limited on terms of detecting and classify features on images. With the development of deep learning and similar to image classification, the creation of large benchmark datasets that helped continuous improvement of a better method for object detection made possible the distinct of two different types of feature detectors.

2.1.7 Deep Learning

As mentioned previously above, neural networks are deeply connected to the field of deep learning, on which deep learning was firstly recognized as term that’s well-known in the present day by Hinton et.al (2006), on the published paper “A Fast Learning Algorithm for Deep Belief Nets”. The paper emphasized the establishment of an artificial neural network in order to create a fast learning algorithm that would produce a better classification model than when compared with other learning algorithms such as machine learning, by evaluating and transforming more data and creating a better efficiency on terms of giving a proposed answer to a given problem.

Deep learning can be defined as “an algorithm that attempts to use the high-level abstraction of data using multiple processing layers consisting of complex structures or multiple nonlinear transform”(Hao,2019), on which in other words, can also be explained and defined as a “cascade of multiple layers of nonlinear processing units for feature extraction and transformation”(Shinde & Shah,2018).

Since deep learning is considered a subset field of machine learning, deep learning models share the same architecture categories when compared to machine learning with the application of and also showed on the figure below :

1. Deep supervised learning (The most popular type of learning)
2. Deep unsupervised learning
3. Deep reinforcement learning
4. Hybrid learning Models.

Deep supervised learning models result on three main types of models such as deep neural networks (DNN), convolutional neural networks (CNN) and recurrent neural network (RNN). Deep neural networks are a product of neural networks, a concept already mentioned on this paper, on which it consists “of functions with higher complexity when the number of layers and units in a layer is increased”(Khoei et al.,2023). In other words, deep neural networks when compared with neural networks, are composed of more layers that allow to process the information significantly more efficiently and quickly mainly caused by multi-layer perceptron (MLP).

2.1.8 Deep Unsupervised Learning

As mentioned previously, deep unsupervised learning does not target labelled data but in fact learning new features or generate and represent new data is it is main function of the learning method.

An autoencoder (AE) by norm, is composed of three different parts, an encoder, code and a decoder, each with a different function in order to work properly. The role of an encoder passes by compressing the input and generating the code until it reaches the decoder that has the responsibility of reconstructing once again the input. A popular application of autoencoders tends to be applied towards generative modelling or feature detection since its main objective is to learn different types of representations.

Restricted Boltzmann Machine (RBM) is considered to be another example that contributes for deep unsupervised learning, on which it characterizes a subset of Boltzmann Machines that have as its main objective to concisely identify and “recognize patterns in data automatically and develop probabilistic or stochastic models”(Sarker,2021). RBMs by norm, are constituted by “visible and hidden nodes and each node is connected to every other node”(Sarker,2021) that further allows to identify and understand certain irregularities in the presented data due to the limited number of connections of nodes.

A deep belief network (DBN) is mainly composed of several layers of Restricted Boltzmann Machines or even autoencoders, on which the main goal is to be a “probability generation model”(Hao,2019) that allows the development of “training unsupervised feed-forward neural networks with unlabeled data before fine-tuning the network with labeled input”(Sarker,2021). DBN “are restricted to a single visible layer and single hidden layer, where connections are formed between the layers”(Mishra & Gupta,2017) with the hidden layer assuring the acquisition of high-order data correlations that can be seen in the visible layers that ultimately leads to recognition of deep patterns between the data presented.

2.1.9 Deep Reinforcement Learning

Regarding the concept of deep reinforcement learning, as mentioned beforehand in this thesis, reinforcement learning is considered to be a mix of supervised and unsupervised learning, on which it aims the intelligent agents (machines) to involve and act in the surrounding environment in order to fulfil their objectives and goals. Authors such as Yu et al. (2022), instate that the main idea of reinforcement learning is based on "perceiving the environment through the interaction between agents and the environment, relying on strategies to select actions, so as to obtain the maximum cumulative reward value" (Yu et al.,2022), and with the introduction of concept of deep learning Hinton et.al (2006), it's rapidly creating new developments over time in areas such as robotics and computer vision , due its unique characteristics in reading and understanding the environment around them for ultimately make decisions independently on their own (Yu et.al.,2022).

The Markov decision process (MDP) introduced by Martin Putterman in 1994[6] and the Decision-Theoretic Planning (DTP) introduced by Craig Boutilier, Thomas Dean and Steve Hanks in 1999[7], constitute two important landmarks for reinforcement learning algorithms due to the significant role that these two approaches have effect on how intelligent agents act when making decisions. The Markov decision process framework is based of four elements: state, action, transition function and reward function, and it's the most common implemented in most reinforcement learning processes for answering sequential decision-making problems, on which it can be explained as the "state after transfer is determined by the state and action before transfer, and the reward is determined by the state before and after transfer"(Yu et al.,2022), or in other words, the Markov Decision Process possess the role of establishing the rules followed by the intelligent agents that process a certain environment in order to reach a decision based on previous knowledge. The Decision-Theoretic Planning (DTP) continued the previous work realized by Putterman, on which took the classic approach of the MDP and brought the focus on creating a better decision-making process based on planning against uncertainty with a clear aim of the DTP being to "form courses of action (plans or policies) that have high expected utility rather than plans that are guaranteed to achieve certain goals"(Boutilier et al.,1999).

Deep reinforcement learning algorithms can be divided into two main methods, a value based method and policy based method.

A value based method functions based on exploration, that can be described as within the deep reinforcement learning approach, as actively looking in the environment for something of value that

[6] Markov Decision Processes: Discrete Stochastic Dynamic Programming

[7] Decision-Theoretic Planning: Structural Assumptions and Computational Leverage

ultimately leads to learning that "'something'' is a reward function and the ''searching and finding'' is an agent's attempt to try to maximise the reward function"(Ladosz et. al,2022).

A policy based method functions when a certain agent uses "a set of successful policies in an experience replay and then minimises the difference between the current policy and the best policies from storage"(Ladosz et. al,2022), or in other words, it learns by sampling a series of other policies and by learning directly through the process itself.

2.1.10 Advantages of Artificial Intelligence

In the previous chapters, the introduction of the general idea of what artificial intelligence is all about, it is also needed to acknowledge what are the main advantages of artificial intelligence and how companies, especially SMEs, can consider for usage in order to gain a competitive advantage in the market.

One of the beliefs of what AI can do, in order, to foster a competitive advantage for SMEs, that ultimately lead to the creation of an advantage, is the idea behind efficiency through automation of repetitive tasks, since repetitive tasks have been a cornerstone through history that companies were always looking out for different approaches in order to fully optimize to an extent of being almost perfect (Ex: Standardization in Ford Motors).

With AI, this optimization is now possible to do, with authors such as Brynjolfsson & McAfee (2011) quoting that "digital technologies now perform mental tasks that had been the exclusive domain of humans in the past" (Brynjolfsson & McAfee,2011). According also to Brynjolfsson & McAfee (2011) , computers are now capable of perform flawlessly "at routine processing, repetitive arithmetic, and error-free consistency and are quickly getting better at complex communication and pattern matching"(Brynjolfsson & McAfee,2011) meaning that ultimately, the change is already happening in terms of organizational behaviour since robots are now "having notable impact upon employment: over the past decades, industrial robots have taken on the routine tasks of most operatives in manufacturing"(Frey & Osborne, 2017).

Another advantage attached to AI is product and service innovation. NPD, or new product development, can be defined as introducing "a new product to the market that will allow a company to achieve a competitive advantage"(Dąbrowski,2023), that also according to the author, NPD is divided into 4 different phases: "opportunity identification, concept generation and evaluation, development, and market launch"(Dąbrowski,2023).

Service innovation, in today's world is often linked to CRM, or in other words, customer relationship management systems. The main objective of a CRM system is to "improve customer

relationships by providing a centralized platform for managing interactions across various touchpoints”(Boppana,2022), that currently in the present, presents a significant challenge due to the evolution of the complexity of managing relationships in today’s world.

The role of AI in CRM systems can enhance the customer experience, due to the fact that customers nowadays are looking for companies that match their needs in order to be able consider it on a more personal level in terms of satisfaction. The integration of AI into CRM systems leverage the use of Big Data in order to generate relevant insights about their customers as well as having a personalized chat support with the usage of chatbots that can directly tailor accurate responses by efficiently support customers to their requests.

With AI defining a new environment by using techniques such as Machine Learning or Big Data that enhance the appearance of new products or services, product development and service innovation are now headed to a point that where the applicability and scalability of new solutions can possibility bring a new horizon on how SMEs should invest in order to stay present in the market with a new surge on competitive advantage.

2.1.11 Concerns and limitations of Artificial Intelligence

The rapid ascension of artificial intelligence in today's society is astonishing, and its influence on enterprises in multiple different areas such as banking, healthcare, logistics have taken by storm how can companies leverage the use of artificial intelligence for their own benefit. However artificial intelligence algorithms are not an exception of being able to always delivery constant and accurate outcomes to the proposed problems and issues that can help change a course of a company, so it’s absolutely necessary to talk about the concerns and limitations that artificial intelligence presents in today’s world. One those concerns is about the role of Bias in use of artificial intelligence, and how does artificial intelligence present to this challenge.

Bias can be defined as ”a systematic error in decision-making processes that results in unfair outcomes”(Ferrara,2023), on which it presents different types of sources, that can be from humans or even from the artificial intelligence systems if not applied correctly during the learning and training stages due it’s complexity and features. For this reason, it’s necessary to explain the different types of bias that exist in artificial intelligence and how they can shape and modify an enterprise not trained properly since the perpetuation and replication of bias in artificial intelligence represents a risk globally if not approached with caution, leading to unexpected outcomes for the companies.

The propagation of bias in artificial intelligence systems or algorithms can occur in different steps of the process, including when collection the data or when data is being processed. Bias sources, such as sampling bias, that can be defined when the” training data are not representative of the population

they serve, leading to poor performance and biased predictions for certain groups"(Ferrara,2023) or the representation bias, that shows when a "dataset does not accurately represent the population it is meant to model, leading to inaccurate predictions."(Ferrara,2023), demonstrates that the creation of an artificial intelligence system/algorithm, is not an easy task and the concept of bias should be taken as a serious matter since it can occur, not only during the development but also after the creation and subsequent implementation of the algorithm/system.

2.1.12 Privacy, Transparency and Data Security

Nowadays, the availability of data compared when artificial intelligence was originally seen as early concept that could flourish later on, almost 50 years ago, the difference is significantly remarkable and opposite. Having more data available for intelligent systems from different sources of information[8], that can be used and applied for different artificial intelligence techniques such as machine learning for firstly train and later on improve the quality of results, it has brought the attention, in recent years, concerns about data privacy and security due to this trend of digital development .

The topic of data privacy and security in the last few years, lead to establishing the term of data governance in companies worldwide, where data governance can be defined as :

- "Data governance specifies a cross-functional framework for managing data as a strategic enterprise asset. In doing so, data governance specifies decision rights and accountabilities for an organization's decision making about its data. Furthermore, data governance formalizes data policies, standards, and procedures and monitors compliance" (Abraham et.al,2019).

Nowadays, with the acceleration and recent explosion of digital business transformation and the introduction of terms such as industry 4.0, the focus has shifted to the discussion of the importance of customer data in the future as a "growing source of competitive advantage"(Morey et al.,2023),where companies will gain a superior advantage in knowing customers habits and preferences that ultimately will gain confidence with them over time. The bridge between gaining confidence and losing confidence of customers can applied to term of transparency. For companies, transparency is not something that can earned just once, because it needs to sustain a certain level of confidence between customers , stakeholders and the surrounding environment in order to maintain. Gaining access to personal data of customers is not an easy task, but is a necessary task that companies have to fulfil in order to be and stay competitive, where various research as seen by Morey et al., (2023), shows that "the more trusted a brand, is, the more willing consumers are to share their data" (Morey et al.,2023), where it is possible

[8] Big data

to say that the resilience of sharing private and personal data by customers to companies is built on trust but also in terms of return of value, that highlights a significant trade-off in how customers sharing their personal data will benefit them later on.

For companies, compliance with terms such as data privacy, transparency, security in the European Union, are kept on strict laws and frameworks such as GDPR and the AI ACT, that ensure a systematic review and oversight in how companies operate in handling data and ensuring risk procedures to protect not only personal data from consumers but ensure healthy and trustworthy business practices when using artificial intelligence.

GDPR stands for General Data Protection Regulation *(Regulation (EU) 2016/679)* and was developed to complement the EU Charter of Fundamental Rights that defends data protection on member states as fundamental right that has to be ensure and maintained as whole for individuals. The GDPR serves as purpose for laying down the "rules relating to the protection of natural persons with regard to the processing of personal data and rules relating to the free movement of personal data"(European Union[EU],2016), on which it's applicable regarding the "processing of personal data wholly or partly by automated means and to the processing other than by automated means of personal data which form part of a filing system or are intended to form part of a filing system" (EU, 2016).

In case of SME's, following the guidelines established in GDPR in regards to the treatment of personal data that is collected from individuals of the European Union, created a new standard in the European market on taking a serious step to combat data breaches, storage and collection of personal data, which proves to be a difficult challenge mainly due to the fact that most small and medium sized-enterprises in the EU use third-party "data processors", or in other words, the use of outsourcing in storing and processing data that is considered to be critical for companies due to lack of funds for the investment on purchasing personal data centers for the storage of collected data and the required human capital to handle these types of emerging technologies and it's requirements.

Furthermore, the EU AI Act (*Regulation (EU) 2024/1689*), introduced on the 12th July of 2024, is considered to be the first legal framework concerning the topic on artificial intelligence that provides companies a set of legal requirements and obligations regarding the use of AI with a clear goal of also helping reducing the significant administrative and financial costs that are considered to be vital for small and medium-sized enterprises.

The main objective of this regulation is to "improve the functioning of the internal market and promote the uptake of human-centric and trustworthy artificial intelligence (AI), while ensuring a high level of protection of health, safety, fundamental rights enshrined in the Charter, including democracy,

the rule of law and environmental protection, against the harmful effects of AI systems in the Union and supporting innovation (EU,2024). The definition of the level of risk is approached as a four level pyramid, on which each level of risk is subject to certain level of exposure that is classified to their usage and application in real life. The regulation intends to address every type of risk, but more importantly establish a comprehensive approach to classify risk to be considered acceptable or prohibited as whole.

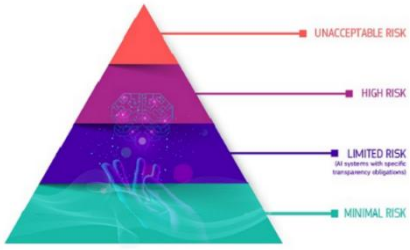

Fig 2.6 – Four level risk-based approach (Source: EU,2024)

For to be considered a High-Risk AI System, due to being most common and more regulated, it's needed to address with the 2 main points: (1) – "the AI system is intended to be used as a safety component of a product, or the AI system is itself a product, covered by the Union harmonisation legislation" (EU,2024); (2) – "the product whose safety component pursuant to point (a) is the AI system, or the AI system itself as a product, is required to undergo a third-party conformity assessment, with a view to the placing on the market or the putting into service of that product pursuant to the Union harmonisation legislation"(EU,2024).

Otherwise, if not properly complied, the AI Act establishes that companies will be faced with penalties and fines as part of correcting their behaviour towards the use of AI Systems by the created officer by the European Commission, named "AI Office" that serves purpose of "contributing to the implementation, monitoring and supervision of AI systems and general-purpose AI models, and AI governance"(EU,2024).

2.2 Portuguese SME's

2.2.1 Definition of Small and Medium-Sized Enterprises (SMEs)

The definition of small and medium-sized enterprises of establishing a common definition and it's first attempt can be traced back to the early 1970's, with the presentation of Bolton (1971) in reporting to committee on enquiry on small firms as requested by the Queen of England at that time period. On this report, Bolton defined what is considered to be a small firm and what characteristics, future trends of the sector and impact on the economy, among other aspects, that a small firm has in her power in

order to continuously develop and produce more value for herself, where it's important to noticed that it clearly marked the future development of the accepted definition of what is a SME based on this particular policy.

By 1999, a new paradigm has just shaken the European market with the establishment of the European Union[9] and the single market alongside the freedom of movement for individuals , money and other services in 1993 and 1999 by the introduction of new policies that completely shaped a new market but also created a new precedent on how SMEs are viewed as in the European perspective. According to Dannreuther (1999), the EU SME policy was classified as an understatement when compared to other policies made by the European Union, with the presence of the EU on "the SME sector is marginal"(Dannreuther,1999).

After the creation the EU and its unique environment the change of SME policy making was real change for the European market, with Dannreuther (1999) arguing that the "SME policy represents more than a new strategy for employment generation or support for a peripheral form of economic activity. SMEs are embedded in the social and cultural diversity that European integration has, until now, been unable to accommodate"(Dannreuther,1999).

Establishing a common and universal definition of what is considered to be small and medium sized enterprise was incredibly fundamental for the European Union due to their policy making as referenced in the SME User Guide that refers that "in a single market with no internal frontiers and in an increasingly globalised business environment, it is essential that measures in support of SMEs are based on a common definition. Lack of a common definition could lead to the uneven application of policies and thus distort competition across Member States"(EU,2020), on which having a common definition, helps promoting consistency and effectiveness across the various policies implemented and designed by the European Union.

According to European Union, small and medium-sized enterprises are considered to be enterprises to be "any entity engaged in an economic activity, irrespective of its legal form. This includes, in particular, self-employed persons and family businesses engaged in craft or other activities, and partnerships or associations regularly engaged in an economic activity"(*2003/361/EC, Article 1*). The actual difference in distinguishing a small and a medium sized enterprise impacts directly on the staff headcount and financial ceilings, as per the following definition provided by the European Union (*Commission Recommendation of 6 May 2003 concerning the definition of micro, small, and medium-sized enterprises (2003/361/EC), Official Journal of the European Union, L 124/36, 20 May 2003*) :

[9] Established by the Maastricht Treaty on November 1, 1993

1. The category of micro, small and medium-sized enterprises (SMEs) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million.
2. Within the SME category, a small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million.
3. Within the SME category, a microenterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million.

Table 1 - SME's Categories

Category	Staff Headcount	Turnover	Balance Sheet Total
Medium-Sized Enterprises	<250 workers	≤ 50 million	≤ 43 million
Small-Sized Enterprises	<50 workers	≤ 10 million	≤ 10 million
Micro-Sized Enterprises	<10 workers	≤ 2 million	≤ 5 million

Source: Author's elaboration

2.2.2 Growth and development in SMEs – The adoption of AI and the influencing factors behind it

As the trend of digital transformation continues to growth and accelerate over time, SMEs are increasingly more aware of the adoption of artificial intelligence for the development of products and services by facilitating the usage regarding its potential benefit. The TOE Framework (Technological-Organization-Environment) was first introduced by Tornatzky et.al (1990) in the book "The Processes of Technological Innovation", that is best explained as an "organization-level theory that explains that three different elements of a firm's context influence adoption decisions"(Baker,2012), or in other words, provides a conceptual framework in how the adoption and use of new technologies can be explained due to the influence of numerous factors.

The three elements that compose the influence of adoption a certain decision are technology, organization and environment, where these 3 elements are considered also to be critical for the functioning of SMEs. The technological element according to Baker (2012), access all available

technologies in force by companies and the ones that are currently available in market in order to drive up innovation where companies should consider and evaluate when choosing the adoption of new technologies due to the emergence of competence-enhancing and competence-destroying discontinuities (Tushman & Anderson,1986). Competence-enhancing discontinuities can be classified as a "process innovations that result in an order-of-magnitude increase in the efficiency of producing a given product" (Tushman & Anderson,1986), or in other words, technology that is already available that evolves with new developments by having expertise on the matter where competence-destroying discontinuities are in opposite spectrum that cause "render many existing technologies and many types of expertise obsolete"(Baker,2012) and ultimately shift the technology paradigm by creating other forms of competitive advantage, similar to the present effect of artificial intelligence.

Since artificial intelligence is part of process of digital transformation that organizations are currently experiencing and managing, in this particular case SMEs, it's needed to address what are dynamic capabilities. The conceptual framework was first introduced by Teece et.al (1997), as an answer in how organizations can achieve and sustain competitive advantage in environments that are known to have a disruptive technological change.

For Teece et.al (1997), dynamic capabilities are defined as "the firm's ability to integrate, build, and reconfigure internal and external competences to rapidly changing environments"(Teece et.al, 1997) as the threat of digital disruption is to ultimately "render the current skills and resources held within a firm obsolete"(Ellström et.al,2021). The adoption of a new technology such as artificial intelligence and its current changes that shape the technological market every day, it is natural for an organization nowadays, to possess the capability of changing its dynamic rather quickly in order to sustain competitive advantage in the market. However, it must be noted that the capabilities as per Teece et.al (1997) refer as "key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment"(Teece et.al, 1997), are not equal for all organisations, which in the case of SMEs, are known to be limited where resource and skills allocation are necessary in order to achieve the expected results to be able to sustain the necessary competitive advantage.

2.2.3 Challenges faced by Small and Medium-Sized Enterprises (SMEs)

The constraints faced by small and medium-sized enterprises significantly limit their share capacity for growth and technological investment when faced with a numerous type of challenges such as financial limitations, the evolution of technology and retain of high-skill workers and also the complex and difficult regulatory that enterprises are inserted in.

Since the early days, innovation and technology are deeply connected and considered to be a fundamental part and conductor of economic development and its growth as seen by Griliches (2020) and Pellegrino (2018). In the other hand, SMEs are continuously exposed to a more global market that imposes constraints, as seen above, that ensures more competition, that in order to sustain a competitive advantage, companies are obliged to innovate their products and services although there is presence of several so-called obstacles .

According to Hadjimanolis (1999), innovation usually concentrates on its main barriers or obstacles, where this approach classifies barriers as related to their origin that can be internal or external that ultimately attempts to "identify their point of impact in the innovation process to measure their effects or consequences"(Hadjimanolis,1999). External barriers are known to be subdivided into demand, supply and environmental that corresponds to "difficulties in obtaining technological information, raw materials, and finance" or "to do with customer needs, their perception of the risk of innovation, and domestic or foreign market limitations" where in opposition, internal barriers are linked to resources with examples such as "lack of internal funds, technical expertise or management time, culture and systems-related"(Hadjimanolis,1999).

It is known that growth in small and medium-sized enterprises is difficult and for Portuguese SMEs is not an exception as showed by (Organisation for Economic Co-operation and Development [OECD],2023) that the Portuguese economy is still apparent representative of having "Low levels of investment, particularly in intangibles, low R&D intensity and low average skill levels remain key challenges, despite recent improvements with respect to workforce skill"(OECD,2023).

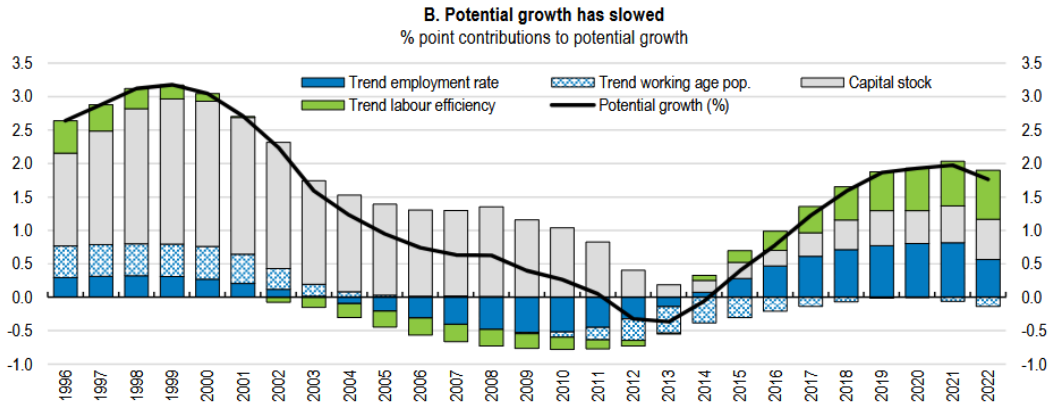

Fig 2.7 – OECD Economic Surveys

Source: OECD (2023)

As previously mentioned on this paper, companies' productivity in Portugal is low when compared to with other EU member states with the main factor being resource allocation, a factor that is known

to small and medium sized enterprises as critical. According to OECD (2023), “facilitating the reallocation of resources while preventing failures of viable businesses and facilitating corporate restructuring and insolvencies will be necessary to support a shift towards stronger growth” (OECD,2023) for Portugal, meaning that it’s needed and necessary to transition to more innovative in terms of economy, where artificial intelligence could take centre stage for the upcoming change.

Another problem faced by SMEs in Portugal, occurs with the current available workforce and their lack of expertise. As mentioned with the latest report of Digital Decade Country Report in 2024, Portugal (EU,2024) is currently ranked within average placement of the 27 member states of the European Union, with a significant 56% of individuals having a basic knowledge of digital skills, showing that’s, it’s needed to accelerate the upskilling[10] of current workforce to match the upcoming development of artificial intelligence.

In order to match these expectations of promoting and enhancing these skills, the contribution of the PRR (Recovery and Resilience Plan), a nation-wide program funding, set a clear goal “with reforms and investments aimed at propelling the country on the path to recovery and sustained economic growth” (Missão Recuperar Portugal, 2025) after Covid-19 pandemic on overcoming the challenges that enterprises encounter on matters such as digital transition of enterprises, investment in human capital and economic resilience.

3. Theoretical approach

Along this dissertation, specifically in the chapter of literature review, several key takeaways were provided by a range of authors regarding the research on how artificial intelligence could potentially benefit and impact SMEs in terms of the core business , by providing an extensive and detailed analysis over its course.

Nevertheless, it’s needed to say that artificial intelligence also has its own set of disadvantages and limitations that could foster a pushback on the implementation of AI solutions due to the environment and scope of Portuguese SMEs but also due to complexity of implementing. As a consequence, the need of establishing a set of research questions was essential with a clear aim of reinforcing the presented arguments.

The first research question is centred around the two variables, in this particular case, AI as an improvement in decision-making in SMEs and AI as a catalyst for innovation for SMEs. Regarding AI as an improvement in decision-making in SMEs, authors such as Pinto & António (2023) in their study, argue that the examination of perceived attitudes from individuals regarding digital transformation in

[10] The process of enhancing the skills of an individual to meet a demand of an evolving job.

SMEs in Portugal, in this case, the top management follows a certain logic that leverages "historical know-how has greater value, or that little may be required to align the information that they consume with what is transversally available to the company"(Pinto & António, 2023), ultimately concluding that SMEs in Portugal suffer a setback by not using advanced technologies due to an perceived established mindset which renders the potential of adding value instead of depending on historical know-how.

Regarding the second variable, Santos et.al (2023) highlights in her study that Portuguese SMEs are aware and promptly carrying new products based on digital technologies, since for SMEs, "performing in-house R&D is imperative to predict and meet future market needs and strengthen competitiveness"(Santos et.al,2023), due to rapidly changes happening in the market and its current environment , while also stating that it's important for SMEs that the "availability of adequate technology to gather real-time data is a valuable resource as it improves the decision-making processes"(Santos et.al,2023).

According to Almeida (2021), the author argues that Portuguese SMEs with the use of the concept of open innovation successfully benefits the development of the innovative capacity of companies as showed in the study. It also highlighted that the "low level of maturity of the innovation processes in Portuguese SMEs is an inhibiting factor for its implementation"(Almeida,2021), stating as previously mentioned that the digital maturity of Portuguese SMEs is low and clearly affects its performance on the market.

The first research question of this dissertation can be defined as :

Q1: Could the applicability of AI solutions influence the perceived improvement in the quality of decision-making by SMEs?

The second research question is based on the unpredictability of AI and impact on business investment and the impact of legal requirements and risks on the adoption of AI.

As we may know, artificial intelligence has grown rapidly in today's world to a point where society seems accepting the use of AI with open arms. Although AI has its benefits as stated before, it cannot be denied that it has to be regulated for its use as an emerging technology due to ethics concerns , bias or data protection.

The global use of AI has provided the need to regulate its use for international regulations such as the EU AI Act as well for the OECD[11] or by standards, such as the ISO. *The ISO/IEC JTC 1/SC 42* serves as a standardization standard for the use of artificial intelligence and as for OECD, with the creation of

[11] Organisation for Economic Co-operation and Development

OECD Working Party on AI Governance (AIGO), a leading expert group that oversees artificial intelligence policies as well as the implementation of OECD standards worldwide. According to Soudi & Bauters (2024), there is not a significant studies or articles regarding AI ethics and SMEs, meaning that the "SMEs need more attention and more research work is needed to know SMEs' needs"(Soudi & Bauters,2024) in order to properly comply and access a based risk assessment that fully understands their business needs.

Authors as Štrukelj & Dankova (2025) also reinforce stating that "is imperative for leaders to acknowledge that AI should be regarded as a complementary tool, rather than a replacement, for human judgment, particularly in decisions that bear significant ethical implications"(Štrukelj & Dankova,2025).

Therefore , the second research question of this dissertation is defined as the following:

Q2: Can perceived risks associated with AI regulation predict SMEs willingness to adopt AI solutions?

3.1 Research Model

As mentioned earlier, a quantitative approach was adopted for this study through the creation of an online survey, whereby according to Creswell and Creswell (2020), the purpose of a survey is that "provides a quantitative description of trends, attitudes, and opinions of a population, or tests for associations among variables of a population, by studying a sample of that population"(Creswell & Creswell,2020. Kothari (2004) defends that a survey "consists of a number of questions printed or typed in a definite order on a form or set of forms"(Kothari,2004) meaning that the main goal is to gather information with fixed set of questions.

Surveys do not allow the researcher to be an active participant in the data collection process, as the questions asked must meet a certain level of candour, unlike interviews, which are more open in terms of questioning, which ultimately means that the questions asked to participants require direct and unambiguous understanding. Throughout the survey, several questions of different types were asked, such as identification questions (gender, professional experience, level of education, and age group), as well as information questions aimed at gathering information about the respondents' personal facts and opinions, and finally, control questions to verify the accuracy of the information provided.

An advantage of resorting to this type of approach is the possibility to "create new data that are not available from other sources"(Arundel,2023) by creating tailored questions that allows investigators to respond directly to a proposed set of research questions allowing statistical analyses of

the relationships between variables to be carried out. Disadvantages are also present in this type of approach, which in this case, it's necessary to account for bias, as mentioned by Walters (2021), that "bias is present whenever a measured value is systematically different from the true population value" (Walters,2021) ultimately leading to a response bias. Walters (2021) also argues that response bias can be defined as "the result when study participants "responses do not accurately represent their true memories, abilities, beliefs, behaviours, or opinions"(Walters,2021).

Regarding the structure of survey (Annex A), it was considered based on the literature review that was incorporated , and the creation of the survey was in Qualtrics , a based web platform tailored for online surveys, with the respective validation of the supervisor. The survey itself has 3 sections in total, with the first section filled with multiple choice questions regarding social groups (gender, professional experience, level of education, and age group) and section number two starting off with a question that allows to identify participants that had a previous experience with an artificial intelligence solution. The following question was set to allow participants to choose based of their own personal perspective what the main topics that prioritize AI's key domains for amplifying value creation and productivity.

For the rest of section number two and section number three, the presented questions had a primary objective of responding to the proposed research questions mentioned earlier in Table 1, by the application of Likert scales in terms of responses (1-5), where each number present an opposed significance towards each other.

The responses were collected between 21st of May 2025 and 21st of June of 2025, having been collected a total of 114 responses. Afterwards, the collected data was exported in Excel format (.xlsx) and imported in IBM SPSS Statistics 29.0.2.0 for further analysis.

4. Methodology

According to Kothari (2004), a research methodology can be defined "as a science of studying how research is done scientifically" (Kothari,2004). In short summary, a research methodology must be able to show the reasoning behind the methods and techniques utilized, as well as, for the interpretation to be able to correctly expose a given theory.

The literature review was conducted by reviewing a series of key topics that allow for a better understanding about the theme of this thesis, starting from what is artificial intelligence and its advantages and disadvantages as well as concerns, later moving on, to the definition of small and medium sized enterprises , as well as, how SMEs produce sustainable value in order to develop and generate growth and lastly, the challenges that SMEs have to face off in a daily basis. The search for

relevant information in the literature review was done by analysing peer-reviewed research papers or articles as well as relevant books that allowed a transversal overview related to artificial intelligence and a specific overview of Portugal SMEs.

Since the topic of artificial intelligence is gaining relevance nowadays, when searching relevant peer-reviewed papers for this thesis , a pattern was noticed and therefore relevant to be mentioned in correspondence to the publishing year of these papers, as seen below:

- In 2024, a number of 24 publications were published, making this number the largest number of peer-reviewed articles mentioned throughout this thesis.
- Secondly, 16 publications were released in 2023 and in 2021 , 13 publications were also published.
- In 2022 and 2020, respectively, 9 publications were also published.

The vast majority of the peer-reviewed papers that can be found later on bibliography, show a clear pattern of being published in a space of approximately 5 years, taking the present year into account. Ultimately, this pattern shows that the upcoming relevance and more predominance of what artificial intelligence can reach in terms of it's potential, is clearly surging a upcoming breakthrough of relevant studies, including this thesis, but nevertheless, it is necessary to clarify that this pattern is the result of previous groundbreaking studies and research that allowed the development of theme of this thesis, which is artificial intelligence.

To adequately ensure the perspective above, with regard to this thesis, we can identify the methodology used. The present study, as showed above, has two main objectives that are being addressed , as seen in Table 2, and the decision was to take a quantitative approach in order to answer the research questions defined in the previous chapter. In the follow up of the two main research questions (Q1: Impact of AI applicability on SMEs' decision-making quality and Q2: Effect of perceived AI regulation risks on SMEs' adoption willingness) , it was decided to carry out a creation of an online survey to collect data.

While collecting data from a survey, the process of sampling comes to mind since there is a dependence on retrieving data that is relevant to the study in order to correctly investigate. In this case, the use of non-probability by convenience sampling or accidental sampling was used , that according to Carmo and Ferreira (2008, Trad.) "can be selected based on systematically used intentional selection criteria with the purpose of determining the population units that are part of the sample". In the case of this thesis, the intended sample would consist of individuals with higher education, in management positions in SMEs in Portugal, in order to meet the established objectives. It is noted that by using accidental sampling, the collected sample may be affected by factors, since there isn't "ways of

checking to see if this kind of sample is in any way representative of others of its kind, so the results of the study can be applied only to that sample"(Walliman & Baiche , 2001).

In Figure 4.1 as seen below, explains how the present study was conducted. In a brief summary, the first step was to write a literature review of the research problem, while afterwards with the creation of an online survey, the field work was elaborated considering, the proposed research questions and ultimately, leading to a quantitative analysis of the said survey.

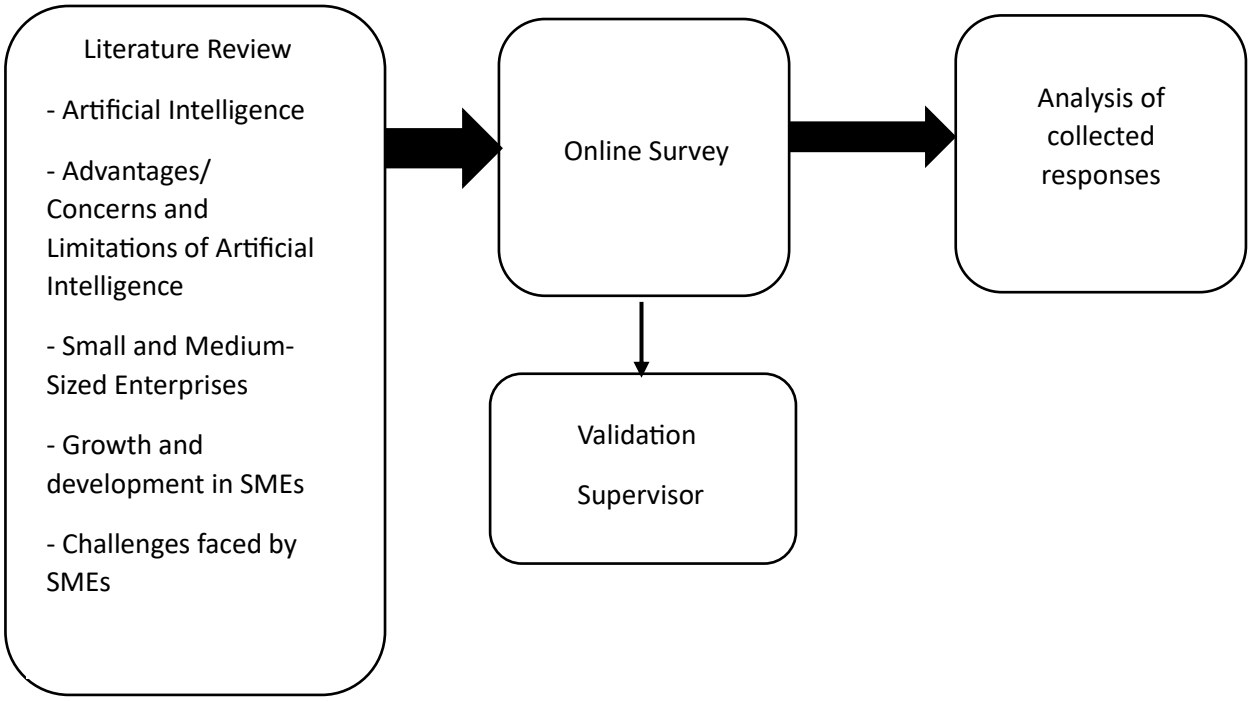

Fig 4.1 – Research Model Source: Author's own elaboration

Table 2 – Relationship between the research questions, literature review, objectives and methodology

Study Objective	**Research Questions**	**Literature Review**	**Methodology**	**Survey Structure**
OBJ1- Assess the extent to which the applicability of artificial	RQ1- Could the applicability of AI solutions influence the perceived	(Morey et al.,2023) (Abraham et.al,2019) (Ferrara,2023)	Quantitative Approach – Online Survey	Section 2 and Section 3 of the survey

intelligence solutions influences the perceived improvement by small and medium-sized enterprises in terms of quality of their decision-making.	improvement in the quality of decision-making by SMEs?	(Dąbrowski,2023) (Ladosz et. al,2022) (Molina,2022) (Russell & Norvig,2020) (Sarker,2021) (Kaplan & Haenlien,2019) (Tan & Kher,2012) (Buchanan,1982)		
OBJ2 - Assess the level on which the risks related to AI regulation can affect the willingness to adopt AI solutions by small and medium-sized enterprises.	RQ2 – Can the perceived risks associated with AI regulation predict SMEs willingness to adopt AI solutions?	(Teece et.al 1997) (Baker,2012) (Hadjimanolis ,1999) (Tushman & Anderson,1986) (Ellstrom et.al,2021)	Quantitative Approach – Online Survey	

Source: Author's elaboration

4.1 Sample Description

The sample present in this study has 114 participants. At first instance, an analysis was conducted to determine the sample in relation to its age group, gender, education level and professional experience with a set goal of understanding the sample in terms of its dimension and origin. After the first analysis, it was concluded that the sample had responses considered not valid (Missing values), since some participants did not finish the entire survey and it was needed to transform these 4 variables from a string to a numeric as data type to adequate these variables to successfully perform further analysis.

In the end, the analysis was conducted as quantitative to the set of responses in order to be able to obtain the relevant information through the data to respond to the proposed research questions.

As seen in Table 3, of a total of 114 participants , 66 participants (77%) had previously experience in an artificial intelligence solution and 18 participants (23%) to the present day, have not been in contact with artificial intelligence solution. Regarding gender, 65 participants (62%) are male and the rest of the participants are 40 female participants (38%).

When it comes to the age group, 31 participants (32%) are between the ages 18 and 25 years old, 27 (28%) participants are considered to be 26 and 35 years old, while 14 participants (15%) are part of the 36-45 age group and finally 24 participants (25%) are between 45-55 years old. In the present study, there wasn't any recorded response that occurred in the over 65 years old age group.

In terms of the education level, 37 participants (36%) completed secondary education, 46 (44%) have a bachelor's degree, 18 (17%) participants have completed a master degree and 3 (3%) participants have another type of education that does not show as a possible option.

Lastly, regarding professional experience, 35 participants (33%) have less than 5 years of experience, 23 participants (22%) have between 5 to 10 years of experience, 9 participants (9%) have among 11 and 15 years of experience and 38 participants (36%) have over 15 years of experience.

Table 3 - Characterisation of the sample's sociodemographic profile

Social Groups		N	%
Age Group	18-25	31	32%
	26-35	27	28%
	36-45	14	15%
	45-55	24	25%
Gender	Male	65	62%
	Female	40	38%
Education Level	Secondary Education	37	36%
	Bachelor's	46	44%
	Masters	18	17%
	Other	3	3%
Professional Experience	Less than 5 years	35	33%

	Between 5 and 10 years	23	22%
	Between 11 and 15 years	9	9%
	Over 15 years	38	36%

Source: Author's Elaboration

5.Results

5.1 Small and Medium-Sized Enterprises in Portugal (SMEs) : Characterization and Indicators

According to the most recent data from the European Union, SMEs in 2023 “played a crucial role in the European Union economy, accounting for 99.8% of all enterprises in the non-financial business sector. With 25.8 million SMEs employing 88.7 million people, they contributed significantly to the EU-27 employment and value added. Micro enterprises were the most prevalent, accounting for 94% of SMEs in 2023”(European Commission[EC],2024) and of course is not an exception when the importance of SMEs is crucial for a country such as Portugal.

According to INE (2024) , 96,3% of enterprises in Portugal were composed with less than 10 people employed, meaning that the economic and business fabric of the country is severely dependent on SMEs to help and guide the development of the country.

Most recent data from INE (2024) still shows a clear pattern of this increased dependency on SME’s , with a clear view in how regions such as Centro or Oeste Vale do Tejo still to his day depend heavily on micro-enterprises (Less than 10 persons employed) to boost the local economy accounting for 96,3% and 96,1% respectively for both regions that the disparity between the presented data is not normal when compared to other European countries, especially when talked about terms such as productivity and value-added.

Geographic localization (NUTS - 2024)	Enterprises (No.) by Geographic localization (NUTS - 2024) and Employment size class; Annual Data reference period 2023 Employment size class				
	Total	Less than 10 persons	10 - 49 persons	50 - 249 persons	250 and more persons
	No.	No.	No.	No.	No.
Portugal	1 510 274	1 454 022	47 483	7 552	1 217
Continente	1 445 184	1 391 355	45 374	7 279	1 176
Norte	502 112	481 174	17 736	2 853	349
Centro	220 083	212 106	6 807	1 031	139
Oeste e Vale do Tejo	105 574	101 477	3 521	521	55
Grande Lisboa	357 760	344 767	10 413	2 049	531
Península de Setúbal	99 962	97 267	2 362	287	46
Alentejo	65 855	63 690	1 877	256	32
Algarve	93 838	90 874	2 658	282	24
Região Autónoma dos Açores	31 396	30 258	1 010	112	16
Região Autónoma dos Açores	31 396	30 258	1 010	112	16
Região Autónoma da Madeira	33 694	32 409	1 099	161	25
Região Autónoma da Madeira	33 694	32 409	1 099	161	25

Fig 5.1– Number of Enterprises by Geographic Location and Dimension in Portugal
Source: INE (2024)

Between 2022 and 2023, the number of SMEs in Portugal grew by 2,1% and the number of individuals employed also grew by 2.0% increasing the value added to the economy by 11% (EC,2023). The number of SMEs in Portugal when compared to other European countries, is quite remarkable when the growing margin of new companies being born is quite high as showed in Figure 5.2 with Portugal being 4th in the number of SMEs per capita in Europe, but it does not translate into a significant advantage for SMEs in Portugal.

Sectors such as tourism have skyrocketed in recent years adding up in nominal value in 2023 at 13,7% and 23.2% respectively in 2022, making up for a significant and important advantage for continuous development of SMEs in Portugal (EC,2023).

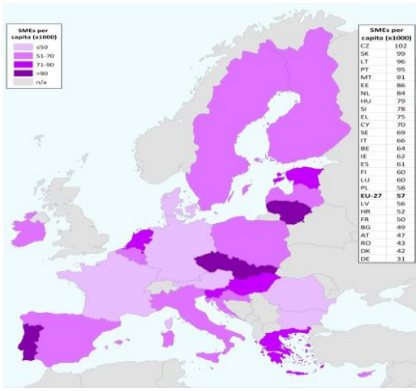

Fig 5.2– Number of SMEs by Member State on per capita Basis in 2023 - Source: EU (2023)

According to OECD Economy Survey (2023), the existence of productivity gap between Portugal and OECD countries as shown below, is deeply connected with resource allocation, in particular “with inefficient allocation of jobs to less productive businesses in both the manufacturing and services sectors”(OECD,2023).

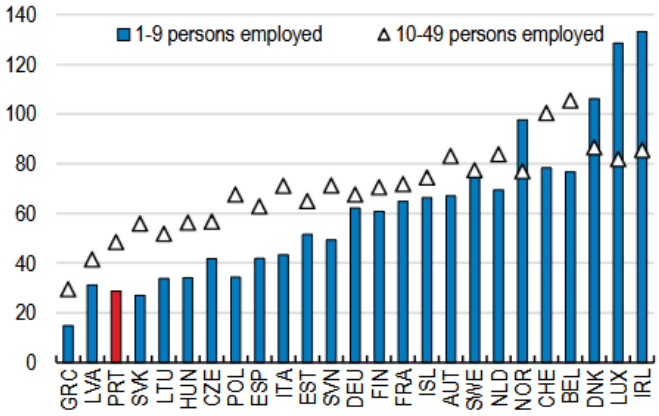

Fig. 5.3 – Value-Added by Country for SMEs in 2020

Source: (OECD,2023)

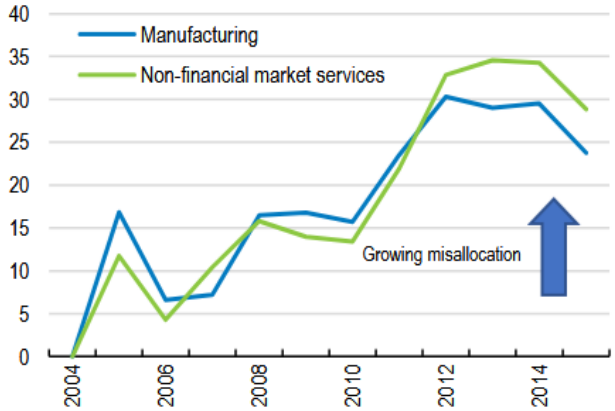

Fig.5.4 – Efficiency of resource allocation in Portugal (2004-2014)

Source: (OECD,2023)

Without a substantial productivity gain, growth cannot be achievable and even sustainable for enterprises in Portugal in the near future, where resource allocation plays an important factor for SMEs. Resource allocation is an integral part of BPM, or in other words, business process management where it can be defined as “in essence, a management idea. Organizations perform better when they pay explicit attention to their business processes from start to end than when they do not”(Reijers,2021).

Nowadays, small and medium-sized enterprises are fully aware of the importance of business process management since it provides knowledge about their business processes and workflows that directly shape their competitive performance that in order to be successful , companies must take in consideration the critical factors such as strategic alignment, project and change management,

governance, performance management, methods, IT, people and culture and communication (Gabryelczyk & Roztocki,2018).

In the present day, SMEs are not competing with other organizations in terms of their services or products but how they perform where the business processes are referred as important and superior since they “provide a decisive, sustainable, competitive advantage”(DeToro & McCabe,1997).

For some authors such as Dias et. al (2016), the inefficiency of resource allocation for SMEs in Portugal can be explained by two important factors, methodological choices made by business owners and by the sectoral structure whose responsibility is to capture the “impact on misallocation of size dependent distortions, and is proxied by the skewness of the productivity distribution”(Dias et al.,2016).

5.2 Discussion of Results

Regarding the analysis and subsequent interpretation of the results of two main objectives of the study, before jumping into the said analysis, it’s important to address the model consistency, in this case, the reliability and internal consistency.

Authors such as Tavakol & Dennick (2011) argue that internal consistency can be defined as “the extent to which all the items in a test measure the same concept or construct and hence it is connected to the inter-relatedness of the items within the test” and reliability can be determined as a part of a “the amount of measurement error in a test” (Tavakol & Dennick, 2011). The reliability of a test ensures the results derivability as constant , when used in similar situations, where internal consistency is meant as an indication that the measurement ideally identifies what is meant to be measured.

In this case, the Cronbach’s alpha (α) is used to evaluate the internal consistency of a test which in this case ,was used to determine the consistency of the model.

Table 4 – Reliability Analysis

Number of Cases		%	Cronbach's Alpha	Nº of items
Valid Cases	82	71,9%	0,712	8
Excluded Cases	32	28,1%		
Total	114	100%		

Source: Author's Elaboration

As seen in the table above, of the total of 114 observations, 82 cases (71,9%) remained for analysis and 32 cases (28,1%) were excluded , while the Cronbach alpha reported a value of 0,712, meaning

that it complies with the corresponding threshold (α ≥ 0.70 – acceptable) , indicating that the items fit together reasonably well.

In order to get an acceptable value of Cronbach alpha, it was necessary to review the item-total statistics and inter-item correlations table at first instance, to check what items are causing a drop on the overall alpha, meaning that some items present in this study do not fit together well, leading to a necessary readjustment of the items.

5.3 Measures of association

For the proposed research questions , it was decided before carrying out the rest of tests, that are present afterwards, that was necessary to see the weight and strength of the relationship between the research variables.

According to Schober (2018) , the Spearman's Rho coefficient "quantifies strictly monotonic relationships between 2 variables"(Schober,2018), or in other words, can be described as a quantification on how strong two variables are related in a relation to their ordering , meaning that for this study, in order to explore the measures of association, since the presented variables are ordinal variables , it was decided to use the Spearman's Rho as reference.

Regarding the first research question ("Could the applicability of AI solutions influence the perceived improvement in the quality of decision-making by SMEs?") and the second research question ("Can the perceived risks associated with AI regulation predict SMEs willingness to adopt AI solutions?") , Table 4 illustrates the following results.

Table 5 – Measure of association

Spearman's Rho	Sig. (2-Tailed)	Correlation Coefficient
RQ1 : Could the applicability of AI solutions influence the perceived improvement in the quality of decision-making by SMEs?	<,001	0,516
RQ2: Can the perceived risks associated with AI regulation predict SMEs willingness to adopt AI solutions?	<,001	0,390

Source: Author's Elaboration

Regarding RQ1, the spearman rho rank correlation (ρ() = .516, p < .001) states a moderate, positive association between AI as an improvement in decision-making in SMEs and AI as a catalyst for

innovation in SMEs, leading to a result that SMEs that tend to rate AI in high standards for helping decision making also tend to see it as boosting innovation forward.

A statistical significance ($p < .001$), with p-value being the reason behind measuring compatibility between the data and the null hypothesis, allows to reinforce the idea that the result is not given by pure chance, but due to the fact that there is a significant link between these variables.

As for RQ2 , the spearman rho rank correlation ($\rho() = .390$, $p < .0001$) indicates also a moderate and positive association between the unpredictability of AI and its impact on business investment and the impact of legal requirements and risks on the adoption of AI by SMEs, meaning that , the general perception of AI unpredictability with legal and risks concerns tends to accompany among each other.

To reinforce this perception, a statistical significance ($p < .001$) shows that, this result is proven to be significant between the two variables, meaning there is strong evidence that the participants who view AI as being unpredictable also report back on its legal concerns and risks within SMEs and vice-versa.

Seeing these results between the tested variables , shows a clear indication that these variables share some association in terms of the presented values of correlation . To help uncover the moderate correlation between these variables , the next step was to apply through a classification model, in this case, a decision tree that enables the identification of the hierarchical and non-linear relationships among the predictors.

By firstly assessing the Spearman rho (ρ) to quantify the strength of two variables to find out their respective values and then fitting into a decision tree, this approach allows to identify the strongest predictor at each split, as well as, visualizing the combinations across nodes.

The general idea behind this approach is that allows the transformation of statistical based relationships into reliable insights regarding our theme by providing accuracy and how variables complement each other in the model.

Authors such as Gunduz & Lutfi (2021), Ramyasree & Kumar (2022), have studies regarding the usage of this two-step approach in order to enrich and foster deliverable results.

In the case of Gunduz & Lutfi (2021), the usage of this approach, according to the authors, “contributes to the current body of knowledge by identifying the factors that have the biggest effect on an owner’s decision and introducing Exhaustive CHAID and QUEST decision-tree models for go/no-go decisions for the first time, to the best of the authors’ knowledge”(Gunduz & Lutfi,2021), while in similar situation, Ramyasree & Kumar (2022) adopted this approach to be a “correlation-based

dependency assessment of one component on another" to further allow the development of a better "automatic emotion detection mechanism based on speech signals" (Ramyasree & Kumar,2022).

5.4 Decision Trees (Classification Model)

After checking the strength of each predictor present in both research questions by computing the Spearman's Rho as a measure of association and checking the descriptives statistics for each variable in order to gain a comprehensive check about them, the next step, in order to be able to respond the proposed research questions, was to run a Decision Tree model to gain valuable insights for each interaction.

A classification model can be defined , according to Jena & Dehuri (2020) as a "two-step process in which the first one constructs the classifier by examining vividly the training set containing the attributes and their associated class labels"(Jena & Dehuri,2020), where the second step is when a chosen classifier is measured to be used in the select data.

The reasons why a decision tree in this case, is considered to be a good fit is due to its performance when handling data that is categorical or even discrete, which it's the case, but also due to comprehensibility when visualizing the results, promptly giving simple interpretational decision rules based off the variables used. For this case , the chosen algorithm was CHAID, or chi-squared automatic interaction detection that according to Jena & Dehuri (2020), a CHAID algorithm is used because it applies the chi-square test "for finding the best split for each independent variable" (Jena & Dehuri,2020).

The goal when using an ordinal classification with decision trees, according to Kotsiantis (2013) is to "aim at producing an ordering which is most consistent with the implicit ordering in the input data" (Kotsiantis,2013).

5.4.1 RQ1 – Decision Tree

Regarding RQ1, the first step is to assess the model reliability and prediction accuracy before moving on to the actual decision tree. As seen in Table 5 right below, the estimate of misclassification stands at 0,419 (41.9%) and the standard error presents a value of 0,0053 (5.3%), whereas the 41,9% represents on how the CHAID Tree labels incorrectly the cases and 5,3% reflects a reasonable stability.

The prediction accuracy of the classification table stands on an overall accuracy of 58,1%.

Table 6 - Model Reliability – RQ1

Risk	
Estimate	**Std.Error**
0,419	0,053

Source: Author elaboration

The decision tree of RQ1 is composed of one root and 3 nodes, where the split significance has an adjusted p-value = 0.000 and Chi-square of 25.903, df=2. The root interpretation (n=86) is that most respondents of the survey lean positive , with 50,0% partially agreeing and 22,0% completing agreeing that AI as an innovation catalyst will influence AI ability to improve decision-making in SMEs.

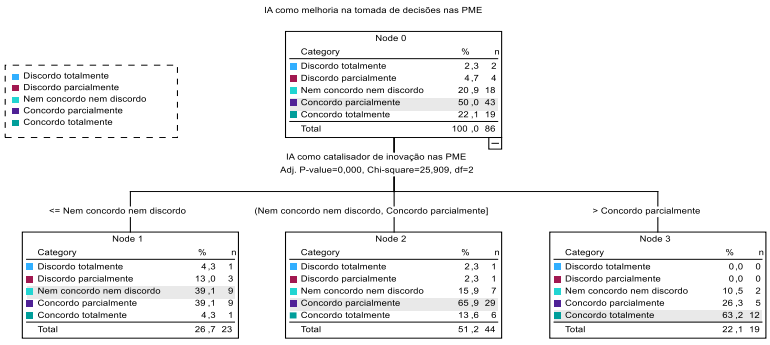

Fig 5.5 – Decision Tree – RQ1

Source: Author elaboration

The 3 nodes can be interpreted as following to be later on profiled based on the results:

- ✓ Node 1 (Neutral stance regarding innovation influence on AI decision making: (n=23, 26,7%), with 4,3% of respondents strongly disagreeing and 13,0% partial agreeing. The highest value comes from two categories, neutral respondents with 39,1%, while also 39,1% partial agreeing and lastly 4,3% of respondents totally agreeing on how innovation can influence AI decision making). The profile in this node represents the participants willingness to no acknowledge AI driven innovation but, in some regard, recognize AI value in the present.

- ✓ Node 2 (Neutral/Partial stance regarding the influence on AI decision making): (n=44, 51,2%), with 2,3% of respondents strongly disagreeing and another 2,3% partially disagreeing while 15,9% remain neutral. 65,9% of respondents partially agree that AI as catalyst for innovation will influence its decision making while only 13,6% totally agree. This node did not have any participants responding negatively , on which, the profile of the participants presents in this

node represents caution regarding AI-driven innovation due to their stance on decision-making capabilities.

- ✓ Node 3 (Total agreement on how innovation will improve AI decision-making): (n=19,22,1%) , with 10,5% remaining neutral. In opposition to the previous results, 26,3% of participants partial agree and 63,2% fully agree that AI drives innovation and as result, exceeds confidence on AI decision making capabilities).

5.4.2 RQ2 – Decision Tree

About RQ2, the model reliability and prediction can be seen in Table 6 right below, where the estimate of misclassification stands at 0,488 (48.8%) and the standard error corresponds to a value of 0,0055 (5.5%), whereas the 48,8% represents on how the CHAID Tree labels wrongly the cases and 5,5% reflects a reasonable stability.

The prediction accuracy of the classification table stands on an overall accuracy of 51,2%.

Table 7 - Model Reliability – RQ2

Risk	
Estimate	**Std.Error**
0,488	0,055

Source: Author elaboration

The decision tree of RQ2 is composed of one root and 3 nodes, where the split significance has an adjusted p-value= 0.009 and Chi-square of 12.991, df=2. The root interpretation (n=82) is that most respondents of the survey remain slightly positive, with 20,7 % stand neutral and 47,6% partially agreeing that perception of legal and risks concerns affects business investment towards AI.

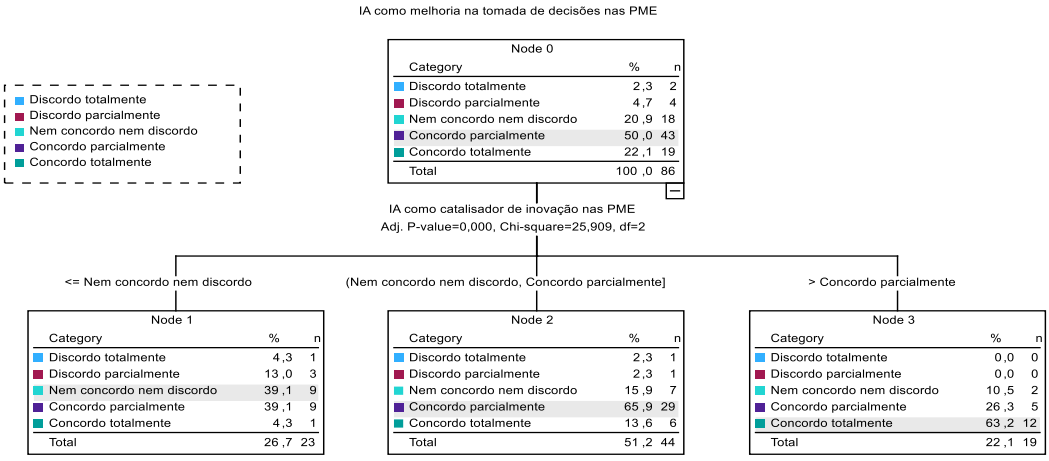

Fig 5.6 – Decision Tree - RQ2

Source: Author elaboration

The interpretation of 3 nodes can be assessed as follow :

- ✓ Node 1 (Neutral stance regarding the perceived legal and risks concerns towards business investment on AI: (n=23, 28%), with 4,3% of respondents strongly disagreeing and 26,1% partial agreeing. The highest value comes from neutral respondents with 39,1%, while 26,1% partial agreeing and lastly 4,3% of respondents totally agreeing on how legal and risks concerns can influence business investment in AI. Participants in this node share a low-risk concern regarding business investment on AI.

- ✓ Node 2 (Neutral/Partial stance regarding the influence of legal and risks concerns): (n=42, 51,2%), with 19,0% of respondents partially disagreeing and 16,7% remain neutral. 59,5% of respondents partially agree that legal and risks concerns will influence the investment towards AI while only 4,8% totally agree. This node did not have any participants responding negatively , on which, the profile of the participants in this node represents a careful stance regarding legal and risks factors ,while being neutral in terms of concern.

- ✓ Node 3 (Total agreement on how legal and risks concerns will shape business investment towards AI): (n=17,20,7%) , with 11,8% disagreeing partially while 5,9% remain neutral. In opposition to the previous results, 47,1% of participants partial agree and 35,3% fully agree that legal and risk concerns will affect directly investment made by SMEs on AI.

6. Conclusion

6.1 – Final considerations

A number of several studies have concluded that the implementation of artificial intelligence, constitutes a generational impact on how companies can produce and deliver value as seen and concluded by Jorzik et. al (2024). As reported by Loureiro et.al (2021) and companies such the Boston Consulting Group through the report regarding AI at Work (2025), the potential of artificial intelligence to organizations cannot be denied in ways that could transform the current business environment and change the global economy.

As reported by Kudryavtsev et.al (2025), ” SMEs are in need of supportive tools that can help assess and strengthen their ability to successfully implement AI” (Kudryavtsev et.al,2025), that in correlation, with the present study regarding the growth and development of organizations by the use of AI and the analysis of the survey with 114 answers , it was possible to reach to different conclusions.

Upon completion of the literature review, it was possible to proceed with the definition of research questions with the variables that could determine and deliver an answer to them as well as, being present in the definitions provided by different authors in the literature review chapter. The first research question was set out to understand if the innovation and therefore the application of AI solutions would determine a significant development in terms of decision-making for SMEs and the second research question was defined regarding whether the effect of legal and risk concerns related to AI would interfere with adoption by SMEs.

Regarding the first research question, as quoted by Halim et.al (2024), a SME performance is “connected to the effectiveness and efficiency of business” (Halim et. al,2024) , since SMEs are known to have a limited set of resources to allocate where decision-making takes a central role. According to Cooper (2025), the possible benefits of using AI solutions are difficult to forecast, since the current outcome is considered to be non-existent due to the fact that the retrievable benefits of using AI all occur based off on expert’s opinion and not any proven evidence.

Based off the results of survey and after analysis of the data, it’s possible to conclude that most participants of the survey show a neutral or even partial agreement that AI can fuel innovation towards the creation of better decisions made by SMEs. However, since there is neutral stance regarding this issue, it must also be noted that this group of participants show a certain type of caution that can be explained by Oldemeyer et.al (2025) that based on his investigation, regarding the main implementation challenges of AI in SMEs, one challenge can be considered to be the most important, which in this case, is the ROI. Oldemeyer et.al (2025) defended that SMEs have several difficulties “of

assessing whether an investment in AI may have a good ROI" (Oldemeyer et.al ,2025) since ROI is considered to be a crucial aspect for SMEs as mentioned previously.

Concerning the second research question of knowing if the effect of legal and risk concerns related to AI would interfere with adoption by SMEs , according to Carayannis et. al (2025), nowadays SMEs must be resilient to be able to endure technological shifts, market volatility and so on, since they are more vulnerable when compared with other types of companies.

According to the results of the survey and afterwards the analysis of the data, indeed it's possible to reach a conclusion that most participants showed also a neutral/partial stance regarding the influence of legal and risks concerns towards the investment in AI, considering to that it is too early to predict the effects of these concerns. To be able to control this influence more effectively , it is needed according to Sotamaa et.al (2024), that SMEs foster a culture of being risk-aware by leveraging various digital technologies and AI as well as having external expertise to be able to add value to an effective risk management. Han et.al (2023) also concluded that SMEs must allocate resources to able to identify, control and monitor risks as well as, governments research and the creation of relevant policies are crucial to create a safe and ethical AI for SMEs as mentioned beforehand in the literature review chapter.

Lastly, the final proposed objective of this thesis regarding on how artificial intelligence can be considered a driver for development and growth for small and medium enterprises in Portugal, based on the obtained results on the survey and literature review, it is possible to conclude that artificial intelligence, although still in the early stages of AI ecosystem, will have an decisive impact on SMEs in Portugal in the near future**.**

How can small and medium-sized enterprises take advantage of artificial intelligence will depend of course on several factors, such as their presence in certain markers or sectors, the availability to invest not only in infrastructure but also in a qualified workforce, as well as oblige to certain legal obligations and monitoring risk, but it is certain that SMEs in Portugal can capitalise on the investment of AI.

The enchantment of operational efficiency for SMEs as retracted in the literature review, can be considered as a crucial aspect that AI can leverage for better by automating repetitive tasks, optimizing the supply chain and the inventory but also monitoring and optimizing resources in operations. The last point is particularly relevant, since Portuguese SMEs according to Dias et. al (2016), have a significant problem in terms of resource allocation leading to inefficiency, that unfortunately damages the performance output of Portuguese SMEs in how they operate. AI can also leverage the monitoring of infrastructure and it´s maintenance as well as upgrading, with a focal point in the usage of machine

learning algorithms, such as supervised learning to correctly learn and predict a determined outcome based on currently known results.

Ultimately, AI as driver for development and growth will be considered as a crucial enabler to foster new forms of working for SMEs as well as, making a substantial contribution to the way that SMEs connect and embrace new challenges and opportunities in the future.

6.2 – Future contributions to business management and Academia

The topic of AI , for many, is considered to be a transformative power that could have everlasting effects in today's society, including in all types of industries and companies that are aware of this trend in order to seize the best possible outcomes. The present study aims at contributing to the discussion in business management related to the use of AI as enabler for growth and development in organizations, with a focus on small and medium enterprises.

For this contribution , the study aimed at capturing the different subfields within artificial intelligence as well as the advantages, disadvantages, concerns and limitations. In addition, the study also captured what are small and medium sized enterprises related to their scope and environment as well the main substantial factors behind growth and development, as for the constraints faced by Portuguese SMEs. The theme of AI is relatively new, with few studies exploring this thematic, leading to an argument that the present study hopes to contribute for the future literature review by analysing the impacts on which AI might have on small and medium-sized enterprises in Portugal.

Lastly, future research is essential and needed to properly assess this research topic, in a way that knowledge can be reinforced along time to further understand all implications that AI could potentially bring in the future.

Regarding the contribution for future research papers and articles, it is absolutely critical that future research must evaluate the impact of AI by developing for example, maturity models that are able to validate and assess SMEs through their proficiency towards AI implementation and also examine how Portuguese SMEs conduct and manage their accountability towards privacy and bias, as shown earlier. The evaluation of national wide programs such as AI Portugal 2030 created by national government[12] with the PRR is also considered to further evaluate its impact since both on these programs contain initiatives regarding artificial intelligence and SMEs that could very well , shape the current environment and foster new developments towards the topic on this thesis.

[12] XXIII (23rd) Portuguese National Government

6.3 – Study Limitations

When conducting this study, the first limitation observed is due to the sample size that is being considered. It's necessary to have caution regarding the generalisation of the results concluded within the survey, although the present study confirmed the existence of the literature review of the topic.

The second limitation is regarding the nature of the present study , that it cannot be represented or generalized, mainly due to the fact of the small sample size and being an exploratory study.

6.4 – Suggestions for future research

My first suggestion around future research for the present topic, since the present study has a scope around AI and SMEs in Portugal, it would be good to see when applied to a specific sector or market , if the results would differ or not between the selected sector or markets.

The second and final suggestion was identified as one of the limitations of AI in the literature review as being the concept around bias and privacy. Both concepts, nowadays, are being discussed in great importance due to the fact the AI may produce end results that are biased in cases such as large language models and the topic of data privacy is a key figure in how organisations can not only protect consumers but also use them for their advantage in terms of business practices.

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Annex

Annex A – Structure of the Survey

1. Age Group
   - 18-25
   - 26-35
   - 36-45
   - 45-55
   - Over 56

2. Gender

   - Masculine
   - Feminine
   - Other

3. Training Level

   - Secondary education
   - Bachelor Degree
   - Master Degree
   - PhD
   - Other

4. Professional Experience

   - Less than 5 years
   - Between 5 and 10 years
   - Between 11 and 15 years old
   - More than 15 years

5. Since you started your professional or academic life, have you ever had any kind of contact with an Artificial Intelligence solution? Answer Yes or No.

   - Yes
   - No

6. SMEs are predominant both in Portugal and in Europe with a consolidated presence in the economy, but when compared to other EU countries, Portugal has poor results in terms of productivity and value that is created by companies. Rank the following topics from 1 to 5, with 1

representing greater importance and 5 meaning less importance of how AI can be a turning point in terms of creating more value and increasing productivity.

i. Automation of repetitive tasks
ii. Analyzing large volumes of data
iii. Improved supply chain efficiency
iv. Product Development
v. Human Resource Management

7. Can the use of Artificial Intelligence in a cost-benefit ratio improve the quality of an SME's decision-making?

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree

8. In recent years, Artificial Intelligence has seen a notorious growth in terms of commercialization that is considerable as remarkable. Could the uncertainty that the current AI landscape brings to the business world that a future evolution will be marked by this unpredictability throughout its course, make companies more open or afraid to invest in Artificial Intelligence?

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree

9. It cannot be denied that adopting a new AI solution brings significant weight in terms of funding, infrastructure and having the respective knowledge to maintain these AI-based solutions. Should there be public investment by the Government to ensure the development of infrastructure as well as for the workforce to match the potential impact of Artificial Intelligence?

- Strongly disagree
- Disagree

- Neither disagree nor agree
- Agree
- Strongly agree

10. Artificial Intelligence, nowadays, is considered an innovative technology with an effect similar to the 1st Industrial Revolution, but some experts argue that the best is yet to come. Should companies look for AI solutions immediately or do the solutions that are available, still lack in terms of real applicability for solving problems?

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree

11. In order to remain competitive in the market, SMEs are required to have the need to be innovative in order to address barriers to entry and market problems. Can AI, through its various techniques such as machine learning or LLMs (large language models such as ChatGPT), be the catalyst for change in terms of the future approach to innovation for SMEs?

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree

12. One of the major concerns around the topic of artificial intelligence is related to data privacy and security. According to a scale of 1 to 5, with 1 meaning that you strongly disagree and 5 that you totally agree, do SMEs have a duty to assume this responsibility to control and ensure the correct storage of data?

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree

13. The evolution of risks associated with AI supports the idea that the use of solutions using artificial intelligence must comply with regulatory requirements, such as *the EU AI Act and ISO Standards*, as well as laws at national and international level. Can these risks associated with the use of AI solutions, as well as compliance with various requirements, condition their use by SMEs?

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree

14. A term known to be important to SMEs is efficiency with regard to it's core operations. Can AI help improve efficiency in SMEs when it is considered relevant to their normal functioning?

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree