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Enhancing Efficiency and Competitiveness: an empirical study on AI perception in the Italian Wood-Furniture Industry

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Sommario

INTRODUCTION

Artificial intelligence is like a developed human brain and using this power in the most effective way has played a role in changing societies. It enables intelligent behavior in artificial systems, i.e., it is the study of how to make computers do tasks that humans currently do better; such behavior involves skills such as reasoning, learning, communication, and action in complex environments.

It is incontestable that in this historical phase, the world of work is facing a major technological acceleration, which is called 'Industry 4.0'; this transformation involves the timely introduction of new technologies into production processes and services. The evolutionary scenario represents an opportunity for Italian companies to facilitate the process of internalization and at the same time to exploit new work technologies to offer better customer service. However, with the advent of new technologies, particular doubts have arisen, especially within companies. Although the use of artificial intelligence offers a wide range of benefits in terms of production, logistics, marketing strategies, and so on, issues such as human-machine substitution, data privacy, or the large investments that AI requires, still reside in people's minds.

The first chapter of this research aims to explore the vast world of artificial intelligence, starting from its inception and explaining its evolution over time. It also aims to examine the multiple applications of artificial intelligence in different fields, to grasp the numerous benefits and potential risks of its use. Even though the benefits of the digital innovation process are within everyone's reach, there are an increasing number of obstacles, mainly of a cultural nature, that limit the Italian industrial sector from implementing innovative systems in its processes. The emergence of new technologies has produced upheavals in the way work is organized, and consequently in economic, cultural, and social structures. These changes have taken place at a time and speed that is not in keeping with the transformational capacity of societies in the various eras, producing collective and individual discomfort. Although there are several research on the use of artificial intelligence in the world of societies and work, there do not seem to be enough studies on companies in the Italian wood-furniture sector.

Consequently, as companies in the Italian wood-furniture sector are fundamental to the

Italian landscape, being part of one of its leading sectors, it is very important to examine their views on artificial intelligence and its use.

In particular, the focus was on the now-pronounced gap between the Southern and Northern regions of Italy. In the area of AI, opinions are contrasting: some argue that this gap is still there, while others maintain that there is no clear gap in the use of new technologies. To understand whether this gap is present among companies and how they perceive artificial intelligence, a semi-structured questionnaire was developed and administered to a sample of six companies in the wood-furniture sector: three from Southern regions and three from Northern regions. The aim of this study, therefore, is to provide a complete overview of the perceptions of Italian companies in the sector in the various Italian territories on the use of artificial intelligence, as well as on the benefits and risks deriving from it, thus investigating the level of information within the Southern and Northern regions.

The third chapter concerns the analysis of this study. The Gioia method was used to examine the transcripts of the interviews, which made it possible to process the structure of the data; based on this, a Grounded Theory model was then developed to discuss the dynamic connections between the themes that emerged during the interviews.

In addition, based on the results obtained, several practical and effective recommendations were provided that companies could adopt in order to improve their digitization process. Finally, the limitations of this study were analyzed, with the aim of helping future research in the same field.

Chapter 1 – Introduction to Artificial Intelligence

1.1. The Evolution of Artificial Intelligence

Although it is thought that artificial intelligence is a recent phenomenon, history shows us that this is not the case. The evolution in the power of computers, the availability of the enormous amount of data and the creation of new algorithms have allowed the technology to evolve quite a bit over the years.

Different types of artificial intelligence have existed for more than 50 years; this is evidenced by the fact that the first of many steps toward this phenomenon was taken by Aristotle, when he began to codify certain styles of deductive reasoning that he called *syllogisms*. Think also of Leibniz, who intended to realize the system called *Calculus philosophicus* or *ratiocinator,* a universal algebra by which all knowledge could one day be brought back within a single deductive system; or again of Boole, who developed the foundations of propositional logic, with the aim of gathering probable clues concerning the nature and constitution of the human mind.

Later, 20th-century logicians, such as Alan Turing, clearly and formally specified the potentials and limitations of logical and computational systems. In particular, Turing is credited with the creation of the test named after him, the Turing Test, contained in *Computing Machinery and Intelligence (1950)*, used as a criterion in order to determine whether a machine is capable of thinking.

However, the term "Artificial Intelligence" is due to Joseph McCarthy; he recommended the term as part of a proposal to create a working group to meet in 1956 at Dartmouth College. He also created the LISP language (List Processor Language), specifically for making intelligent reasoning with symbolic manipulation.

It is also important to remember in the history of AI the intervention of Rosenblatt who, in 1962, studied the use of networks, called "perceptrons" and consisting of neuron-like elements, for learning and shape recognition; however, due to the limitations of the neural network used, the perceptron was not as successful as hoped.

Between the 1970s-80s, various types of problem representations, solution-finding techniques, and heuristics were studied and employed in programs capable of solving simple puzzles, playing games, and acquiring information. More and more capable programs were created, including knowledge rooted to achieve the performance of

human experts during various tasks, such as diagnosis, design, and analysis.
The first expert system born with this purpose was called “Dendral”, which can provide the structure of a molecule from its spectral analysis.
In the same period, neural networks were developed, with machine learning as their key feature. Due to their potential, they attracted the interest of industries and were quickly integrated into processes up to the present day. In recent years, AI has been accelerating development, and progress is increasingly important, thanks to the fundamental contributions made by the large databases that are becoming available.

The chronology can be summarized with these seasonal cycles (*Roberto Marmo, 2020*):

- 1940-74: birth and golden years.
- 1974-80: first winter, due to disappointments on the perceptron.
- 1980-87: second spring, due to the development of expert systems.
- 1987-1993: second winter, only specific results, neural networks not suitable for complex problems.
- 1993-2019: third spring, due to 4 factors: hardware offers high computing performance, availability of large amounts of data, the possibility of using increasingly sophisticated algorithms, and increase in the amount of interested people exchanging experience and knowledge.

1.1.1. Artificial Intelligence: theoretical foundations

Human beings developed intelligence in order to have the ability to adapt to their surroundings, in which to survive and reproduce. Literally, intelligence is the "*complex of mental and practical faculties that enable humans to reason, understand reality, and cope with novel situations*"; in summary, it can be said that intelligence represents not only the ability to produce adaptive and functional behavior to achieve a purpose but also the ability to think and understand as an alternative to doing things by following instinct.
Artificial intelligence is like a developed human brain, and the use of this power in the most effective way has played a role in changing societies. It enables intelligent

behavior in artificial systems, that is, it is the study of how to make computers do activities that humans currently do best; such behavior involves capabilities such as reasoning, learning, communication, and action in complex environments. Therefore, it is nothing more than the ability of machines to process huge amounts of information and use it to make autonomous decisions, as well as a set of technologies that, when applied, enable human beings to increase their capabilities. It does not create an artificial life as commonly believed, but an intelligent machine.

In addition, AI studies the theoretical foundations, methodologies, and techniques that enable the design of hardware systems and software programs capable of providing the electronic processor with performance that, to a common observer, would seem to be the exclusive domain of human intelligence (*Marco Somalvico, 1992*). Marvin Minsky, one of the founders of AI, believes that it is represented by a huge number of people trying to make smarter machines and formulate theories about how the human mind works, employing computers for experimentation.

There are different definitions of Artificial Intelligence; in *Table 1* below, several definitions have been reported, arranged along two dimensions: those at the top relate to thinking and reasoning processes, while those at the bottom relate to behavior; those on the left measure success in terms of fidelity to human performance, while those on the right measure rationality.

Table 1 – Some definitions of AI in two dimensions and four categories

Thinking Humanly	**Thinking Rationally**
▪ "The exciting new effort to make computers thinks… machines with minds, in the full and literal sense." (Haugeland, 1985) ▪ "The automation of activities that we associate with human thinking, activities such as decision-making, problem-solving, learning…" (Bellman, 1978) ▪	▪ "The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) ▪ "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
▪ "The art of creating machines that perform functions that	▪ "Computational intelligence is the study of the design of

require intelligence when performed by people." (Kurzweil, 1990) ▪ "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	intelligent agents." (Poole et al., 1998) ▪ "AI… is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Source: "Artificial Intelligence: a modern approach", Stuart Russell and Peter Norvig, 1995.

Looking at the comparison with humans, artificial intelligence should rationally perform the following actions:

- *Act humanly*, indistinguishably from a human being.
- *Think humanly*, solving problems through human-like cognitive functions.
- *Thinking rationally*, resorting to logic.
- *Acting rationally*, through a process that enables AI to achieve the best expected outcome based on the information at hand.

To do this, an AI system must be equipped with:

- *Comprehension*: systems that simulate cognitive abilities to correlate data and events to recognize text, images, tables, etc., from which to extract information.
- *Reasoning*: systems that exploit logic to simultaneously consider multiple pieces of information collected, using precise algorithms.
- *Learning*: machine learning systems that define how to process data inputs and how to return them, capable of learning from human-provided examples and improving performance with continuous learning.
- *Human-machine interaction*: systems to interact through human perception modes.

Based on these considerations, scholars have hypothesized two different approaches to AI:

- *Weak AI*: it concerns systems that can simulate some human cognitive functionality without, however, achieving typical human intellectual

capabilities. These are programs that can replicate some human logical reasoning to solve problems and make decisions. Therefore, human supervision and presence remain essential for the operation of these machines.

- *Strong AI*: it concerns systems capable of becoming sapient and self-aware, even without having human-like thinking processes and reasoning. Its goal is to make the machine as similar as possible to a human mind; it is based on expert systems, i.e., programs that exploit inferential mechanisms to solve complex problems, achieving the performance of people who are experts in specific domains.

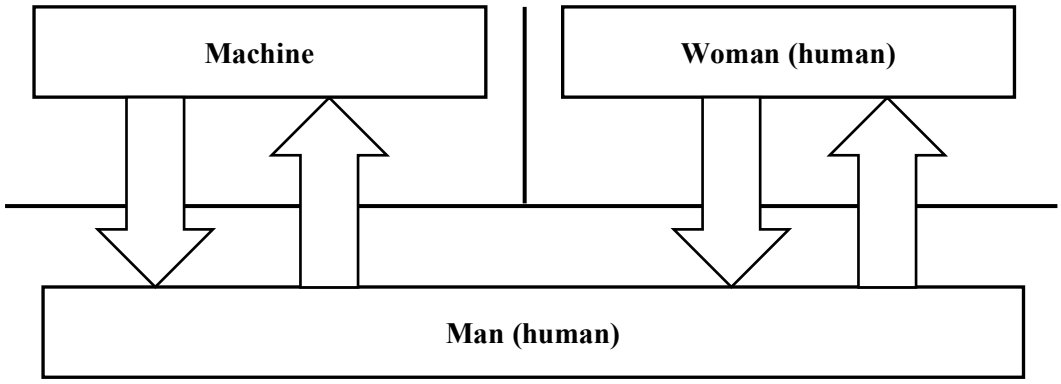
In the following sections, the focus will be on the dimensions of behavior previously set out in *Table 1*.

1.1.2. The Turing Test

Alan Turing was a pivotal figure in the progress of computer science and AI. Since it is very difficult to define in the abstract what intelligence is, Turing avoided this problem by defining a concrete test to decide how well machines were able to imitate it. This criterion was published in the article *Computing Machinery and Intelligence (Mind Magazine, 1950).* Turing called this criterion "The Imitation Game."

A computer passes the test if a human interrogator, after asking some written questions, cannot tell whether the written answers come from a person or a computer. The test scenario involves 3 players unrelated to each other: a man, a woman, an interrogator.

Figure 1 – Structure of the Turing Test



Source: "Algoritmi per l'intelligenza artificiale", Roberto Marmo, 2020

The interrogator tries to figure out the identity of the other two people just based on their answers on the questions, the man tries to confuse the interrogator, the woman tries to help the interrogator. If this latter guesses the identity of the two candidates, the woman wins, otherwise the man wins. The dialogue takes place only with teletype text, to prevent the computer from being recognized by the pronunciation. At some point, the computer is substituted for the male to see if, when faced with female opponents, it can confuse the interrogator (human being) as frequently as the average man. If so, the computer passes the test because it can converse like a person, it can say things that people say under the same circumstances, and it is not possible to distinguish between a computer and a person.

Programming a computer to pass such a test is very complicated; it must possess:

- Natural language processing so that it can communicate.
- Knowledge representation to memorize what it knows or feels.
- Automated reasoning to use stored information to answer questions and draw new conclusions.
- Machine learning to adapt to new situations and to identify patterns.

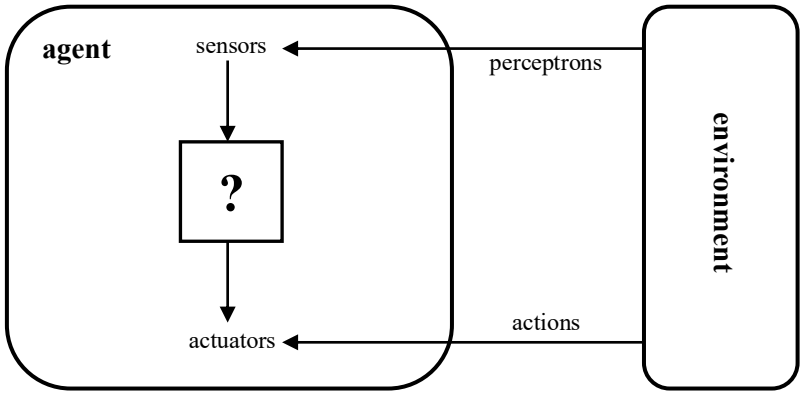
The test focuses on cognitive aspects, what internal structure and operations are needed to give the right answer at the right time. To overcome the total test, the computer will require computer vision to see objects and robotics to control objects and move.

1.1.3. The rational agent approach and the environment concept

A system is rational if it "does the right thing" given what it knows.

To better understand the theoretical foundations of AI, it is first necessary to introduce the concepts of agent and environment. An agent is something that acts; all computer programs do something, but computer agents are expected to do something more: operate autonomously, perceive the environment, persist for an extended period of time, adapt to change, create, and pursue goals (*Russel and Norvig, 1995*). A rational agent is one that acts in such a way as to obtain the best result or at least the best-expected result. Thus, we can say that a rational agent is something that, through sensors, can perceive its environment by acting on it through actuators.

Figure 2 - Interconnection between agent and environment through actuators and sensors



Source: "Artificial Intelligence: a modern approach", Stuart Russel and Peter Norvig, 1995

Sensors detect perceptions, and the agent uses them by processing them, providing as output an action to be performed through the actuators it has at its disposal. How the agent performs actions based on perceptions identifies it as rational or not.

All the skills required for the Turing test enable an agent to act rationally; knowledge and reasoning enable agents to make good decisions.

This approach has several advantages, including the fact that it is more suitable for scientific development than approaches based on human behavior and

thinking. However, it also has several disadvantages, particularly dictated by the fact that achieving perfect rationality in complicated environments is very difficult.

The decisions made by the agent are the more optimal the more information available about the surrounding environment. The environment may have such characteristics:

- *Fully/partially observable:* it is fully observable if the agent, through sensors, can always determine and have access to the current state of the environment. It is partially observable, on the other hand, if limitations of the agent's sensory system are present.
- *Deterministic/stochastic*: if the environment is fully observable, then you have a deterministic environment, otherwise it will be stochastic.
- *Episodic/sequential*: if the environment is defined in well-defined moments and the agent has to respond only to the stimuli perceived at that particular moment, the environment is episodic. Otherwise, the environment is sequential.
- *Static/dynamic*: the environment is static if it does not change while the agent decides to perform the action. It is dynamic if it changes and, whenever the agent decides to perform an action, it must observe the contingency.
- *Discrete/continuous*: is observed when time, actions, and perceptions within an environment take on discrete or continuous values.
- *Known/ignored*: refers to the agent's state of knowledge of the laws governing to the environment.

1.1.4. The Big Data

The definition of big data is very broad, and it is not easy to determine what is a traditional tool in information technology. They are used when tools other than traditional tools are needed to collect, store, analyze, and visualize data.
They are characterized by:

- Large volume in memory (at least 10 Terabytes).

- They must be processed at speed.
- Wide variety of file structures and formats.
- Veracity of sources.
- They can create value to those who must use them.
- Complexity, as data come from different sources and must be linked together to derive useful information.

There are 3 different types of data:

1. *Structured*: put away in a database, they have a committed data model, a well-defined structure and take after a reliable arrange.
2. *Unstructured*: do not have a structure or follow the formal structural rules of data models. They have no consistent format and vary continuously.
3. *Semi-structured*: they inherit some properties of structured data, but most have no defined structure and do not obey the formal structure of data models.

In the context of AI, big data is used because large amounts of data are needed to carry out the various forms of learning, which can be handled appropriately with this technology. The advantage derived from this data lies in its storage, organization, and processing; through this, insights can be extracted regarding consumers and the market that enable the company to be more competitive through the development of ad hoc strategies.

1.2. Learning

An agent is learning if it improves its performance in future tasks after making observations about the world. Any component of an agent can be improved by learning from data; the improvements and the techniques used to achieve them depend on 4 main factors:

1. Which component should be improved.
2. What earlier information the agent already has.
3. What representation is used for the information and the component.
4. What feedback is available for learning.

One can follow numerous AI developments to two concepts: machine learning and deep learning.

1.2.1. Machine Learning

Machine learning is a subset of the broad field of AI consisting of techniques, theories, methods, and technologies that enable machine learning.

Machine learning is an implementation of artificial intelligence that incorporates algorithms that analyze information, learn from that information, and apply what they have learned to form educated choices. It involves complex mathematical calculations and the programming of codes that perform a mechanical function comparable to that of a flashlight, a car, or a computer screen.

The most widely used definition of machine learning is by Tom M. Mitchell[1]: "*A machine that learns from experience E with reference to some task T and with performance measurement P is defined as the machine whose performance in task T, as measured by P, improves with experience E."* By using machine learning and applying it to data, it is possible to build a decision-making model, i.e., an AI system, that generates results based on the data.

Machine learning underlies many types of automated tasks in a wide variety of fields; algorithms are programmed to constantly learn in a way that mimics humans, like a true virtual personal assistant.

The machine learning approach also has disadvantages:

- Need for data.
- System performance depends on data quality.
- AI systems are often non-transparent.

The characteristic of machine learning systems is to learn from data; based on the data at hand, three types of learning can be distinguished:

1. *Supervised learning*: this is one of the most widely used techniques in the corporate world, particularly in marketing, and requires the greatest level of supervision. Learning data is labeled, that is, for each input stimulus the

[1] (Mitchell, Machine Learning, 1997)

desired output response is also provided. Its goal is to provide the model with all exact responses (labeled data) to teach it to identify non-exact data (unlabeled data), to minimize classification error. Pairs of input/output data are provided for training to a computer and a model to respond to the data; as the new data are entered into the computer, a specialist oversees the process by confirming the computer's accurate responses and correcting the inaccurate ones.

One of the earliest examples of a supervised learning model was the perceptron (Rosenblatt, 1958), which is a device that receives as input an ordered set of values, processes it according to a precise mathematical function, and returns as output a numerical value representing the neuron's activation.

2. *Unsupervised learning*: means providing the computer with only unlabeled data, and then letting the model independently identify patterns. Therefore, the learning data is not labeled; only the input stimulus is provided. This method is often used in cases where it is unclear what the results will look like, and it is necessary for the computer to search through the hidden data and clusters based on similarities or differences.

   The agent learns input patterns even if no explicit feedback is provided. Clustering and dimensionality reduction models fall into this category. The goal here is to identify potentially useful clusters and group them based on the similar characteristics they share; for example, it can be useful to segment and create groups of consumers on the historical basis of their purchases and preferences.

   For example, imagine that a company wants to analyze data to identify customer segments, however, the company does not yet know which segments exist; there will be the need to feed the unsupervised learning model with unlabeled input data so that it can independently classify customer segments.

3. *Reinforcement learning*: is an approach performed by trial and error that allows a model to learn through feedback. The computer gets "positive feedback" when it accurately understands or classifies information and "negative feedback" when it comes up short. In this case, AI is created by

having an algorithm interact in an environment subjected to a system of rewards and punishments that allows the machine to gain experience and then recreate input/output pairs through exploration.

Therefore, the learning data are not labeled, but the agent is able to interact with the environment by producing a series of actions that affect subsequent sensory inputs. The environment provides indirect feedback (punishment or reward) depending on the chosen action; the goal is to maximize cumulative reinforcement over the agent's lifetime.

The advantage of this approach is that when input/output pairs are not available, reinforcement learning still allows the AI system to be created; the disadvantage is that it requires many iterations, because it must simultaneously explore the environment and recreate input/output pairs, so it is only permissible where iterations can be performed in simulated environments. It is used to help machines juggle complex tasks involving complex data sets, such as driving a car. Through numerous attempts, the program learns how to make a series of decisions that are necessary for multi-step processes.

1.2.2. Neural Networks

Machine learning can enable computers to perform complex tasks, but these cannot mimic human intelligence. Neural networks echo the working structure of the human brain; they consist of millions of interconnected artificial neurons. Deep neural networks are modeled after the human brain and represent an even more sophisticated level of AI.

Neural networks have applications in several areas, such as:

- *Marketing*: allows you to micro-segment your target audience automatically by considering multiple variables such as income, demographic information, purchases, locations, etc.
- *Retail and sales*: the neural network is able to make sales forecasts by considering different inputs such as price, demand, population, market share. These forecasts are useful to the salesperson as they enable him to

anticipate the needs of his customers to implement useful strategies to prevent them from meeting their needs from competitors.

- *Banking and finance*: with neural networks, increasingly accurate predictions are obtained regarding the performance of financial stocks.
- *Medicine*: using neural network, diagnostics are enhanced, and new scenarios are opened, both in terms of disease prevention and remedies particularly in the field of genetics.

1.2.3. Deep Learning

Deep learning is a field of machine learning that structures algorithms at different levels to create an artificial neural network that can learn and make intelligent decisions autonomously.

Deep learning models are designed to continuously analyze data with a logical structure like that analyzed by humans to draw conclusions. To achieve this goal, deep learning applications make use of a multi-level algorithm structure called an artificial neural network.

Deep learning is a subclass of machine learning and works similarly; however, their inherent capabilities are different. Both are part of the big world of the Artificial Intelligence, but deep learning underlies AI more like human insight.

- Machine learning uses algorithms to analyze data, learn from that data, and make informed decisions based on what it has learned (*Yustyna Velykholova, 2018).*
- Deep learning structures algorithms at different levels to create an artificial neural network that can learn and make intelligent decisions autonomously.

There are several types of deep learning algorithms, the most popular of which are:

1. Convolutional neural networks (CNNs): these are algorithms specially designed for image processing and object identification. Convolution is a process of filtering an image to evaluate each element it contains. Such

networks are often used to stimulate computer vision, a field of AI that teaches machines to process the visual world.

2. Recurrent neural networks (RNNs): are embedded feedback loops that allow algorithms to remember past point data. RNNs can use this memory of past events to inform their understanding of current events or even to predict the future.

The main fields of use of this tool are:

- *Automated translation machines*: translation applications that take advantage of deep learning technology are able to make much more accurate translations as they can understand the relationships between various words.
- *Object classification*: there are algorithms that can classify objects within a photo.
- *Autonomous vehicles*: equipped with multiple deep learning systems, each of which is assigned to perform a specific task with the goal of making the car as autonomous as possible.
- *Sentiment analysis*: based on labels assigned to words, the machine is able to classify and interpret comments expressed by users about news, products, movies, etc.

One of the main limitations of deep learning concerns the efficiency of these models. Training large neural networks is a very expensive process: huge amounts of data and a lot of computing power are needed to achieve good performance. In addition, building a model for language processing has an environmental impact far greater than the annual energy impact of a car.

Another critical point concerns the interpretability of such models: when employed in sensitive contexts, these algorithms must produce accurate decisions and provide precise indications as to why a certain decision was made.

1.3. Relationships with other technologies

This section describes the links between AI and other computer science technologies that relate to it.

- *Cybernetics*: this is the theory of feedback and control, created by Wiener, author of the book Cybernetics; he studied a new scientific discipline with which to assign other quantities to quantities that can be evaluated and described. With this approach, he intended to give a new interpretation of observing the universe and the way its components behave. In humans, as well as in machines, the process of regulation, the basis of cybernetic theory, is a transfer of information.

  By dealing with the control mechanisms of complex processes, cybernetics can be considered as the basis of any other science. In the field of AI, it wants to simulate the logical activity of the human brain by artificially reproducing with neural networks, that is, built through electronic components, the brain structure of networks of neurons.
- *Cloud computing*: thanks to it, AI developers can use very sophisticated algorithms, and have ample memory availability and computational speed. The disadvantages come from always having to be connected online with the cloud, having to be careful about payments so as not to lose the license, and also that one's data is processed by companies and there may be privacy issues about sensitive data that should not go outside the business context.
- *Data mining*: is seen as a technology to be used to obtain certain summary variables useful for automated prediction of trends, discovery of otherwise unknown relationships and behaviors, and as a business intelligence tool for decision support. Data mining results must be relevant, so they need to be validated in the relevant business context. Data mining is exploratory in nature, with a high degree of uncertainty in producing useful results; the more nonobvious, structured, and unassumed a piece of information is, the more its value increases.

  AI also enables information mining with an exploratory nature, so there is an affinity of purpose, such that many techniques derived from supervised and unsupervised learning are used to do data mining.

- *Internet of Things (IoT)*: this concept refers to the global network formed by the interconnections between physical devices capable of transmitting data. Given the enormous amount of data generated, typical of big data, AI algorithms can express their power to extract useful information, eliminate noise, reconstruct missing data, make decisions in a very short time and much more.
- *Robotics*: the term "robot" is generally used to refer to a mechanical human. The first documented design of a humanoid robot is traced back to Leonardo da Vinci, who made detailed drawings to create a mechanical horseman, capable of standing up, waving his arms, and moving his head and jaws.
  Robotics is the union of various sciences, disciplines and technologies to study and develop methods that enable a robot to perform scientific tasks by automatically reproducing human work. AI is related to robotics because it enables forms of reasoning, perception, and planning that are essential for interaction with the surrounding environment. In particular, it makes it possible for the robot to react to emotions manifested by humans. In addition, much research and applications of robotics have enabled the creation of new methods of computation.
- *Augmented intelligence*: augmented intelligence combines technologies from big data, machine learning, natural language processing, and data analytics to generate information useful for making targeted decisions. An important role is attributed to human interaction through a continuous engagement process: humans provide the examples, the AI module learns a model and proposes the results to the humans, who evaluate the quantity of the model and decide how to return the results into the model for a further processing cycle with which to improve the results.
- *Cognitive computing*: through cognitive computing, technology platforms can be built that seek to understand and emulate human behavior, starting from simpler tasks and progressing to increasingly complex processing, with a focus on cognitive abilities, encompassing all the processes by which an individual perceives, records, maintains, retrieves, manipulates, uses and expresses information. It can create a more accessible and intuitive interaction

with software systems to do AI, with the advantage of facilitating use even by skeptical and undecided people. It needs to bring together self-learning algorithms, data mining and big data analytics, pattern recognition, natural language processing, signal processing, and hardware technologies.

- *Soft computing*: soft computing techniques enable evaluation, decision making, control, and computation in an imprecise and vague domain by emulating and using the ability of humans to perform tasks based on their experience. It deals with approximate models and offers solutions to complex real-life problems. It tolerates imprecision, uncertainty, partial truths, and approximations.

1.4. Applications of Artificial Intelligence

The applications of AI are so many, and it is therefore difficult to make a complete list in a short space.

- Business scope, concerning financial services, insurance, blockchain.
  - GIG economy: economic model based on temporary benefits, "work on demand." These are those businesses that could not exist without advanced technology, such as Airbnb or Deliveroo.
  - Bitcoin and blockchain: these are digital currencies, protected by cryptography and managed via blockchain that could enter everyday use. Blockchain refers to a new "blockchain" technology capable of regulating transactions in total security.
- Social and humanitarian scope, especially in developing countries.

Purpose of applications and deployment:

- *Intelligent data processing*: analyze specific data to extract information and perform actions accordingly.
- *Virtual assistant/Chatbot:* capable of performing actions or delivering services for an individual based on commands received by voice and text. A chatterbot is a computer-written program to simulate intelligent conversations with humans; it learns with each conversation session made

with people and enriches its database of responses so that it can deliver them in an increasingly accurate and more human-like manner from time to time.

- *Recommendations*: they direct users' choices based on the information they provide.
- *Image processing*: analyze static images or video for object, person, or animal recognition.
- *Autonomous vehicle*: refers to self-driving means of transportation.
- *Intelligent object*: capable of performing actions without human intervention and making decisions based on the conditions of the surrounding environment.
- *Language processing*: they process language for purposes such as text comprehension and translation.
- *Autonomous robots*: types of robots capable of moving without human intervention, based on information gathered from the surrounding environment.
- In the case of the COVID-19 epidemic, AI was used for temperature checks in public places or to provide data on the progression of the epidemic.

One of the areas with so many case histories involve marketing regarding:

- *Targeted advertising campaigns*: based on the characteristics of prospects most likely to purchase the company's products. AI is used to make suggestions based, for example, on previous purchases, searches, and other behaviors recorded online.
- AI is also widely used in retail to optimize inventories and organize supplies and logistics.
- *Content generation*: the creation of content that can generate interest in customers.
- *Churn analysis*: consists of customer analysis to determine customers with a high probability of switching to competitors in order to intervene before this happens.

- *Customer experience*: to follow the customer during the cognitive, emotional, sensory, and behavioral reactions he or she develops in meeting the product, the company.
- *Customer management*: to respond to customer requests for help, advice, and complaints. Thanks to the implementation of machine-based AI systems with specific learning, chatbots could be the ones to interact with customers on the simplest issues; only in case the chatbot cannot answer the customer's question, the problem will be passed directly to a "human" ready to solve it.
- *Market basket analysis*: to suggest products for a customer to buy based on his or her purchasing behaviors.
- *Product recommendation*: to recommend what to buy based on previous purchases.
- *Customer segmentation*: to create groups of similar customers, determine the behavioral profile of customers, and identify strategies for each group.

1.5. Benefits and limitations of AI

AI is increasingly present in our lives. It can present risks but also benefits for security, business, and employment.

Benefits:

- The use of AI could mean better health care, safer cars, and other transportation systems, and even tailored, cheaper, and more resilient products and services.
- It can encourage get to data, instruction, and preparing.
- It helps make the workplace safer because the most dangerous work can be done by a robot and provide new jobs through the growth of AI industries.
- It can enable the development of a new generation of products and services, including in industries where companies are already in a strong position such as the circular economy, agriculture, healthcare, tourism, etc. Indeed, it can offer smoother and more optimized sales paths, improve machinery maintenance, increase both production and quality, improve customer services, and save energy.

- Applied to public services, it can reduce costs and offer new options in public transportation, education, energy, and waste management, and improve product sustainability.

Limits:

- *Human vs. Artificial Intelligence*: Boden[2], a cognitive science research professor, argues that artificial intelligence seeks to make computers do things that human minds can do; the problem is knowing how the human mind does the kinds of things it does, to be able to replicate those same things in a computer. Addresses a pointed criticism of artificial intelligence: intelligence implies consciousness; there is not even agreement on what consciousness is and how humans acquired it; therefore, determining whether a computer machine achieves a conscious state is problematic.
- *Abuse and underuse of AI*: Abuse is a problem in that it should not be used for problems for which it is not suitable. Underutilization has several causes, starting with public and business distrust, low investment, fragmented digital markets.
- When people are asked their opinion on discussions regarding AI, three options are formed: it will come soon and wipe us out, it will not come so soon and we will be saved, it will never come.
- Those who support the first option only emphasize the negative consequences, which are certainly not lacking and are of various kinds.
- Industrial automation has reduced the number of workers employed since the appearance of AI, with not insignificant social repercussions.
- Creating the complex algorithms requires lengthy specialized studies, requiring commitment and economic investment that is not always affordable.
- AI requires uninterrupted power; its production has a non-negligible cost and has negative impacts on environmental pollution.
- *Liability:* determining who is liable for damages caused by an AI-operated device or service is difficult. If the manufacturer is without liability, there may not be

[2] (Boden, Artificial Intelligence: A very short introduction, 2018)

sufficient incentive to provide a safe and efficient product; the public may have less confidence in the technology.

- It may threaten data protection and privacy rights.
- It can create "bubbles" in the web, where content is presented based on content that the user has interacted with in the past, instead of creating an open environment for multi-voice, inclusive and accessible debate.
- *Deepfake*: can be used to create fake but extremely realistic images, videos, and audio that can be used to scam, ruin reputations, and challenge trust in decision-making processes.
- It could lead to the disappearance of many jobs. Although more and better ones will be created, it is crucial that there is adequate training so that the unemployed can access them and so that there is a long-term skilled workforce.

In order to avoid negative consequences on human development, the European Commission (EU) in 2018 formed a working group on AI called the High-Level Expert Group on Artificial Intelligence, which produced a paper on ethics; it consists of 52 experts tasked with defining code of ethics for the use of human-centered AI that can enable responsible competitiveness, generate trust from users, and facilitate its deployment for purposes useful to humans.

The essential principles provided by the guidelines are 7:

1. There must always be human control.
2. Algorithms must be reliable, secure, and resilient in the face of inconsistencies.
3. Citizens must always be informed about the use of their personal data, as well as have full control over it.
4. Traceability and nondiscrimination must be guaranteed.
5. Social and environmental welfare must be worked for.
6. Accountability must be attributable to those who operate these systems.

Chapter 2 – Artificial Intelligence in the business world and the wood-furniture sector

2.1. Introduction to the wood-furniture industry

The wood-furniture sector is one of the main pivots of Made in Italy; it is composed of two sectors, the first is *furniture* (60 percent of total production) and the second is *wood* (remaining 40 percent of total production). This sector represents one of the most important economic realities not only for the Italian territory but also for the global market, counting in 2019 a value of more than $730 billion. The containment measures caused by the COVID-19 epidemic, with the consequent closure of commercial and production activities, have had a huge impact on the sector, which has found itself to be among the most penalized by the crisis, due both to the zeroing of tourism and the change in household consumption habits. In fact, since March 2020, the compartment has suffered the largest contraction in our country, and only since the second quarter of the year has there been a recovery with most of the sector's production hubs returning to the positive.
In Europe, Italy is the leading country for furniture production, boasting a production turnover of 56.5 billion euros (up 12.6 percent from the estimated 50.2 billion in 2021).

The wood-furniture sector is characterized by many distinctive elements, which find their highest expression in Italy, such as high concentration of labor, creativity, innovation, craft origin, and design.
The Italian system consists of small and medium-sized family-owned enterprises and is predominantly made up of industrial districts, as well as groupings of production systems by geographic areas, in which each territory corresponds to its excellence. These districts are characterized by high organizational efficiency and are mainly concentrated in

Veneto, Friuli-Venezia Giulia, Trentino-Alto Adige, Piedmont, Lombardy, Emilia-Romagna, Marche, and Puglia.

In order to better understand the dynamics of the sector, attention will be paid to the analysis of the following elements:

- *Intensity of competition*: it is necessary that competition is not high within the industry in order to make a good profit. A company must focus on elements such as differentiation, prices, positive and negative externalities, and barriers to exit, since the greater the differentiation and the more compliant the prices, then the stronger the competitors will be. In the wood-furniture industry, there are many established companies supplying the same products; they offer affordable prices to "fight" threats from smaller brands by implementing a strong marketing strategy.

  The main competitors internationally are China (in terms of labor cost), Northern Europe and USA (in terms of marketing and distribution) and Eastern Countries (in terms of cost for raw materials).
- *Bargaining power of customers*: customers are the recipients of the enterprise's output; they are influenced by the enterprise's purchase and sales costs, the level of product specialization, the possibility of substitution, etc. In this industry, many people need furniture, so the size of customers is high. However, one of the disadvantages for companies is that for the customer there is no connection with the company itself, as it costs them nothing to switch from one brand to another if the latter offers similar furniture at a lower price.
- *Potential entrants*: since the demand for furniture is very high, it is not difficult to enter the market and produce one's own furniture. However, it takes large investments and a lot of time to become a major enterprise and stand out in the market.

For a more accurate analysis, some of the critical points of the industry have been given below.

- As the sector is characterized by the presence of small and medium-sized family-owned enterprises, in case of difficulties in the markets it would only be the large enterprises that would be able to cope with market turbulence.

- There is a strong presence of lack of training: many productions require manual processing stages and high labor qualification, especially in the product finishing stages; therefore, it is difficult to find competent and specialized personnel.
- As previously announced, there is growing competition with low labor cost countries.
- Italy turns out to be almost totally dependent on foreign countries for the import of wood raw material.

2.2. Artificial Intelligence in the Wood-Furniture industry

It is indisputable that at this historical stage the world of work is facing a major technological acceleration, which goes by the name of "*Industry 4.0*"; this transformation involves the timely introduction of new technologies into production processes and services. The evolving scenario represents an opportunity for Italian companies to facilitate the internalization process while leveraging new work technologies to provide better customer service.

Companies in the wood-furniture sector have always relied on manual labor and craftsmanship to produce their furniture. However, thanks to advances in technology, furniture makers are incorporating artificial intelligence into their production processes to improve efficiency, quality, and customer satisfaction.

Innovation has always been a mainstay in the wood-furniture industry, characterized by the constant search for new ways to improve the design, functionality, and sustainability of furniture. Artificial Intelligence in recent years has emerged as a powerful tool to revolutionize the furniture research and development process; by harnessing artificial intelligence algorithms and machine learning techniques, furniture designers and manufacturers are opening new possibilities, transforming the way furniture is conceived, created, and experienced.

Two of the main drivers of growth for the industry and for restarting in foreign markets after the Covid-19 pandemic have been the use of e-commerce and increasingly omnichannel marketing strategies, using many different channels both online and offline. The shock of the health crisis has thus accelerated digitization processes in many companies, especially in the more structured ones.

Here are some of the possible improvements within the industry after the application of artificial intelligence:

- *Design*: artificial intelligence can help generate 3D models and prototypes, simplifying the design iteration process and enabling designers to quickly refine their creations, leading to more efficient and successful product development cycles.

  Using artificial intelligence, it is easier to analyze large amounts of data, such as consumer preferences, market trends, and historical designs; in addition, new technologies can provide innovative design elements and combinations to suit changing customer tastes. In this way, furniture can be created that meets both consumers' functional and aesthetic requirements.
- *Functionality:* AI can enable furniture to adapt to users' needs in real time, for example by integrating lighting or temperature controllers, or wireless systems to products, creating "smart" furniture, and enhancing the consumer experience. This is the case with desks, sliding doors, or seating equipped with interactive systems and wireless connections that are predisposed to voice recognition and the application of basic commands.
- *Sustainability*: in terms of sustainability, companies in the industry can leverage AI to reap numerous benefits. First, by analyzing data on material properties, availability, and environmental impact, artificial intelligence algorithms can help make informed and important decisions about the choice of sustainable materials and production processes.

  Artificial intelligence can also be used to optimize resource use, minimizing waste, and inventory levels, reducing the risk of over- or underproduction and storage costs.

  In addition, AI could not only help in waste reduction but, through the use of green investments, i.e., investments in machinery that ensure energy savings and lower environmental impact, it also would record lower electricity consumption and climate-changing emissions.
- *Automation*: machines with artificial intelligence can perform operations such as cutting, sanding, and drilling with greater precision and speed than human labor, improving production efficiency, increasing productivity, and reducing errors.

- *Product quality*: quality control is essential for certain types of processing in furniture manufacturing, and through the use of AI algorithms, which analyze images and data from sensors that identify defects or inconsistencies, product quality can be improved.
- *Assistance*: AI-powered chatbots can provide customers with personalized assistance, product advice, and shopping assistance, improving customer satisfaction, and allowing staff to focus on more complex issues. In this way, consumers will receive answers to their product questions quickly and easily, without having to wait for a salesperson to be available.
- *Consumer needs*: through the use of machine learning algorithms, which analyze data from social media, online searches, and consumer purchase history, they are able to identify the most popular styles, colors, and materials; this can be useful for designers to create furniture that best meets consumer needs.
- *Security*: security plays an important role in manufacturing environments as well as in infrastructure management; the use of artificial intelligence could help enterprises to optimally safeguard and protect their data. However, the use of new technologies in this area is not always an advantage, since, as announced in Chapter 1, the enterprise could face numerous risks, such as exposure to web espionage.

Nevertheless, digitization is still a challenge for the wood-furniture sector; the health crisis has shown that the digital channel proves to be a very important pivot for attacking foreign markets interested in high-end Italian design production. Furniture factories that adopt artificial intelligence will be better equipped to meet the demands of a competitive market and stay ahead in an industry that is becoming increasingly automated. The expansion of the virtual dimension in which to operate will also substantially alter the actual real dimension, allowing for a multiplication of action capabilities within the enterprise.

In addition, artificial intelligence could benefit the evolution of logistics; the transition from traditional logistics to a "4.0" type takes place through organizational innovation of working methods and reorganization based on the principles of change management, in order to ensure efficiency and productivity for companies. The digitization process of

recent years has opened up great scenarios for this type of change, particularly through the use of e-logistics programs, the task of which is to ensure better product-solution monitoring throughout the industry and better order forecasting; the aim is to establish a business model based on the interdependence between actors and the intensity of information and communication flows. Optimizing logistics processes would lead the company to reduce costs and ensure better customer service.

Although the benefits of the digital innovation process are within everyone's reach, there are an increasing number of obstacles, mainly cultural in nature, that limit the Italian industrial sector from implementing innovative systems in its processes.
The rise of new technologies has produced upheavals in the manner and organization of work and consequently in economic, cultural, and social structures. These changes have taken place at a time and speed that is not in keeping with the transformative capacity of societies in the various eras, producing collective and individual hardships. These discomforts focus mainly on the risk of being faced with ungovernable upheavals in the work environment and the differences between timing and pace of development, leading to the fear of not being able to keep up with the times. The processes of dematerialization and digitization and the entry of new technologies have taken on a clear acceleration, the effects of which are already evident on work organization and productivity. Habits and low appetite for risk are just some of the many obstacles that separate Italian companies from European and global models of success.

Listed below are the main points of concern about the advent and use of artificial intelligence within business and the world of work.

- One of the most important and common problems appears to be the integration of artificial intelligence with traditional design processes: a balance must be maintained between automation and human creativity.
- Artificial intelligence algorithms rely on robust and diverse data sets in order to perform analysis and make accurate decisions; it is complicated and difficult to ensure the availability of reliable and complete data.
- Socio-cognitive issues related to existing technologies: the concepts of delegation and trust turn out to be very important. Human agents need to be able to develop

trust with machines in order to make them real tools for collaborative development.

- A further problem to be taken into account concerns the multiplicity of decisions that will no longer be the sole human responsibility. In order for AI to best accomplish the tasks entrusted to it, it needs to have a certain amount of autonomy in order to relieve the human agent of the need to follow the realization of the product step by step. As new technologies evolve, the number and complexity of decision spaces will grow.
- Although there are many useful places where artificial intelligence will definitely find a place, there are some parts of the business that will always be better with a focus on craftsmanship and building lasting relationships with customers.

2.3. Artificial intelligence in enterprises: doubts, inequalities, and the South-North gap

The introduction of new technologies has always led to questions and reflections on the developments they would produce. In particular, on October 9, 2017, at the Senate of the Italian Republic, a conference entitled "Perspectives on Artificial Intelligence" was held in order to understand the prospects and processes of change that are emerging in relation to the entry of new technologies into the world of work and daily life. Various topics were discussed during the day, mainly pertaining to how natural and artificial intelligence are transforming human behavior, attitudes, environments and thinking. Numerous ISTAT data were also presented, showing how, in Italy, there are simultaneously problems related to the acceleration in innovation processes and problems related to the serious delay with which these processes are being carried out in some segments of our country, with the serious risk that these processes may lead to an increase in inequalities.

In terms of accessibility, we can define the term "inequality" according to four different aspects (Van Dijk, 2005):

1. *Material access*, or the actual accessibility to technologies.
2. *Mental access*, which is people's ability to take an interest in technologies.
3. *Skill access,* or the availability of skills to access technologies.
4. *Usage access,* or the availability of the skills to actually use these

technologies.

Currently, the applications of machine learning are really numerous, many of which are integrated with everyday life; however, very many people are excluded from these opportunities, thus risking entering new "groups" of technological marginalization. There are also very few companies that take full advantage of new technologies: in fact, only 6.2 percent of Italian companies use AI systems, compared to a European Union average of 8 percent; this could cause the risk of increasing the process of concentration of wealth in the hands of a few and the resulting gap between rich and poor. While the result does not return a positive scenario, it should be emphasized that Italy is progressively changing; there are still many challenges to be faced, such as the progress of digitization of public administration and the improvement of digital skills of the population, but further acceleration is expected due to the funds provided by the PNRR (Piano Nazionale Ripresa Resilienza, a plan approved in 2021 by the country for the revitalization of the economy after the health crisis by Covid-19), precisely for the digitization of EU countries.

On the Italian territory, as far as the use of new technologies within companies is concerned, the territorial reference base of the company has a great impact; in fact, 65.3 percent of companies in the Northwest have a basic level of digitization, compared to 56.9 percent of companies in the South (ISTAT). This is due to the lack of information on the subject of new technologies: very often it is thought that large investments of money are needed for big data analysis and that it takes a long time to implement them when in reality many of the new technologies turn out to be more accessible and effective than people think.

It is now common knowledge that areas in the South are in a more backward state than regions in the North; in the field of AI application, this does not turn out to be strictly the case: it is true that digitized companies in Northern Italy outnumber those in the South, but according to a note released by Confindustria, it turns out that companies in the South are the most aligned with European values, coming in at 7.6 percent: in 2021, the digital market exceeded 4.6 billion in Campania alone, growing by 4.6 percent over 2020; the percentage of regional companies with at least a basic level of digitization is still lower

than the national average, but growing by +13.3 percent in 2022.

In the next chapter, the focus will be precisely on analyzing this gap within the wood-furniture sector. The main objective of the study is to better understand the dynamics between artificial intelligence and the industry, to understand the now sharp gap between the North and the South and in order to help companies in the industry develop practices to adopt for their growth and advancement in the market. The research question will therefore be, "*How do companies in northern and southern Italy perceive artificial intelligence? Is the gap still stark even in this area?"*

To answer these questions, qualitative research will be conducted among several companies in the wood-furniture sector belonging to the territories of Southern and Northern Italy, to assess whether and how they use artificial intelligence and their perception not only with respect to it, but especially with respect to the gap between companies in different territories.

Chapter 3 – The research: methodology, data analysis and results

3.1. Qualitative vs. quantitative approach

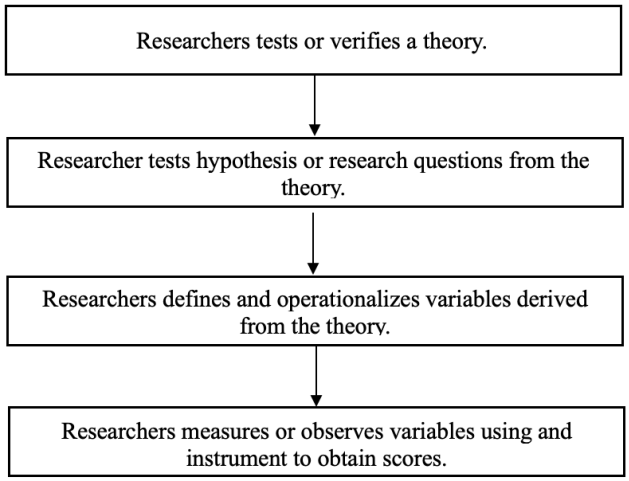
When conducting research, scholars often find it difficult to choose between two types of research methods, the extensive and the intensive (Harré, 1979); these terms are often associated with the terms 'quantitative' and 'qualitative' research, respectively. As far as quantitative research is concerned, it is used when actual, real data must be collected to answer the research question; the researcher uses the theory deductively and proposes it as the beginning of a study (Cresswell, 2003). They test and verify a theory by examining the research questions or hypotheses derived from the theory, developing instruments to measure and observe the respondents' behavior for the study, and finally processing the instrument scores used to confirm or not confirm the theories.

Qualitative research, on the other hand, concerns the use of human techniques to investigate significant behavioral tendencies; thus, the researcher will make knowledge claims based on constructivist perspectives (Cresswell, 2003).

It is possible to combine quantitative and qualitative approaches, taking great care to ensure that the theory behind each method is compatible and that the methods are used for appropriate reasons (Hammarberg et al, 2016).

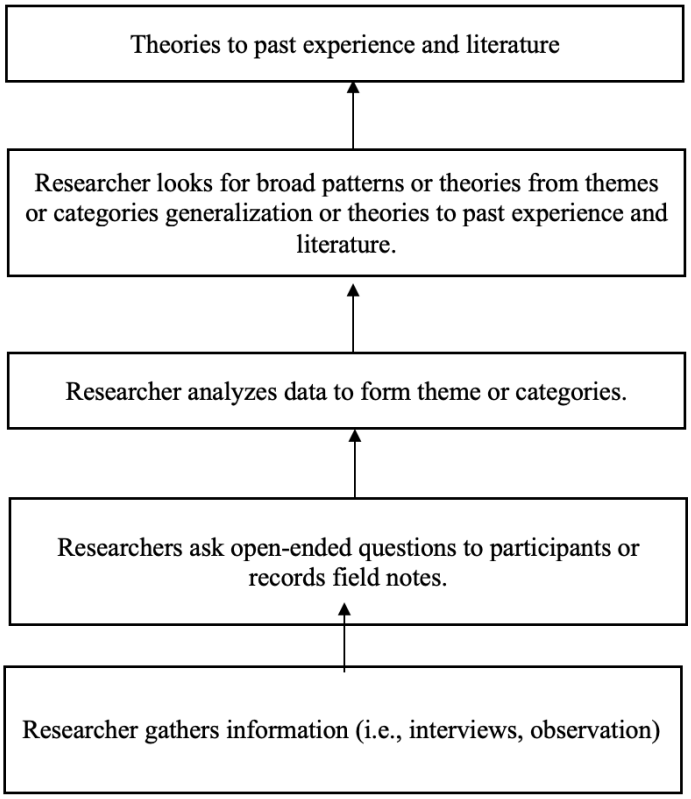
In order to better understand the logic of these two approaches and to understand the differences between them, the figures below show the procedures of both approaches:

Figure 3 – The quantitative logic



Source: Research design: Qualitative, quantitative, and mixed method approaches. Cresswell, J.W., (2003).

Figure 4 – The qualitative logic



Source: Research design: Qualitative, quantitative, and mixed method approaches. Cresswell, J.W., (2003).

3.1.1. Qualitative research

The qualitative research approach involves the development of a theory as a result of empirical observations (Saunders et al, 2009). As already announced in the previous section, the researcher starts by gathering information from the participants and develops it into themes; these themes are then developed into broad models, theories, or generalizations and, finally, are compared with personal experiences or existing literature related to the topic. The researcher then conducts a preliminary study and then refers to the theories.

The qualitative approach is mainly employed with the aim of understanding a phenomenon of interest in its social context. There have been many definitions given to this method in the literature over time. To date, it can be said that the term 'qualitative' refers to a type of research that produces results that are not obtained by statistical

processes or other means of quantification; it may concern research into people's lives, lived experiences, behavior, social movements, etc. (Strauss and Corbin, 1990). Such research is interested in analyzing the subjective meaning of events, collecting non-standardized data, and analyzing texts and images rather than numbers and statistics (Flick, 2014). In addition, in this type of method, the researcher typically acts as the instrument of inquiry and the main subject of the study becomes the participant himself (Denzin and Lincoln, 1998).

Qualitative research must consist of the following fundamental characteristics:

- *Reliability*: the research objective, methodology, procedural decisions, and data management details must be transparent and explicit so that the researcher can follow the progression of events and understand their logic.
- *Credibility*: a qualitative study is credible when its results are recognizable to the people who share the experience and to those who assist or care for them. If data extracts and interpretations are inconsistent, the credibility of the study is in doubt.
- *Applicability*: a qualitative study is applicable when its results can be adapted to contexts outside the study situation and when researchers believe that the results are meaningful and applicable to their experiences.
- *Consistency*: or reliability of results, is the criterion for assessing reliability.

There are several qualitative research techniques (Hammarberg et al, 2016):

- *Small group discussions* can be used to investigate beliefs and attitudes.
- It is possible to use *in-depth interviews* to understand a condition or experience from a personal perspective.
- It is possible to *analyze texts and documents* such as government reports, articles, and websites, to learn about distributed or private knowledge.
- It is possible to use *semi-structured interviews* to seek opinions on a targeted topic.

Using the qualitative research approach also has numerous advantages:

1. It produces a detailed description of participants' feelings, opinions, and experiences and interprets the meanings of their actions (Denzin, 1989).
2. During data collection, researchers interact directly with participants through interviews, making it subjective and detailed.

3. It has a flexible structure, so in-depth analyses can be produced, and participants have enough freedom to determine what is consistent for them (Flick, 2011).

It is precisely for these reasons that this study will follow the logic of the qualitative approach. In order to answer the research question and to pursue the objective of the study, as well as to investigate the level of knowledge on artificial intelligence and explore the possible gap in Italy, it was deemed more appropriate to use a qualitative approach to research. When collecting types of data to answer questions on social meaning, one has to be able to capture real life experiences, which cannot be identical from one person to another; meaning is culturally subject to evolutionary change: the way to explain a phenomenon, such as artificial intelligence in this case, will vary according to cultural meaning.

3.1.2. The semi-structured interview

As mentioned in the previous section, semi-structured interviews represent one of the qualitative research methods. They are mainly used to investigate targeted topics and provide a more flexible but methodical approach to data collection; indeed, one of the main advantages of this type of method is that it allows the use of open-ended questions and follow-up questions, in order to enable more in-depth research into participants' life experiences. This would not be possible with a more organized approach or with unstructured interviews, which are characterized by the complete absence of any kind of structure.

Semi-structured interviews are therefore governed by an interview guide that serves as the structure of the interview; the interviewer uses a predetermined list of potential topics to be addressed and can refer to it to contribute to the discussion and ensure that the conversation goes in the direction defined by the project. The interviewer may also vary the questions and topics within the interview structure among interviewees depending on the situation in order to extract rich and comprehensive responses from the participants.

Furthermore, researchers must be able to investigate and deepen interpretations, giving respondents sufficient opportunity to elaborate on their answers; they must also avoid bringing out their own ideas (Easterby-Smith et al., 2008).

The use of semi-structured interviews has many advantages:

- As mentioned above, as they are characterized by the presence of a structure to the interview, they allow the researcher to gather as rich and detailed an amount of information as possible.
- Personal interviews can be more effective than questionnaire presentation in generating higher participation rates. Previous research has shown that participants prefer to be interviewed rather than complete a survey. (Healey, M. J., 1991). Participants may find the process of providing comprehensive answers to open-ended questions time-consuming, especially if they are unsure of the meaning of certain topics.

The use of semi-structured interviews has several disadvantages and concerns, which will be discussed later in the context of study limitations.

3.2. The study: introduction to the research

This section will be concerned with answering the research question outlined earlier in Chapter 2. In particular, the focus will be on the explanation of the methods used to answer the question, the analysis of the data collected, and the explanation of the results obtained, with the advantages and limitations of the research being added.

As previously announced, the aim of the research is first and foremost to investigate the extent to which companies in the wood-furniture sector in Italy are familiar with artificial intelligence, and how they use it, in order to understand the clear divide that exists between the regions of northern and southern Italy.

In order to conduct this analysis, a sequential approach will be adopted, involving several steps:

- First of all, the level of knowledge and information that enterprises have with respect to the topic of artificial intelligence will be identified, so the focus will mainly be on the presence or absence of a lack of training in this area.
- Next, the ways and methodologies (if any) that businesses have adopted to keep up with the digitization process will be analyzed, so the focus will mainly be on how businesses in the northern and southern regions use artificial intelligence (if they use it).

- Finally, the problems and doubts (if any) of firms in the sector with respect to the use of new technologies will be analyzed, so the focus will be mainly on analyzing the different characteristics of the possible limitations that firms have with respect to the topic.

As already announced in the previous section, a qualitative approach was adopted to conduct this research, assessing a sample of six respondents. Furthermore, in order to collect as detailed data as possible concerning the perception of companies with respect to artificial intelligence, the qualitative study will follow a semi-structured face-to-face interview approach. The questions will be asked to the interviewees in such a way that they provide as in-depth an answer as possible, allowing them to share their level of education on the topic, their concerns, if any, and their attitudes towards the use of artificial intelligence. Furthermore, the use of a semi-structured interview allows for a comprehensive understanding of the respondents' views on the study topic and provides an opportunity to solicit detailed and rich data on the participants' perspectives, allowing for an in-depth investigation of the research question.

By choosing this type of interview, it was possible to adapt the questions from one interviewee to another, also based on the themes that emerged from the first surveys. In addition, some interviews lasted longer, others shorter; this could be due to the fact that some interviewees were aware of more information related to the field of AI, and consequently were able to give important insights into the topic and to explore deeper into it.

3.2.1. Sample selection

To conduct qualitative research, one or more participants are chosen on the basis that the data they will provide will be sufficient to answer the research question; to obtain detailed results, the researcher must choose the most appropriate sampling technique according to the research objective. There are different sampling techniques divided into two macro-areas:

- *Probabilistic sampling techniques*: rarely used in qualitative research, more

common for quantitative research. They are mainly used when the aim of the research is to obtain statistically generalizable insights by selecting a random number of participants.

- *Non-probabilistic sampling techniques*: these are used when the focus is on obtaining insights that give information rather than statistical explanations and qualitative data are collected.

To pursue the objective of this research, it was deemed more appropriate and adequate to use non-probability sampling techniques, choosing to actively include participants in the research.

There are different probability sampling techniques:

1. *Purposive sampling*: participants are selected on the basis of the researcher's judgement as to their relevance to answering the research question. It is usually used to select a small number of participants who, it is hoped, will be particularly informative. The researcher first identifies a particular relevant group and then chooses participants from within it.
2. *Heterogeneous and homogeneous sampling*: used to select a small group of participants, rather than just one. The difference with purposive sampling lies in the fact that in heterogeneous sampling the researcher first identifies relevant diversity characteristics as criteria and then chooses participants who meet them to identify the maximum variation in the data collected.
3. *Voluntary sampling*: this is mainly used when the population is difficult to identify; an example is snowball sampling in which a subsequent course of action is implemented to reach the necessary individuals by asking the already identified individuals to nominate others.

In order to conduct this research in the best possible way and to pursue its objective of answering the study's question, and since this is a particular sector, a purposive sampling was deemed most appropriate. In fact, the group of companies belonging to the wood-furniture sector was taken into consideration and then some of the companies belonging to this group were selected.

In particular, six companies were identified. This sample is made up of three companies

from the north of Italy and the remaining three companies from the south of Italy. All the companies interviewed are part of the wood-furniture sector, although they pursue different objectives: two companies sell wood raw materials, another produces and sells furniture, another produces and sells naval furniture, another produces and sells plated wood panels, and the last company only sells naval furniture. The choice of these types of companies is due to the fact that, as the wood-furniture sector is made up of multiple types of work, we want to investigate the use of artificial intelligence in several possible and different fields.

Before conducting the interviews, the purpose of the research and the method of data storage were explained; all interviewees signed a consent form. Each respondent was assigned a code and, in order to guarantee the privacy of the companies that opted not to leave their name visible, a fictitious name was proposed.
The following table represents a schematic summary of the characteristics of the respondents; fictitious names have been outlined in italics.

RESPONDENTS	**ENTERPRISE**	**PURPOSE OF ENTERPRISE**	**CODE**	**LOCATION**
Paola Gugliotta	PGM SRLS	Sales and production of furniture	01	Southern Italy
Serena Cilia	Iblea Legnami	Sales of wood raw material	02	Southern Italy
Alessandro Beninati	Naval Interior	Sales and production of naval furniture	03	Southern Italy
Mario Rossi	Italia Yachts	Sales of naval furniture	04	Northern Italy
Alberto Rossi	BIMP	Sales of wood raw material	05	Northern Italy
Alberto Magnanini	ITP Panels	Sales and production of plated wood panels	06	Northern Italy

3.2.2. The questionnaire

This section will present and explain in detail the questionnaire used during the face-to-face interviews.

The questionnaire consists of a series of questions on various aspects, in particular it is divided into four sections that summarize the elements to be investigated in order to answer the research question:

1. Respondent's general knowledge about AI.
2. Use of AI.
3. Concerns and risks about the use of AI.
4. Southern-Northern gap.

A final section was then added with a final question concerning any advice or measures to be taken to improve the use of AI within wood-furniture companies. The questions were formulated in such a way as to obtain a complete picture of the respondents' opinions on artificial intelligence and to find out in detail their view on the subject in the different Italian territories.

Respondents were asked to answer each question honestly and to provide further information on their skills and experience with the use of artificial intelligence, any issues that lead them not to use it and their opinions on the now pronounced North-South divide in Italy, as their answers could be helpful for future studies and could help future companies in the sector.

The questions were administered in Italian to facilitate respondents in better articulating their answers and for practical reasons. Furthermore, all interviews will be recorded and subsequently transcribed to facilitate subsequent data analysis.

Below is a schematic representation of the questionnaire and the questions asked during the interview.

Respondent's general knowledge about AI	What do you think artificial intelligence is?
	What do you think are the main benefits of using AI?
	What do you think are the main concerns related to the use of AI?
	How do you think AI has affected or could affect your daily life?
Use of Artificial Intelligence	Do you exploit or plan to exploit AI in the future for personal or professional purposes?
	Do you have direct or indirect experience in using AI in the company where you work?
	If yes, how do you exploit AI or how do you think AI can be useful for the business in which you work?
Concerns and risks about the use of AI	Do you have an overall positive or negative view on AI? Why?
	Do you have a fear of AI and its possible replacement of people in certain jobs?
	In your opinion, using artificial intelligence is risky?
Southern-Northern gap issue	In your perception, do companies in Northern and Southern Italy use AI differently?
	Have you noticed significant differences in AI adoption between large companies and small businesses in northern and southern Italy? Give examples if possible.
	If yes, what do you think might be the main causes of the gap in AI use between companies in Northern and Southern Italy?
	What benefits could come from AI adoption for companies in the North and South? What challenges might hinder AI adoption in these regions?
	Do you think specific measures should be taken to reduce the gap in its AI between Northern and Southern regions? Which ones?
Final Question	Do you have suggestions on how to improve the use of AI in wood-furniture companies in Italy and your area?

Figure 5 – Questionnarie

Going into detail, the first section of the questionnaire has as its objective to assess the general knowledge respondents have about artificial intelligence. Indeed, the first question "*What do you think artificial intelligence is*?" is intended to investigate the

respondents' general opinion on the subject, and the next three questions aim to identify how they perceive the use of AI. It can also be said that this section aims to identify any lack of education of the respondents; in fact, questions such as "*How do you think AI has influenced or could influence your daily life?*" aim to find out whether the respondents recognize the true meaning of artificial intelligence, understanding that it has now become an integral part of our daily lives, starting from the most basic things, such as the use of smartphones, to more complex processes, such as automation in a company.

The second section of questions, on the other hand, concerns the use of AI within the companies in which the interviewees work; this section aims to identify the extent to which the various companies interviewed have adopted or intend to adopt the measures of new technologies in order to keep up with the times.

The third section turns out to be an in-depth study of the first section, but it deals with the possible risks and concerns that respondents have towards the use of AI within the company. The question "*Do you have a fear of AI and its possible replacement of people in certain jobs?*" aims precisely at investigating what is thought to be the main problem workers have with the use of artificial intelligence: the replacement of human staff by machines. As already announced in chapter one, this problem often stems from a lack of training and cultural problems; therefore, this section aims to confirm or overturn this idea. Therefore, this section aims to indirectly prompt the interviewees to discuss the specific risks outlined in the previous chapters.

The third section dealt with the issue of the gap between northern and southern regions of Italy. Respondents were asked for their opinion on the use of AI in companies in the different Italian regions and were asked whether they noticed significant differences in the adoption of new technologies within the northern and southern Italian companies in the sector, with the aim of understanding whether the gap between the companies in the different territories is also present with regard to the use of AI in the wood-furniture sector. If so, the participants were asked to provide examples of such differences and what, in their opinion, are the main causes of this gap, if any.

With the aim then of helping companies to better implement the new technologies and in order to keep up with other companies in the market, a final section was added with a final question regarding any suggestions on how companies in the sector can best introduce AI into their reality.

These pre-determined questions provide a framework for conducting the interview and may bring out further topics to be explored through the use of open-ended questions. The implementation of a semi-structured interview approach allows for follow-up questions, thus facilitating the acquisition of broader and more complete information.

3.3. Data analysis: introduction

This section concerns the explanation of the methodology used to analyze the data from the interviews.

In order to maximize the relevance of the information, the Gioia method was chosen, a qualitative analysis model developed by Dennis A. Gioia, which represents an inductive approach starting from the individual themes that emerged from the interviews and aims to establish one or more final theories (Gioia et al., 2013).

The Gioia methodology involves three stages:

1. The first stage concerns the identification of the individual relevant terms that emerged from the interviews, as well as the identification of first-order codes.
2. Once these codes have been established, they have to be grouped into categories, bringing the second-order codes to life. It is important to understand whether the themes emerging from the interviews can come up with useful concepts to describe and explain the phenomena being observed.
3. After having reached a certain number of themes, aggregate dimensions will be created in order to determine the main themes emerging from the survey.

After processing these three steps, it will be possible to construct the data structure, which will provide a detailed view of the information received and demonstrate the accuracy of the research, and the data table, which will allow the empirical validity of the second-order codes to be demonstrated, with the most significant quotations from the interview transcripts.

Subsequently, attention will be paid to the analysis of the Grounded Theory model, as well as a graphical representation of the conversion from a static data analysis structure into a dynamic logical model. This model aims to represent the dynamic relationships between the codes that emerged and helps to understand the linkage and correlations

within the data structure.

3.3.1. Data analysis: the research

In order to have the most accurate and detailed analysis of the data possible, the process of open coding was adopted (Strauss and Corbin, 1998); this method, in Grounded Theory, concerns that analytical process by which codes are associated with the data and phenomena observed during the analysis of qualitative data (Strauss and Corbin, 1998). Through open coding, it is possible to develop the substantive codes that describe the phenomenon under investigation.
Analyzing the data from the interviews using the Gioia method resulted in a wide range of codes. These codes were examined and categorized in a separate Excel file and, in order to ensure a clear analysis, only the fundamental and most important codes were selected to achieve the research objective. To identify and assess the importance of the codes, a classification system based on a traffic light signal was used, as well as a system for indicating the status of a variable using the red, orange, or green of a traffic light. This system allows us to have a simple and intuitive scheme; in particular:

- Codes in green are considered suitable.
- Codes in orange are those requiring further evaluation.
- Codes in red are those excluded because they are considered unsuitable to pursue the objective of the research question.

Subsequently, codes with similar meanings were grouped together, thus creating the first categories. Then, using the axial coding method (Strauss and Corbin, 1998), affinities and contrasts between the different categories were identified; this method concerns the process by which codes are related to each other through the combination of deductive and inductive thinking (Strauss and Corbin, 1998).

Through the Gioia method, it was also possible to construct the structure of the data. As explained in the previous section, first-order codes, which comprise the most relevant themes derived from the interviews, and second-order codes, which comprise the first-order codes grouped into similar codes according to meaning, were collected. Starting

from the latter, three general themes addressed by the interviewees were identified:

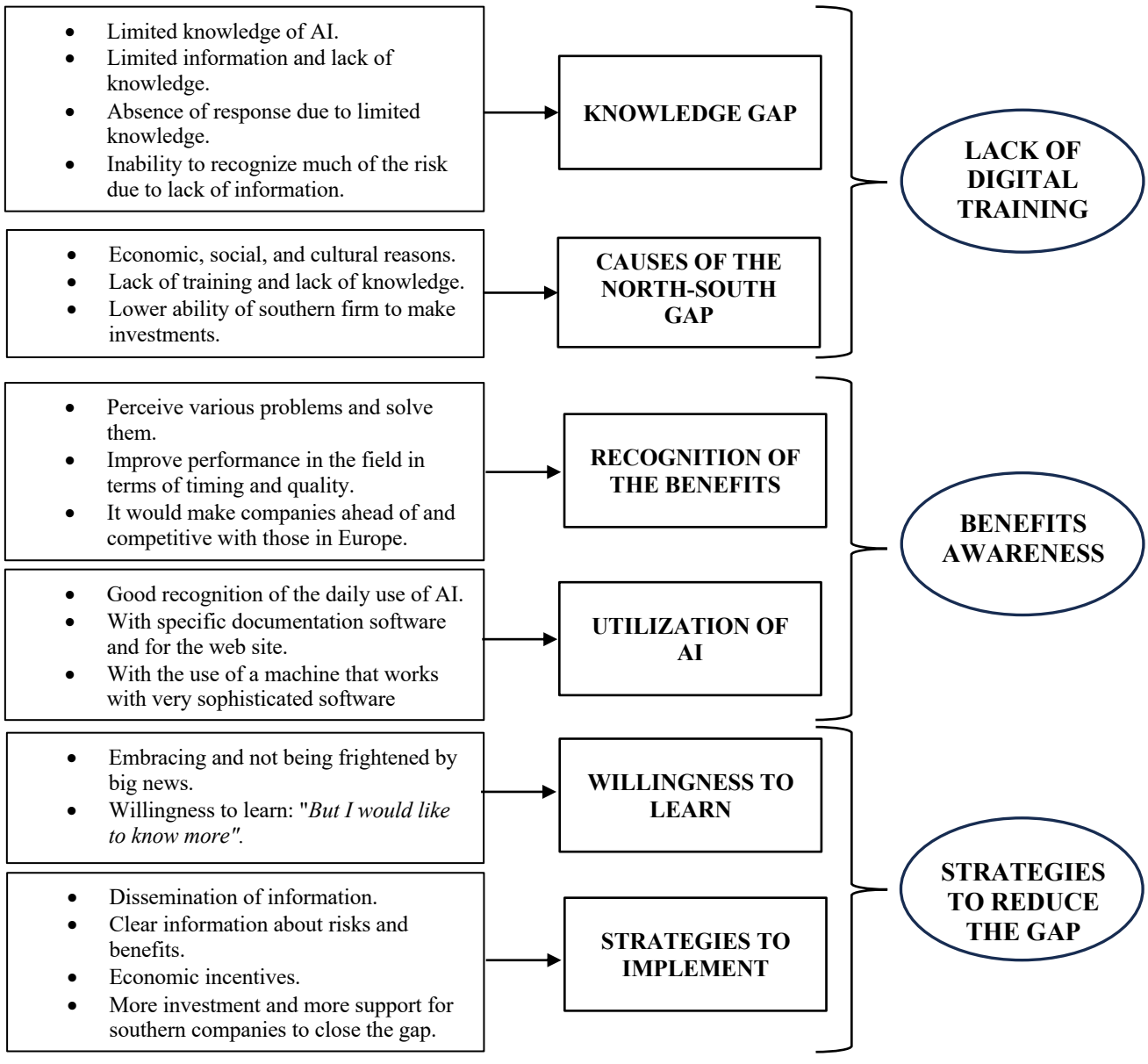
1. Lack of digital training
2. Benefits awareness.
3. Strategies to reduce the gap.

As already announced in section 3.2.1, each respondent was associated with a code, and to facilitate the drafting of the results these codes were abbreviated as follows: I01; I02; I03 and so on.

3.4. The research: results

Attention will now shift to explaining the results; as announced in the previous section, three macro-themes were outlined. Below are the most relevant features that emerged from the interviews, highlighted, and presented to reinforce the results and confirm their validity.

Figure 6 – Data structure



Instead, now the data table will be presented, showing the most important features of the interviews to demonstrate the validity of the first-order codes.

DATA TABLE

Second Order Codes	*First-order codes and main citations*
KNOWLEDGE GAP	*"I don't think I'm informed enough" – I01* *"I don't consider myself informed enough" – I03* *"I'm sure I don't know most of the processes that could help us improve." – I01* *"I am not 100% aware of the information either". – I05*
CAUSES OF THE NORTH-SOUTH GAP	*"Southern companies need to open their doors to new technologies, perhaps with more information" – I05* *"We are not actually on the same page digitally". -I04* *"Southern progress and modernization do not go hand in hand with the rest of Italy" – I01* *"The main cause of the gap is the economic resources of the south certainly lower than those of the north, and thus the lower ability of southern companies to make investments". – I02* *"Small businesses give up AI precisely because of cost issues. This is a worry more for the South than for the North having to work is better paid than in the South". – I06*
RECOGNITION OF THE BENEFITS	*"Every company's daily life could benefit in no small way, such as saving time and speeding up processes". - I01* *"Benefits could be speed and accuracy of the production process, which would mean savings and greater environmental sustainability". - I04* *"Produce more in the same time frame and you would get a qualitatively better product". – I06*
UTILIZATION OF AI	*"Already use home automation technology through smart devices such as thermostats and app-controlled air conditioning systems". - I03* *"Trivially on search engines or in managing what my smartphone is". -I04* *"We are already experimenting with using artificial intelligence to automate tasks and processes, making many tasks more efficient and mapping processes". – I05*
WILLINGNESS TO LEARN	*"I don't think I'm well enough informed, but I think there are both great benefits and great risks, and I would like to know more". – I01* *"I find it's right to embrace and not be frightened by big news, the same as what happened with the Internet or big technological revolutions." – I04* *"I would certainly like to be more informed" – I06*

STRATEGIES TO IMPLEMENT	*"More investment and more support for southern companies to close a gap that has been dragging on for several decades and will only increase if action is not taken, helping healthy companies with training courses and economic contributions". – I02* *"I would suggest that we start implementing training programs as early as schools all the way through college, with the goal of preparing the next generation and incentivizing businesses to adapt to the fourth industrial revolution". – I03*

3.4.1. Lack of digital training

This section is concerned with a detailed explanation of the first of the three findings, namely lack of digital training, in order to better understand the research analysis.
The interviews first revealed that enterprises do not have enough knowledge on the topic of artificial intelligence. In particular, many of the interviewees failed to give a clear definition of artificial intelligence, raising numerous doubts from the start. In addition, two of the respondents, I01 and I02, did not recognize the smartphone's own AI capabilities, not even considering it as a primary source of their daily use of new technologies.

I01: "I think it's that thing that some machines have [...]"
I05: "I am not 100% aware of the information either."
I02: "I don't personally use AI."

Only one respondent seems particularly interested in the topic of artificial intelligence:

I03: "Personally, I am very interested and keep myself informed about the potential of AI and how it can be applied in our industry."

What follows from this is that therefore most of the respondents are not aware of the many features that artificial intelligence possesses.
On the other hand, with regard to perceptions regarding the risks associated with the use of AI, a common and general fear emerged that one day humans will be replaced by machines, resulting in the loss of many jobs.
Specifically, two of the respondents were particularly concerned about human-machine

substitution, I03 and I04:

I04: "I also fear that artificial intelligence may one day be generated that escapes human control."
I03: "It is natural that there is some level of concern about its ability to replace people in some jobs."

While respondent I01 does not believe that humans can be replaced by a machine within this particular industry:

I01: "I think our industry is one that still needs craftsmen and manual labor, which is what makes us unique."

In addition, one of the biggest concerns appear to be related to misuse caused by a lack of knowledge of the technological landscape and data security. This shows that respondents have only a fictitious or superficial knowledge of what the risks of using AI may be, and very often they are just afraid to use it as they lack basic knowledge.
Moreover, it was found by all respondents that the main causes of the gap between southern and northern enterprises lie in economic, social, and cultural reasons.

I05: "However, I am convinced that there are timing differences between the North and the South in terms of modernization."
I01: "I think the gap is caused for economic reasons, but I think also for lack of information and lack of knowledge about artificial intelligence. I'm sure I don't know most of the processes that could help us improve."
I06: "Small businesses give up AI precisely because of cost issues.
This is a worry more for the South than for the North having to work is better paid than in the South".

Only one of the respondents, I03, believes that this gap does not affect different territories, but different types of companies and sectors:

I03: "The significant variation is found in the type of industry in which companies

operate and the level of technology they possess."

It tended to be generally found that regions in the south lag behind those in the north. All companies were convinced that there were two main types of reasons for this: economic, in that they believe the southern regions do not have enough economic resources and incentives in order to invest in training and new machinery; and informational, in that they do not have the necessary information to use machinery equipped with artificial intelligence and are unable to keep up with the times.

Therefore, the knowledge gap of the respondents is quite wide; not knowing most of the functions and risks of artificial intelligence, it follows that companies have difficulty implementing new technologies and automating their processes.

3.4.2. Benefits awareness

This section, however, deals with the second category of results obtained, namely benefits awareness. Specifically, despite the identification of numerous risks and a variety of concerns, all respondents appear to have a positive perception of artificial intelligence and their opinion of it is good.

I03: "Although I am aware of potential critical issues, such as those related to data security and possible job losses, my view on AI remains positive overall."

Regarding the use of artificial intelligence, it appears that most respondents recognize the main basic forms of artificial intelligence that we use daily, such as smartphones and computers; as we mentioned earlier, only two respondents do not recognize its use.

I01: "Currently, we take advantage of artificial intelligence only through a 5-axis machine that works with very sophisticated software and is capable of performing machining in tight time frames, which is not possible by relying on human forces."
I05: "We are already experimenting with using artificial intelligence to automate tasks and processes, making many tasks more efficient and mapping processes".
In addition, all respondents were able to recognize many of the benefits of new

technologies; here are some examples:

It also turns out that most of the companies surveyed use the new technologies, albeit some to a small degree:

I02: "The benefits would be manifold because the use of artificial intelligence would make companies ahead of and competitive with European companies.

I06: "Produce more in the same time frame and you would get a qualitatively better product".

I05: "In general within companies would make certain activities more efficient, reducing timelines and improving productivity. i don't see any major obstacles."

All respondents acknowledged that the use of artificial intelligence leads to many benefits. Specifically, there is a common view that the main benefits that AI could bring within the industry's enterprises relate to speeding up production timelines, speeding up problem solving, and improving the accuracy of quality control.
In conclusion, it seems that companies in the wood-furniture sector in different Italian regions are aware of the potential advantages and benefits that the implementation of artificial intelligence within their production processes would bring.

3.4.3. Strategies to reduce the gap

In this section is the analysis of the last macro-area of results, which are about strategies to reduce the gap.
From the very first interviews, along with the lack of information on artificial intelligence, the other theme that jumped out immediately was the eagerness to learn that respondents have about the topic. They, recognizing the enormous benefits of new technologies but also that there could be just as many disadvantages, want to learn more in order to be able to stay abreast of the digitization process that has now taken over in recent years.

I01: "I don't think I'm well enough informed, but I think there are both great benefits and great risks, and I'd like to know more".

I04: "I find it right to embrace and not be frightened by big news, the same as

happened with the Internet or big technological revolutions".

In general, all businesses, not just those in the South, would like to be better informed about how to benefit from the use of artificial intelligence.
As for strategies to be implemented to reduce the gap, most respondents believe that there is a need for more incentives and investment, but most importantly, a suitable training course to learn about the risks and benefits inherent in the use of new technologies. In particular, there was one respondent who made a notable suggestion:

I03: "To promote the adoption of AI in companies in the wood-furniture sector, I would suggest that we start implementing training programs as early as schools up to university, with the aim of preparing the next generation and incentivizing companies to adapt to the fourth industrial revolution. In addition, we could support and reward companies that invest in new capital goods, both tangible and intangible, and encourage companies' investment in staff training to acquire skills in technologies crucial to the technological and digital transformation of companies".

Implementing artificial intelligence training courses in schools could be a good step for the future of many workplaces.
In addition, the common view seems to be that southern regions are more in need of economic resources than northern regions. More economic investment is demanded by all respondents, both in training for company workers and for the companies themselves to adapt to the new digitized world.

I02: "More investment and more support for southern companies to close a gap that has dragged on for several decades and will only increase if action is not taken, helping healthy companies with training courses and economic contributions".
I01: "in my opinion there is a need for information dissemination about the use of artificial intelligence, with clear news about the benefits and risks involved."

3.5. Grounded Theory Model

The analysis of the result categories showed that all the themes surfaced during the interviews appear to be interconnected. In this section, therefore, the focus will be on analyzing the dynamic relationships between the different categories obtained from the interview results.

With regard to the issue of the knowledge gap and that of the causes of the North-South gap, they appear to have a reciprocal relationship, as it turned out that the main causes of the knowledge gap lie not only in scarce economic resources, but mainly in the lack of training and information that respondents have in the field of artificial intelligence.

As a result, if companies do not understand the influence AI could have in their realities, they may be less likely to engage change their minds about using it. Moreover, the absence of active engagement could prolong their knowledge gap, creating a vicious cycle that would further increase the gap between enterprises in Northern regions and those in Southern regions.

On the other hand, regarding the perception on artificial intelligence, it follows that respondents recognize more advantages in it than disadvantages. The opinion derived from the risks is certainly related to the lack of training, and the inability to recognize most of the risks related to the use of AI is a confirmation of this; on the other hand, all respondents recognize in the use of new technologies a great potential, capable of making production more efficient, precise, and accurate, saving time and money. Most companies, in fact, not only recognize many of the benefits that the use of AI could bring, but they are already using or adequately utilizing new machinery equipped with great technologies, and the remaining companies that do not use it would like to have more information about it, in order to be able to implement artificial intelligence as well and be able to take advantage of its benefits. This shows not only the subsequential relationship that exists between the recognition of the benefits and the use of AI itself, but also shows us the controversial relationship between the knowledge gap theme and the two previously mentioned themes: despite the fact that the respondents appear to be lacking information of many of the areas related to artificial intelligence, they

recognize much of its benefits and have chosen to implement its use within their companies anyway.

The analysis of the results also revealed the willingness respondents have to learn more about the topic of artificial intelligence: recognizing in it most of the benefits they can derive from it and especially acknowledging their lack of training, all respondents expressed the desire to fully learn about the world of new technologies in order to make the most of their potential and be competitive with the global market.

This demonstrates the reciprocal relationship between recognition of benefits and willingness to learn. The latter is followed by the strategies proposed by the interviewees themselves to implement artificial intelligence within companies, which are reciprocally related to the causes of the gap between Northern and Southern regions. As mentioned earlier, the interviews revealed that the main causes of the gap between the regions relate to the lack of training and economic resources; as a result, it emerged that the most important strategies in order to reduce this gap are precisely more investment and more training courses in AI for the Southern regions.

In conclusion, it can be said that companies in the Northern regions are in a more advanced state of digitization than those in the South; in general, they all have a positive perception of artificial intelligence, but do not feel sufficiently incentivized to use it, both in terms of the large investments it requires and because they are still bound by superficial opinions about the risks involved in using AI.

A graphical representation of the model has been in the following page.

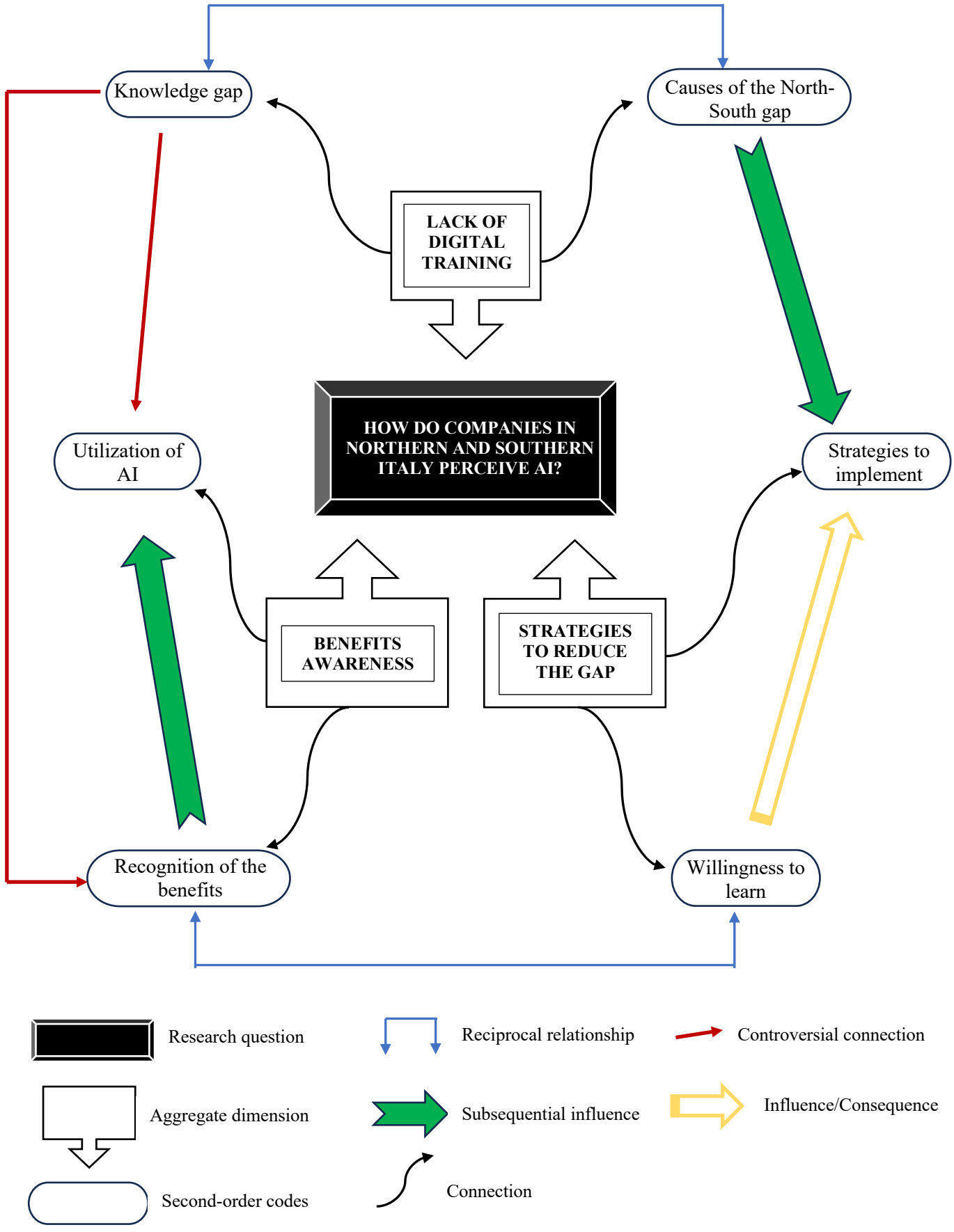


Figure 6 – Grounded Theory Model

3.6. Research recommendations and limitations

This research aims to identify the perceptions of businesses in the Italian territory on artificial intelligence, in order to know the reasons for the possible, and now evident, gap between businesses in northern regions and businesses in southern regions, not only in general but specifically in the wood-furniture sector. The purpose of the research, moreover, is to provide useful recommendations and advice to firms in the sector to increase their knowledge about new technology and their awareness of the vast risks and benefits they can derive from it.

This study also made it possible to confirm what was expressed in Chapter 2 about the digitization process that has now taken over our lives in recent years. It thus turns out to be confirmed that the obstacles that limit the Italian industrial sector are merely economic, cultural and social in nature; these obstacles, moreover, turn out to be very common in the perception of Italian companies and impact them negatively, not allowing them to implement innovative systems in their production and logistics processes. As previously mentioned, the processes of dematerialization and digitization and the entry of new technologies have taken on a clear acceleration whose effects are already evident on the organization of work and productivity, and this study confirms that habits and low appetite for risk are just some of the many obstacles that separate Italian companies from European and global models of success.

In addition, the results of this research showed the constant and present demand from the regions for more incentives and investment, especially with regard to the countries of the South, and there is a great desire in them to want to catch up with the rest of the Italian territory. Therefore, one of the first recommendations that this study wants to provide is to spur companies to show real interest in pursuing this change and not to be frightened by new things, in order to be able to apply for more incentives from the Italian state to learn about and implement new machinery and new technologies. Another recommendation that is meant to be given to Italian companies is to not stop in front of the mere rejection of more incentives and to start informing themselves independently, through the use of the Internet, video explanations or more simply with books, newspapers and magazines.

Instead, below are the limitations of this research in order to help possible future research:

- This study considered only a small group of respondents, consequently it may not necessarily be representative of the general population. Consequently, future research with larger samples may reveal more detailed results.
- Half of the interviews were conducted online via video call, due to geographical distance. Consequently, this may have influenced respondents not to fully answer some questions due to lack of space and time.
- Furthermore, this study covers only one of many sectors in the Italian industrial landscape. As it is made up of several and varied sectors, future research considering different sectors may reveal more meaningful and accurate results.

In addition, the use of semi-structured interviews can lead to several problems:

- Reliability of the data, which can result, for example, from interviewer or respondent bias.
- Validity of the data.
- Generalizability of the data: as explained earlier, due to the limited and non-random sample sizes used, the study may not accurately consider the general population.
- It may also be the case that the interviewer expounds his or her own ideas through the questionnaire, thus manipulating the respondent's answers and altering the quality of the data.
- The long duration of the interview may lead to a decreased desire for participation in respondents (Robson, 2002).

CONCLUSION

The rise of new technologies has produced upheavals in the manner and organization of work and consequently in economic, cultural and social structures. These changes have taken place at a time and speed not in keeping with the transformative capacity of societies in the various eras, producing collective and individual hardships. These discomforts focus mainly on the risk of being faced with ungovernable upheavals in the work environment and the differences between timing and pace of development, leading to the fear of not being able to keep up with the times. The processes of dematerialization and digitization and the entry of new technologies have taken on a clear acceleration, the effects of which are already evident on work organization and productivity.

Although the advantages of the digital innovation process are within everyone's reach, there are more and more obstacles, mainly cultural in nature, that limit the Italian industrial sector from implementing innovative systems in its processes. On the Italian territory, with regard to the use of new technologies within companies, the company's territorial reference base has a great impact; in fact, 65.3 percent of companies in the Northwest have a basic level of digitization, compared to 56.9 percent of companies in the South. This is due to the lack of information on the subject of new technologies: very often it is thought that large investments of money are needed for big data analysis and that it takes a long time to implement them, when in reality many of the new technologies turn out to be more accessible and effective than people think.

In addition to the few studies related to the use of artificial intelligence within companies in the industrial sector, there appears to be little literature regarding the use of AI within the wood-furniture sector, one of the leading sectors in the Italian industrial landscape. Therefore, the main objective of the study is to better understand the dynamics between artificial intelligence and the industry, so as to understand the now clear gap between the North and the South and in order to help help companies in the industry develop practices to adopt for their growth and advancement in the market. Thus, the research question will be, *"How do companies in northern and southern Italy perceive artificial intelligence? Is the gap still stark even in this sector?"* with the aim of obtaining the knowledge, opinions and attitudes of businesses in the Italian territory toward new technologies.

The results of the study showed that enterprises in northern regions appear to be in a more advanced state of digitization than those in the south; analysis of the interview data also

revealed that this gap is due to the lack of incentives, economic resources and lack of training that characterize southern enterprises. In addition, the results showed that all enterprises in the Italian territory have a fairly positive perception and opinion of artificial intelligence and are eager to know more accurate and detailed information on the topic, requiring more training courses and more investment. In fact, it turned out that they do not feel incentivized enough in the use of it, both in terms of the large investments it requires and because they want to know more about the possible risks they may incur, as they are still bound to superficial opinions about them.

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APPENDICES

APPENDIX #1 – Example of Interview Transcript

INTERVISTA 3 – NAVAL INTERIOR

I03: Mi chiamo Alessandro Beninati e sono il project manager nel settore dell'arredamento navale all'interno di Naval Interior.
ME: Perfetto, iniziamo. Che cos'è secondo te l'intelligenza artificiale?
I03: L'intelligenza artificiale **è un campo dell'informatica che si focalizza sulla creazione di sistemi e software in grado di simulare o replicare alcune delle capacità cognitive umane**, come il ragionamento, l'apprendimento, il riconoscimento di immagini, la comprensione del linguaggio, la percezione visiva, ecc.
ME: Quali sono secondo te i principali vantaggi dell'utilizzo dell'AI?
I03: L'utilizzo dell'intelligenza artificiale offre numerosi vantaggi in molteplici ambiti. Può **automatizzare compiti ripetitivi, facendo recuperare del tempo**, elaborando grandi quantità di dati in modo molto più rapido ed efficiente rispetto agli esseri umani. Si possono creare sistemi che funzionano ininterrottamente fornendo assistenza e servizi in qualsiasi momento della giornata. **Nel campo medico possono migliorare la diagnosi**, (tramite analisi di immagini mediche), personalizzare i trattamenti, monitorare i pazienti, assistere i chirurghi nelle loro attività. **In un futuro non troppo lontano la AI potrà guidare veicoli autonomi e ottimizzare il traffico, migliorando la sicurezza stradale.**
ME: Quali sono secondo te le principali preoccupazioni legate all'uso di intelligenza artificiale?
I03: Le principali preoccupazioni riguardo all'utilizzo dell'intelligenza artificiale sono legate alla **privacy, visto l'accesso a molte informazioni personali, e ai sistemi di automazione, che potrebbero sostituire alcuni lavori umani**. Di conseguenza molte persone vedono questa tecnologia come una minaccia per la loro sicurezza nella vita di tutti i giorni.
ME: Come pensi che l'IA abbia influenzato o potrebbe influenzare la tua vita quotidiana?
I03: Credo che l'intelligenza artificiale stia già influenzando la mia vita quotidiana e questo impatto diventerà **sempre più evidente grazie a tecnologie in pieno sviluppo** come veicoli autonomi e una crescente automazione dell'ambiente circostante.
ME: Sfrutti o hai intenzione di sfruttare l'IA in futuro per scopi personali o professionali?
I03: Come Project Manager, **sto già valutando l'idea di sfruttare l'AI per migliorare l'efficienza dei progetti e la qualità dei prodotti.**
Nel privato, un po' come molte altre persone, **uso già la tecnologia dell'automazione domestica attraverso dispositivi intelligenti come termostati e sistemi di aria condizionata controllati tramite app**. **Faccio uso quotidiano di servizi di streaming** che utilizzano l'intelligenza artificiale per personalizzare i contenuti in base alle mie preferenze e di **app di navigazione** che forniscono indicazioni stradali e aggiornamenti

sul traffico in tempo reale.
ME: Hai esperienza diretta o indiretta nell'uso di IA nell'azienda in cui lavori?
I03: Non ho esperienza diretta nell'uso dell'AI sul posto di lavoro, come azienda **stiamo attualmente esplorando l'iniziativa di modernizzazione dell'Industria 4.0.** Al momento, siamo nella fase di studio e valutazione delle possibilità e stiamo lavorando attivamente per mettere le basi per futuri sviluppi in questa direzione. Personalmente sono molto interessato e **mi tengo informato sulle potenzialità dell'AI e su come possa essere applicata nel nostro settore**. Credo fermamente che possa offrire numerose opportunità per migliorare l'efficienza, la qualità e la competitività della nostra azienda.
ME: In che modo sfrutti l'AI o in che modo pensi che l'AI possa essere utile per l'attività in cui lavori?
I03: L'AI potrebbe svolgere un ruolo fondamentale nella **verifica delle specifiche tecniche costruttive navali, analizzando rapidamente centinaia di pagine di dettagli complessi per individuare potenziali problemi o non conformità nei progetti.** Inoltre, potrebbe essere preziosa per **verificare la conformità dei progetti alle linee guida sanitarie (USPHS), alle normative dell'Americans with Disabilities Act (ADA) e alle normative SOLAS (Safety Of Life At Sea**), compiti complessi che richiedono un'analisi accurata dei dettagli progettuali, ma che l'AI potrebbe svolgere con rapidità ed efficienza. Potrebbe inoltre aiutare nell'analisi dei dati per una migliore gestione delle risorse e dei costi nei progetti.
In sintesi, si tratta di uno strumento potente che **può migliorare la precisione e l'efficacia del nostro lavoro, consentendo progetti di alta qualità conformi alle normative e alle specifiche tecniche.**
ME: Perciò ritieni di avere una visione complessivamente positiva o negativa sull'IA? Perché?
I03: Nonostante sia consapevole delle potenziali criticità, come quelle legate alla sicurezza dei dati e alla possibile perdita di posti di lavoro, **la mia visione sull'AI rimane complessivamente positiva.** Credo fermamente che essa abbia il potenziale per apportare miglioramenti significativi in vari settori, come la medicina, la ricerca scientifica e l'automazione industriale. Questa tecnologia **può contribuire a migliorare l'efficienza, la precisione e la convenienza in molti aspetti della vita quotidiana,** e vedo numerose opportunità per utilizzarla in modo responsabile e a vantaggio dell'umanità.
ME: Hai una paura dell'IA e della sua possibile sostituzione delle persone in determinati lavori?
I03: È naturale che ci sia un certo livello di preoccupazione riguardo la sua capacità di sostituire le persone in alcuni lavori.
ME: secondo te, utilizzare l'IA è rischioso?
I03: è importante considerare che si possono creare nuove opportunità di lavoro e migliorare la produttività in molte industrie. Per affrontare questa sfida, **è essenziale un investimento significativo nella formazione e nell'adattamento delle competenze**

dei lavoratori. Inoltre, è importante **utilizzare l'AI in modo responsabile**, affinché diventi uno strumento complementare al lavoro umano anziché sostituirlo completamente.

ME: Secondo la tua percezione, le aziende nel settentrione e nel meridione d'italia utilizzano l'IA in modo diverso?

I03: Personalmente **non credo che ci sia una differenza significativa nell'uso dell'AI tra le aziende del settentrione e del meridione d'Italia**. Piuttosto, **la variazione significativa si riscontra nella tipologia di settore in cui operano le aziende e nel livello tecnologico che queste posseggono.**

ME: hai notato differenze significative nell'adozione dell'IA tra le grandi aziende e le piccole imprese del nord e del sud?

I03: Le **grandi aziende che sono all'avanguardia nella tecnologia, indipendentemente dalla loro collocazione geografica, tenderanno ad adottare e sfruttare l'AI in modo più ampio e avanzato**, mentre **le aziende più piccole o meno orientate alla tecnologia la utilizzeranno probabilmente in modo più limitato.**

ME: e secondo te quali potrebbero essere le cause principali del divario nell'uso di IA tra le imprese del nord e del sud?

I03: A mio avviso **non esiste questo divario.**

ME: quali benefici potrebbero derivare dall'adozione di IA per le aziende nel settentrione e nel meridione? E quali sfide potrebbero ostacolare l'adozione della stessa nelle diverse regioni?

I03: L'adozione dell'Intelligenza Artificiale da parte delle aziende nel settentrione e nel meridione **potrebbe comportare benefici come un aumento della produttività, un miglioramento della customer experience** (esigenza del cliente), e quindi personalizzazione dei servizi, riduzione degli errori umani, ottimizzazione dei processi, analisi avanzate dei dati, miglioramento della sicurezza. In definitiva potrebbe **offrire molteplici vantaggi che vanno oltre l'aumento della produttività e la competitività.** Tuttavia, ci sono sfide da affrontare, come **gli investimenti iniziali, la mancanza di competenze specializzate, regolamentazioni complesse e adattamenti culturali e organizzativi**. La realizzazione di questi benefici dipenderà dalla capacità delle aziende di superare queste sfide.

ME: pensi che dovrebbero essere prese misure specifiche per ridurre il divario nell'uso dell'IA?

I03: Non credo che ci sia un divario tra nord e sud circa l'uso dell'AI, piuttosto **la differenza ricade sulla densità di territorio industrializzato che in proporzione riduce la presenza dell'uso dell'AI.**

ME: un'ultima domanda. Hai suggerimenti su come migliorare l'uso di IA nelle aziende del settore legno-arredo?

I03: Per promuovere l'adozione dell'AI nelle aziende del settore legno-arredo, suggerirei di iniziare a **implementare programmi di formazione sin dalle scuole fino all'università, con l'obiettivo di preparare le nuove generazioni e incentivare le imprese ad adeguarsi alla quarta rivoluzione industriale**. Inoltre, potremmo

sostenere e premiare le aziende che investono in nuovi beni strumentali, sia materiali che immateriali, e incoraggiare gli investimenti delle imprese nella formazione del personale per acquisire competenze nelle tecnologie cruciali per la trasformazione tecnologica e digitale delle aziende.

ME: okay, abbiamo finito. Grazie del suo contributo.

APPENDIX #2 – Example of Coded Interview

	A	B	C	D	E	F	G
1		**What do you think artificial intelligence is?**	**What do you think are the main benefits of using AI?**	**What do you think are the main concerns related to the use of AI?**	**How do you think AI has affected or could affect your daily life?**	**Do you exploit or plan to exploit AI in the future for personal or professional purposes?**	**Do you have direct or indrect experience in using AI in the company where you work?**
2	**Respondent 1**	That *thing* that some machines have	Understand the environment	Make sure the confidentiality of the data is secure	Saving time and speeding up processes	Yes, through the use of a machine that works with very sophisticated software	Yes, with specific documentation software for her tasks
3			Perceive various problems and solve them			Open to the future, but "*it takes great investment to buy and learn their use to the fullest*"	No for woodworking
4						No answer for personal purposes	