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Artificial Intelligence: history, evolution and application with a focus in the Financial Services sector

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PREFACE

Artificial Intelligence (AI) stands at the forefront of technological innovation, shaping the way we interact with machines and revolutionizing industries across the globe. From its humble beginnings to its current applications, the evolution of AI has been characterized by groundbreaking advancements and transformative breakthroughs.

This elaborate explores the rich history, evolutionary trajectory, and diverse applications of Artificial Intelligence, with a specific focus on its role within the Financial Services sector. As AI continues to permeate various aspects of our daily lives, its impact on financial institutions is particularly profound, reshaping how businesses operate, make decisions and interact with customers.

The journey of Artificial Intelligence begins with its conceptual origins in the early 20th century, as visionary thinkers such as Alan Turing and John McCarthy laid the groundwork for the pursuit of intelligent machines. From the seminal Turing Test to the birth of symbolic AI and expert systems, each milestone in AI's history represents a triumph of human ingenuity and scientific inquiry.

However, it was not until the advent of machine learning and neural networks that AI truly began to realize its potential. The emergence of algorithms capable of learning from data, coupled with advances in computational power and big data analytics, ushered in a new era of AI innovation. Suddenly, machines could perceive patterns, make predictions and adapt their behavior in ways that mirrored human intelligence.

Against this backdrop of technological progress, the Financial Services sector emerged as a fertile ground for the application of AI-driven solutions. In an industry characterized by vast amounts of data, complex decision-making processes and stringent regulatory requirements, AI offered a promising avenue for enhancing efficiency, mitigating risks and unlocking new opportunities.

In the realm of banking, AI-powered algorithms and some of its application (RPA, DPA) revolutionized customer service, fraud detection and risk management, enabling financial institutions to deliver personalized experiences and safeguard against emerging threats. In insurance, predictive analytics and machine learning algorithms transformed underwriting processes, claims management and customer engagement, leading to improved profitability and customer satisfaction.

Moreover, in asset management and investment banking, AI-driven solutions have empowered decision-makers with actionable insights, enabling them to navigate volatile markets, optimize portfolios and identify lucrative investment opportunities. From algorithmic trading to robo-advisors, AI has become an indispensable tool for navigating the complexities of modern finance.

As we delve deeper into the intersections of AI and the Financial Services sector, we are confronted with a myriad of opportunities, challenges and ethical considerations. While AI holds the promise of revolutionizing the industry, its widespread adoption also raises concerns about data privacy, algorithmic bias and the displacement of human workers.

Nevertheless, the potential benefits of AI in finance are too significant to ignore. By harnessing the power of machine learning, natural language processing and predictive analytics, financial institutions can unlock new frontiers of innovation, drive operational efficiencies and deliver superior customer experiences.

In this thesis, we embark on a journey to explore the multifaceted landscape of Artificial Intelligence, from its historical origins to its cutting-edge applications in the Financial Services sector. Through a blend of scholarly inquiry, empirical research and real-world case studies, we aim to provide a comprehensive understanding of AI's past, present and future, and its profound impact on the world of finance.

1.0 Artificial Intelligence: from its birth to the present day

STATE OF ART

In recent years, the proliferation of Artificial Intelligence (AI) has undergone substantial growth, owing to advancements in robust hardware, development platforms, and extensive datasets. Numerous applications have gained widespread adoption, delivering efficient outcomes at reduced costs. Media extensively covers the technological progress of AI and its increasing integration into society. Businesses have begun incorporating AI to address technical challenges and analyze business data. According to McKinsey's research, half of the respondents indicate that their companies have embraced AI in at least one business function, with 22% attributing at least 5% of the EBIT in 2019 to AI usage[1].

Governments are increasingly focusing on future investments in AI technologies. Discussions surrounding ethical implications, impacts on the workforce, legal frameworks, and cultural considerations remain highly debated. People are beginning to perceive AI as an integral part of their daily lives, capable of swiftly tackling practical issues. After years of research, successes, and setbacks, Artificial Intelligence has finally become an ingrained component of our daily existence, and it seems that it will remain for a long time.

1.1 History and Definitions

In recent decades, there have been numerous attempts to define the concept of Artificial Intelligence (AI). The reality is that AI has diverse applications across various fields, making it challenging to formulate a universal definition applicable to all scenarios. The Oxford Dictionary characterizes AI as "the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages"[2]. IBM Research provides a more simplified definition, describing AI as "anything that makes the machine act more intelligently"[3], operating autonomously without human interaction.

In a broader context, AI constitutes a discipline encompassing theoretical frameworks, methodologies, and techniques enabling the development of hardware and software systems capable of performing actions that, to an ordinary observer, appear exclusively linked to human intelligence[4]. The primary objective of this discipline is not replication but emulation of human

[1] T. Balakrishnan et oth., *The state of AI in 2020,* McKinsey, November 17, 2020, https://www.mckinsey.com/business-functions/quantumblack/our-insights/global-survey-the-state-of-ai-in-2020
[2] Oxford Reference, https://www.oxfordreference.com/view/10.1093/oi/authority.20110803095426960
[3] IBM, *Big Data Hush*, https://www.bigdatahush.com/artificial-intelligence
[4] M. Somalvico, *Intelligenza Artificiale*, Rusconi Editore, Milano 1987, p. 2

intelligence through mechanisms within a machine that can deliver performances qualitatively equal to or quantitatively superior to human capabilities. Achieving this outcome has required years of research, testing, and trials, and implementing AI in a business context remains a complex and computationally intensive process.

Over the years, researchers have explored various models of human reasoning to develop new AI techniques and systems. The study of human mental processes has ancient roots, with references such as Cartesian's famous quote "Cogito, ergo sum" from the 17th century suggesting that human existence is evidenced by awareness of cognitive processes[5].

The enduring and ambitious dream of humanity has consistently revolved around creating machines capable of communication, reasoning, and potentially serving as substitutes in our daily tasks. This particular fantasy serves as a foundational element that gave rise to the emergence of the field of Artificial Intelligence (AI) and continues to inspire scholars across various disciplines today. The notion of constructing a machine capable of processing thoughts, feelings, and emotions through a set of rules is no longer an idealistic and distant prospect, as it might have seemed in the past.

To comprehend the evolution of this discipline and the scientific advancements that have launched this technology into widespread use in our society, it is essential to trace its origins.

The official birth of AI is commonly dated back to 1956[6], marked by the famous summer seminar held in Dartmouth. During this event, the groundwork for the new discipline was laid, drawing from contributions by influential figures in the computational field who envisioned the development of potential intelligent systems. While 1956 is the agreed-upon official birth year within the scientific community, the history of AI extends beyond this date.

The concept of a human alter-ego is evident even in Greek mythology, as noted by Pamela Corduck who identified the Greek gods as the earliest instances of the desire to create artificial entities, portraying superhumans whose behavior mirrors our own, given the means. A notable attempt to emulate human actions from that era includes the creation of the first self-propelled automata by Heron of Alexandria in the 1st Century A.D. The "Heron's Machine" was designed

[5] L. Cena, *L'intelligenza artificiale: un profilo storico, Vita e Pensiero,* Pubblicazioni dell'Università Cattolica, Milano 1992, p. 113

[6] R. Anyoha, *The History of Artificial Intelligence*, Harvard University Website, 2017 https://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/

with mechanical and hydraulic components, capable of automatically opening and closing the doors of a temple[7].

During the medieval era, Raimondo Lullo, a Catalan philosopher and theologian, exemplified a notable inclination towards replicating human thought. Drawing inspiration from an Arab-origin concept of a "thinking machine," Lullo conceived the "Ars Magna"[8], described as a tangible artifact featuring concentric circles made of metal discs or plaster. The objective was to distill all sciences into fundamental principles represented by numbers and symbols. These elements, arranged in combinable arcs within concentric circles, facilitated systematic reasoning for problem-solving.

Advancing through time, the pursuit of a mechanical method for rational calculations persisted in Leibniz's "ars combinatoria"[9] in the late 17th century. This was followed by Cartesian investigations into the mind-body relationship, as mentioned earlier. According to Leibniz, logic, as a structured system of reasoning, needed to be mastered and mechanized to develop rational calculations, transforming reasoning into a form of thought algebra. The exploration of human rationale, the advent of early calculating machines, and the human inclination for self-imitation converged in Charles Babbage's "analytical machine"[10], constructed between 1834 and 1837. The characteristics of this machine laid the groundwork for modern calculators.

Beyond the scope of this extensive research tradition, disciplines such as philosophy, psychology, and mathematics played crucial roles in shaping the history of artificial intelligence. Philosophy contributed to debates on the nature of intelligence, mathematics provided a formal and logical approach, and psychology explored the relationship between knowledge and action.

However, it was only through the contributions of cybernetics and informatics that these considerations took on a more practical form, paving the way for the actual emergence of artificial intelligence (AI). Notably, neurophysiologists McCulloch and Pitts, in 1943, developed what is widely acknowledged as the inaugural artificial intelligent system[11]. This system comprised a model of artificial neurons capable of being "activated" in response to stimuli generated by a sufficient number of neighboring neurons. To achieve success, AI needed

[7] https://historyofinformation.com/detail.php?id=10
[8] https://plato.stanford.edu/entries/llull/
[9] https://www.treccani.it/enciclopedia/ars-combinatoria/
[10] https://www.eamesoffice.com/the-work/babbages-calculating-machine-or-difference-engine/
[11] https://www.historyofinformation.com/detail.php?entryid=782

a system capable of emulating intelligent phenomena, and the computer consistently proved to be the most suitable candidate for this role. Turing's universal machine, with its conceptual apparatus endowed with a potentially infinite tape for reading or writing symbols, played a significant role in its invention. This machine could execute algorithms and perform diverse procedures.

The formalization of these scientific principles in the 18th, 19th and 20th centuries allowed for the analysis of intelligence and its potential artificialization. The advent of electronic processors during the aftermath of World War II made a practical contribution, outlining these interests through the research program articulated in the 1956 Dartmouth seminar. This marked the inception of the field, with mathematician John McCarthy, one of the seminar organizers, proposing the term "Artificial Intelligence"[12].

The years following the seminar were initially marked by great expectations, fueled by the exponential growth of supporting computer systems. However, AI researchers soon encountered the first setbacks, as methods successful for simple examples proved wholly inadequate for more complex and expansive cases. In the 1970s, this led to a shift towards focusing on specific and narrower areas of expertise, giving rise to the development of the first "expert systems" – programs designed to replicate, through machines, the performances of experts in particular fields.

Starting with the rise in expectations, the 1980s witnessed the conceptualization of AI within industries. In 1982, the inaugural commercial system emerged[13], primarily designed to facilitate the configurations of new computer orders. During this period, there was a resurgence of interest in the neural network approach, boosted by the formation of the emerging discipline of cognitive science.

In recent years, AI has undergone numerous changes, both methodologically and substantively. The prevailing trend now leans towards building on existing theories rather than forging new ones, basing new considerations on established theorems or experimental evidence.

Tracing the history of AI unveils its character as a discipline shaped by a multitude of approaches. It lacks a singular "root" but instead finds its origins spanning various scientific

[12] M. Somalvico, *Intelligenza Artificiale*, Rusconi Editore, Milano 1987, page 4
[13] See note 6

and humanistic sources. Presently, AI permeates nearly every domain, including everyday life, instigating innovation and occasionally revolutionizing numerous facets of society.

1.1.1 Strong and Weak AI

A significant differentiation, aligned with previously outlined concepts, lies in the categorization of "strong" and "weak" AI, initially introduced by Searle in his work "Minds, brains, and programs. Behavioral and Brain Sciences".

Strong AI

In Searle's view, "strong AI" presumes that “the computer is not merely a tool in the study of the mind; rather, the appropriately programmed computer really is a mind, in the sense that computers, given the right programs, can be really understand and have other cognitive states” [14]. This hard assumption traces its origins to the philosophy of Hobbes, who asserted that intelligence, or the capacity for reasoning, is essentially a series of calculations performed by the human mind.

The technology underpinning "strong AI" is rooted in expert systems, as mentioned earlier. These systems comprise four key components: a knowledge base, an inference system, a knowledge acquisition system, and the user interface[15]. The knowledge base and acquisition system involve the creation of a set of rules and procedures necessary for the system's functioning. The inference engine extracts knowledge from the database and applies it in specific situations. Finally, the user interface facilitates interaction between the user and the machine.

Weak AI

On the contrary, in the context of "weak" AI, the primary value attributed to the computer in the study of the mind is its role as an exceptionally potent tool (Searle 1980). It can simulate cognitive human processes but falls short of replicating them or truly embodying a mind.

This perspective emerged when, during the early stages of automation, complex problems couldn't always be resolved, necessitating the development of new calculation and processing systems. "Weak" AI functions by examining analogous cases, making comparisons, and

[14] J. R. Searle*, Minds, brains and programs.* Behavioral and Brain Sciences, University of California, USA 1980, page 1

[15] F. Schmalhofer, *Expert Systems in Cognitive Science,* International Encyclopedia of the Social & Behavioral Sciences, 2001
https://www.sciencedirect.com/science/article/pii/B0080430767016156

formulating a range of solutions, ultimately selecting the most rational and fitting one. Its focus lies solely on problem-solving, without attempting to emulate the intricate cognitive processes of humans.

1.1.2 Debate over AI

Over time, theories regarding AI have caused intense debates. This discourse has its roots in a fundamental question: if the brain functions as a machine, is it theoretically possible to construct a machine that replicates all the functions of the human mind in its entirety?

From a scientific standpoint, the human mind and brain are distinct concepts. The brain serves as the central component of the nervous system, coordinating movements, thoughts, and emotions. On the other hand, the human mind is a more encompassing concept, pertaining to an individual's consciousness and comprehension of things. As previously indicated, advocates of the "weak" AI theory would respond negatively to the question, asserting that AI does not constitute a genuine form of intelligence. Conversely, the ongoing debate regarding the potential development of "strong" AI, like real human minds, was initiated by Turing in 1936[16]. Turing aimed to devise a system to assess the intelligence of a machine, drawing inspiration from a social game known as the "imitation game." In this game, a human player poses questions to both a human and a computer respondent. Subsequently, the questioner attempts to determine which terminal is operated by the human respondent and which by the computer. The test is deemed successful if the human questioner cannot distinguish between the two. As of now, no system has passed the Turing test, but a few have come close to achieving this outcome.

However, the Turing test has some limitations and a conceptual challenge. It is essentially a behavioral test, requiring the machine to emulate human behavior without necessarily possessing a mind or thoughts. Considering this, advocates of "weak" AI argue that creating intelligent machines with human-like cognitive capacities is unachievable, regardless of Turing test results.

This viewpoint is illustrated by Searle in his renowned thought experiment known as the Chinese room. In this experiment, Searle invites us to envision a closed room containing an individual unable to speak or comprehend Chinese characters, equipped only with an instruction manual. The manual details how, upon receiving a sequence of Chinese characters as input, the person must produce an output comprising another sequence with the same characteristics. The

[16] A. M. Turing, *Computing Machinery and Intelligence,* 1950

scenario takes place as follows: the person inside the room receives a sheet of paper with questions in Chinese characters, and by following the manual's instructions, produces answers indistinguishable from those of a person fluent in Chinese. Even though the person inside the room may provide correct answers in Chinese, Searle contends that they are merely manipulating symbols without truly understanding their meanings. The person in the room serves as a metaphor for a computer guided by software (represented by the instruction manual). Consequently, Searle concludes that even a calculator capable of conversing like a human being lacks the ability to generate thoughts, lacks a mind, and is confined to a "blind" manipulation of symbols.

Numerous researchers have confronted Searle's challenges, contending that even if the person inside the room lacks an understanding of Chinese, the entire system (comprising the person, the instruction manual, and the room) should be regarded as a unified entity capable of comprehending Chinese. Others have noted that intelligence can emerge from mechanical behaviors, even within the human brain, suggesting a similar phenomenon occurs within a calculator.

In summary, contemporary theories have moved beyond the distinction between "weak" and "strong" AI, proposing a new perspective on the question: a machine can be deemed intelligent only when it successfully replicates the functioning of the human brain at the cellular level[17].

Generally, when discussing AI, the common perception often revolves around intelligent robots capable of autonomous speech and actions without human interaction. However, AI assumes diverse "forms" beyond just robots; it serves as a fundamental component of IT systems, functioning as a supportive tool for various tasks by processing wide amounts of data. As previously mentioned, AI amalgamates various disciplines, with mathematics, logic, and statistics being the primary ones. These disciplines are applied to yield specific outcomes, typically involving prediction, optimization, deduction or reclassification.

In this context, before delving into the economic implications of AI and examining industry-specific applications, it is beneficial to explore the technological framework behind this novel form of intelligence. This exploration will particularly emphasize concepts such as Machine Learning, Deep Learning, and Neural Networks.

[17]https://www.intelligenzaartificiale.it/intelligenza-artificiale-forte-e debole/#Intelligenza_Artificiale_forte_e_debole_il_dibattito

1.2 Algorithms behind AI

In the book "Introduction to Algorithms," the press organ of the Massachusetts Institute of Technology defines an algorithm as "any well-defined computational procedure that takes some value, or set of values, as input and produces some value, or set of values, as output. An algorithm is thus a sequence of computational steps that transform the input into the output"[18].

The primary purpose of algorithms is to solve problems, ranging from simple tasks like ordering a list of numbers to complex ones such as mapping the human genome. The emergence and advancement of innovative algorithms are closely tied to research in the field of AI. Through AI algorithms, it becomes possible to identify correlations among data related to specific phenomena, aiming to provide increasingly accurate predictions about future scenarios. This, in turn, supports decision-making processes and helps overcome various cognitive barriers.

The significance of these algorithms lies in their ability to transfer both fundamental and sophisticated knowledge to machines, acquired through experience. This capability has given rise to two crucial branches that serve as the foundations of AI: Machine Learning and Deep Learning.

1.2.1 Machine Learning

Machine Learning, also known as automatic learning, represents a specific branch within informatics that can be regarded as a subset of AI. Defining the characteristics and applications of Machine Learning is challenging due to its broad scope, encompassing various methods, techniques, and tools. However, we can conceptualize Machine Learning as a comprehensive set of mechanisms enabling intelligent machines to enhance their capacities and performance over time. These machines can learn and perform diverse tasks, refining their abilities and functions through accumulated experience. The foundation of this automatic learning system lies in algorithms, which, starting from fundamental principles, make decisions based on specific criteria.

Alan Turing is perhaps the most renowned scientist associated with Machine Learning, recognizing the necessity of developing specific algorithms for creating machines capable of learning. During that era, AI studies, expert systems and neural networks underwent cycles of

[18] T. H.Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to Algorithms,* The MIT Press ,Third Edition, Cambride, Massachusetts, London, England 2009, page 5

both high and slow growth, attributed to challenges in creating intelligent systems, lack of economic support, and skepticism regarding their success. In the 1980s, noteworthy results attracted significant investments, reigniting growth in this sector. Finally, in the 1990s, Machine Learning witnessed renewed success with innovative techniques tied to statistical and probabilistic elements. This marked a crucial step, establishing automatic learning as a highly recognized and widely sought-after branch of research.

Machine Learning algorithms employ statistical and mathematical techniques to discern patterns and correlations within extensive datasets, encompassing numbers, words, images, videos, and more. Once information is digitized, it can be stored and input into a Machine Learning algorithm. The outcome is a machine that can learn to identify images and words, categorize information, analyze documents, engage in natural language conversations, or navigate routes for autonomous vehicles.

Presently, Machine Learning is integrated into various everyday products and services. Examples include recommendation systems on streaming platforms like Netflix, YouTube, and Spotify, as well as search engines like Google and social media platforms such as Facebook and Twitter, all relying on automatic learning systems. Practical instances include Google and Amazon's voice assistants. These technologies incorporate Natural Language Processing Understanding (NLU) algorithms, associating a user's request with a Frequently Asked Questions (FAQ) database and then providing an answer that best meets their needs. Such systems form the conversational marketing sector, likely representing the future of interactions between consumers and businesses. As consumer expectations rise, the ability to deliver a swift and personalized experience becomes integral to companies' strategies.

1.2.2 Deep learning

A concept closely related to the previously discussed one is Deep Learning, which serves as a subset of Machine Learning but constructs learning models on more profound levels. This technique endows machines with an enhanced ability to recognize patterns through a more intricate utilization of neural networks. From a scientific standpoint, it is accurate to characterize this mechanism as a means of learning data not provided by humans but through the use of statistical algorithms. The objective of these algorithms is to comprehend the functioning of the human brain and its capacity to interpret images and speech.

Conceptually, the framework behind Deep Learning can be envisioned as a pyramid, where higher-level concepts are learned from lower levels. This transformation is crucial as it enables

machines to classify input and output data, highlighting relevant information while disregarding less pertinent elements.

It's important to note that the concept of Deep Learning is sometimes confused with that of Neural Networks. The distinction lies in the fact that the term "deep" in Deep Learning exclusively refers to the depth of layers in a neural network. A neural network comprising more than three layers qualifies as a deep learning algorithm; otherwise, it remains a basic neural network.

The revolutionary aspect of Deep Learning lies in its ability, similar to the human capacity, to process data. Through this capability, machines can learn and process more complex functions. But how do machines learn? To address this question, it is necessary to introduce the concept of neural networks.

1.2.3 Neural network

Neural Networks, a subset of Machine Learning and a key component of Deep Learning algorithms, emulate human cognitive processes by copying the signaling behavior of biological neurons. This enables software programs to identify and solve common issues in the field of AI, machine learning, and deep learning.

The structure of a neural network consists of interconnected nodes, encompassing an input layer, multiple hidden layers, and an output layer. Each node is linked to another, featuring a specific weight and threshold. If a node's output surpasses the associated threshold, the node activates and transmits data to the next network level; otherwise, no data is transmitted. This process follows a "feedforward" methodology, where the output of one node serves as the input for the subsequent node in the network.

1.3 Big Data

The true driving force behind the ML engine is data. The greater the volume of data available to an intelligent machine, the more algorithms can learn, enhancing their ability to generate more precise results. This is exemplified in social networks, where the collection of vast amounts of information about our reading habits, posts, and preferences enables ML machines to suggest content tailored to our liking.

The term "Big Data" refers to the extensive quantity of data and information collected and managed daily by businesses and entities. The enthusiasm surrounding Big Data stems from the insights that can be extracted and utilized for statistical and market analysis. Managing such

massive datasets is a challenging task. To address this challenge, companies must adopt technological tools capable of efficiently handling these data to generate commercially and socially valuable insights.

The true revolution in this domain aligns with the proliferation of social networks, a phenomenon described as the Internet of People. Each individual has become a content creator, generating billions of pieces of information. Alongside people, we also encounter "things." The concept of the Internet of Things (IoT) pertains to a network of sensors installed on various devices connected via the Internet. The applications of these devices are widespread, including smart home devices like lighting and heating systems, which enable remote control of lights and temperature. Even the smartwatches we wear, recording physical activity, vital parameters, eating habits, and sleep quality, offer valuable insights to improve our overall well-being. These devices accumulate an exponential amount of information daily, and many companies are beginning to recognize their potential.

Around a decade ago, companies such as Facebook, Amazon, and Google recognized the immense value of the vast amounts of data they were collecting. These firms sparked a significant revolution in the field of marketing. For instance, Facebook exploited the ability to analyze information generated by each user and their interactions with friends, introducing a more personalized approach to advertising. Over the years, with the widespread use of smartphones and tablets in daily life, the influx of information from users has continued to grow. The aggregation of all this data holds substantial economic value.

The concept of big data, as outlined by Doug Laney in the 2000s, is encapsulated in the "Theory of the 3 Vs", highlighting three crucial characteristics: Variety, Volume, and Velocity. Variety pertains to the diversity of data, encompassing photos, documents, videos, audios, and more. Volume denotes the significant quantity of data originating from diverse sources, including social media, financial transactions and online purchases. Velocity addresses the speed at which data is transmitted and the subsequent need for immediate processing.

1.3.1 AI & Big Data

Big Data encompasses two primary processes: Management, involving processes related to the acquisition and storage of information, and Analytics, which involves the analysis of data.

Every user generates data, and the acquisition of this vast amount of data typically occurs through Application Programming Interface (API). Using this channel, data can be collected from users accessing a website through specific software, importing data from existing

databases, or extrapolating information flow through the web or cookies. This operation generates a substantial amount of information, which, at this stage, is not yet useful because the data must be "cleaned" and processed into the correct format. Finally, the data needs to be stored and analyzed. This last process is not only crucial but also computationally intensive, performed through algorithms that transform data into valuable insights used to enhance a firm's performance. It is in this final phase that the realms of AI and Big Data intersect. Big Data would lack value without algorithms capable of performing operations that can only be executed by intelligent machines.

1.3.2 Data Economy

MIT Technology Review defines the data economy as "the global digital ecosystem in which the producers and consumers of data – businesses and individuals – and government and municipal agencies gather, organize, and share accumulated data from a wide variety of sources"[19]. In Italy, researchers from the Polytechnic University of Milan note a significant advancement in technologies, complex experiments, and competencies in data science. The Analytics market in 2019 reached a value of 1.7 billion euros, marking a 23% growth from the previous year[20]. Big Data finds utility among various sectors, particularly benefiting companies aiming to analyze the market, understand current trends, explore new markets, or monitor and measure the performance and interactions of different business units. Notable users of Big Data include Banks (28%), Manufacturing Industries (24%), Media and Telecommunication (14%), Public Administration and Health (7%), Services (8%), Distribution (7%), Utility (6%), and Insurance (6%)[21].

AI serves as a key entry point into the "data economy." The EU Commission estimates that by 2020, there will be over 10 million data workers in Europe, with around 359,000 firms contributing to the EU "data economy," valued at approximately 739 billion euros, representing 4% of European GDP[22]. To actively participate in this economy, firms need to develop tailored policies, share data, and adopt Industry 4.0 technologies, where AI algorithms play a central role in extracting knowledge from data. In 2019, 54% of Italian firms had already conducted

[19] MIT Technology Review, *https://www.technologyreview.com/2021/11/16/1040036/capitalizing-on-the-data-economy/#:~:text=The%20data%20economy%20is%20the,a%20wide%20variety%20of%20sources*
[20] A. Perego, *Trasformazione digitale per cambiare il business,* Il Sole 24 Ore, July 16, 2020, page 55
[21] A. Perego, *Trasformazione digitale per cambiare il business,* Il Sole 24 Ore, July 16, 2020, page 55
[22] A. Perego, *Trasformazione digitale per cambiare il business,* Il Sole 24 Ore, July 16, 2020, page 55

tests for AI use, 20% had integrated stable applications into their production systems, and only 12% had initiated full-fledged AI projects[23].

Italian and European companies have not fully capitalized on the opportunities presented by the "data economy," leading to a lag in the adoption and proliferation of digital technologies compared to their Chinese and American counterparts. An indicative measure of this discrepancy is reflected in the percentage of GDP attributed to the AI and digital sector. As illustrated in the graph below, these sectors represent 1.7% of the total GDP in Europe, 2.2% in China, and 3.3% in the United States. In Italy, the percentage of GDP for the digital sector stands at approximately 1.2%.[24]

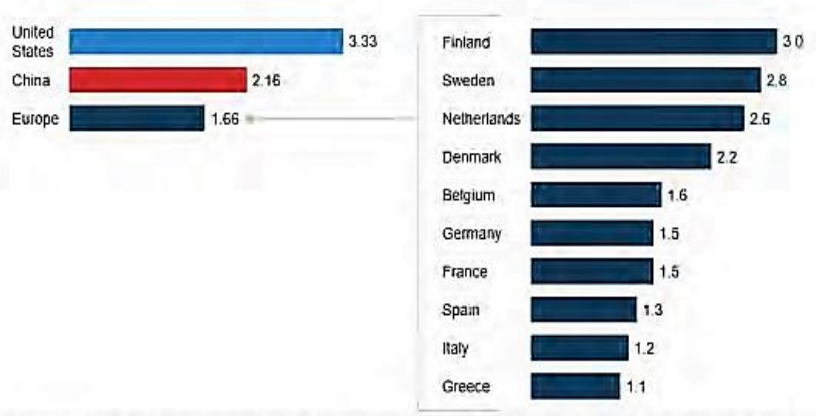

Figure 1: *GDP Percentage of Digital Sector and AI*, Source: McKinsey Digital Survey, 2018

The primary sectors incorporating AI are Banking & Finance (25%), Manufacturing (13%), and Utility (13%)[25]. In all these sectors, the role of the data scientist has gained increasing significance. The team of data scientists merges AI algorithms with data analytics to oversee firms' processes, identifying inefficiencies and exploring ways to integrate data generated within the firm with external occurrences. Their responsibility is to propel traditional businesses into the new era of data.

1.4 AI in the industry

In the industrial context, AI is not synonymous with complexity but should be seen as a means or tool to optimize a firm's value chain and enhance efficiency by assisting in repetitive tasks

[23] Ministero dello Sviluppo Economico (MISE), *Proposte per una strategia italiana per l'intelligenza artificiale*, 2019, page 34
[24] Ministero dello Sviluppo Economico (MISE), *Proposte per una strategia italiana per l'intelligenza artificiale*, 2019, page 34
[25] A. Perego, *Trasformazione digitale per cambiare il business,* Il Sole 24 Ore, July 16, 2020

or handling activities too intricate for traditional methods. Additionally, it opens up the possibility of gaining implicit suggestions and insights into future scenarios, enabling the formulation of new strategies accordingly.

Introducing an AI system in a firm doesn't necessarily entail adopting a technology accessible only to experts or burdening the infrastructure with expensive changes. Instead, a firm can leverage existing infrastructure to maximize value. AI initiatives generally range from simple virtual assistants or chatbots, which will be further discussed in the Financial Services field, to complete predictive maintenance systems. The latter collects machine operating data and can predict, for instance, breakdowns or discrepancies in production, taking corrective action before accidents occur.

Virtual assistants (chatbots) only require instruction and typically serve as the external face of the company. Their complexity varies depending on the programmed dialogue's intricacy. The technology needed for these initiatives is often already present in the firm's IT system and is typically deployed through a Cloud infrastructure. On the other hand, the second type of initiative mentioned represents an application of Artificial Intelligence that can potentially optimize and save costs, providing a significant return on investment (ROI). This application is more complex, involving the transport of data from machines to a central repository, filtering, transformation, and subsequent analysis to provide valuable insights into the production chain's functioning.

As explored in the following paragraphs, the impact of AI on firms differs across industries and geographic levels, driving various transformations based on the nature of the businesses involved, assuming diverse "shapes" and connotations.

1.4.1 Digital Transformation

AI and Digital Transformation are more interconnected than ever. AI exerts a significant influence on the latest digital initiatives, enabling improvements that were previously unachievable.

Digital transformation is the process of utilizing technologies to create new business processes, modify existing ones, shape organizational culture, and enhance customer experiences to meet evolving business and market requirements[26].

[26] Salesforce, *What is Digital Transformation*, https://www.salesforce.com/products/platform/what-is-digital-transformation/

Historically, expanding digitization within companies might have been seen as less strategically vital. Nevertheless, in the present scenario, AI precisely validates this form of digital transformation in the context of value creation.

Now, let's delve into the six technological fields commonly considered in the literature as pillars for constructing a digital transformation plan, where the correlation with AI becomes evident.

1. ***Automation***

In this scenario, the term denotes any solution that eases the burden of repetitive tasks and actions within a computer or mechanical system. The concept of "Industrial Automation" commonly refers to technologies that automate production processes either partially or entirely. However, the scope of "automation" extends beyond industry to areas such as service delivery, logistics, and tracking of goods in Smart Warehouses. The incorporation of AI technologies unlocks new possibilities in automation, enabling the adoption of advanced technologies like Robotic Process Automation (RPA) and Intelligent Process Automation (IPA). This empowers companies to tackle intricate decision-making processes.

2. ***Computerization***

Computerization involves implementing software applications, servers, and the necessary infrastructure to enable a computer to execute tasks that were previously carried out by people or other machines. In the business context, it enables firms to automate and streamline processes for increased efficiency. Computerization serves as a fundamental prerequisite for the exploitation of the capabilities of AI, as it allows the collection and generation of structured and unstructured data. From this data, AI can extract valuable insights, facilitating process optimization and the definition of new business models.

3. ***Dematerialization***

Dematerialization involves replacing paper documents with digital counterparts to enhance the efficiency, effectiveness, and security of firm processes. In line with the new GDPR regulation, tools for tracking and safeguarding access to digital documents have become crucial in this regard.

4. ***Virtualization***

Virtualization, broadly speaking, can be characterized as a collection of technologies that create an abstraction layer between computer hardware systems and the software operating on them. It involves logically partitioning resources such as CPU, RAM, and Storage among the

applications requiring them. This approach enables firms to optimize the processing capabilities of a hardware system.

5. Cloud Computing

Cloud Computing is a consumption and delivery model inspired by consumer internet services[27] (IBM). It operates as an on-demand, measured service where users can select required resources from a catalog and are billed only for the resources they use. These resources are accessible via an Internet connection, potentially on a global scale, and can be shared among users to reduce costs (resource pooling), regardless of the underlying hardware. The advantages of Cloud Computing extend beyond economic benefits. For instance, it can address sudden increases in processing capacity or implement mechanisms to enhance service availability (Disaster Recovery and Business Continuity). When combined with AI technologies, Cloud infrastructure enables the delivery of AI software-as-a-service on hybrid cloud infrastructure, providing firms with access to Artificial Intelligence technologies. By reducing adoption costs and leveraging the flexibility, agility, and scalability of the Cloud, AI initiatives become more widely and easily undertaken by enterprises.

6. Mobile

One of the most transformative developments in recent years is the widespread adoption of mobile devices, both in daily and business contexts. The evolution of wireless telecommunications and networks, coupled with the imminent introduction of 5G in mobile telephony, stands as a key driver in the companies' digital transformation process. This impact extends across various domains, with Smart Working and the Internet of Things (IoT) being notable examples in business life, while everyday life is influenced by features like Facial Recognition in smartphone security systems.

When contemplating Digital Transformation, it's crucial to avoid confining the phenomenon to isolated actions within a firm's value chain. The challenges inherent in a digital transformation process are diverse and must be addressed within the unique context of each company. As previously highlighted, adopting AI and embarking on a digital transformation journey within a business can yield numerous advantages in terms of productivity and efficiency.

Examining a practical case in the streaming industry, Netflix serves as an example of successful digital change management. Netflix outpaced Blockbuster in the movie rental realm by

[27] IBM, *Cloud Computing definition from the National Institute of Standards and Technology, https://csrc.nist.gov/publications/detail/sp/800-145/final,* 2011

implementing streamlined and computerized processes, along with intelligent algorithms for content recommendations. This approach allowed Netflix to offer a broad selection and personalized user experience, ultimately establishing itself as the world's most renowned and widely used streaming platform.

AI emerges as a paramount opportunity within the landscape of Digital Transformation. Effectively harnessing its potential poses a primary challenge that firms and entrepreneurs must navigate through a well-structured and long-term plan.

1.4.2 The economic impact of AI

Advancements in AI technology have brought about profound implications for both the economy and society as a whole. These breakthroughs hold the potential to directly impact the production and characteristics of a wide range of products and services, significantly influencing productivity, employment, and competition[28].

In recent years, heightened awareness of AI's potential within businesses has led to an exponential increase in the number of companies investing in this technology. The AI market is anticipated to experience a remarkable 39.4% compound annual growth rate (CAGR) from 2022 to 2028[29]. According to Research and Market, the global AI market reached a value of $51 billion in 2021 and is projected to reach $171 billion by 2025[30]. Gartner forecasts the AI software market to hit $62 billion in 2022[31]. Taking a broader perspective, PwC estimates that by 2030, AI could contribute $15.7 trillion to the global economy, accounting for a 1.4% annual growth[32].

In the realm of investments, the effort undertaken by the United States and China to dominate the AI sector far surpass those of other nations. According to Stanford University's estimates for 2020, the U.S. took a dominant position by investing $23.6 billion in the private investment sector, while China invested $9.9 billion[33]. Additionally, both countries accounted for most investments in AI start-ups and research and development projects.

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[28] A. Agrawal, J. Gans, A. Goldfarb, *The economics of Artificial Intelligence: An Agenda,* University of Chicago Press, 2019, p. 115

[29] Bloomberg, https://www.bloomberg.com/press-releases/2022-06-27/-422-37-billion-global-artificial-intelligence-ai-market-size-likely-to-grow-at-39-4-cagr-during-2022-2028-industry, 2022

[30] ReasearchAndMarkets.com, "Artificial Intelligence Global Market Report 2021: COVID-19 Growth and Change to 2030, 2021

[31] Gartner, https://www.gartner.com/en/newsroom/press-releases/2021-11-22-gartner-forecasts-worldwide-artificial-intelligence-software-market-to-reach-62-billion-in-2022

[32] See note 34

[33] Stanford University, *Artificial Intelligence Index Report 2021*, 2021 page 95 https://aiindex.stanford.edu/wp-content/uploads/2021/11/2021-AI-Index-Report_Master.pdf

The United States' recent investment trajectory has been largely influenced by Silicon Valley giants, driven by the nationalist and protectionist policies of the Trump administration. In this scenario, the focus of American policy appears to be directed towards promoting the advancement of AI applications, aiming to maintain the country's leadership in the global AI market.

Conversely, China has placed massive emphasis on advancing cutting-edge technologies, particularly AI, investing substantial public resources with the overarching goal of realizing the "Made in China" plan[34]. To achieve this, China has implemented a series of initiatives spearheaded by its multinational firms Alibaba, Huawei, and Baidu, comparable to their U.S. counterparts, in a bid to secure global leadership in the field of AI.

In Europe, while the level of investments remains considerably lower compared to the U.S. and China, various national initiatives have been launched. In 2016, Europe took steps to bolster the coordination of these initiatives through the "Digitising European Industry" plan, mobilizing over 50 million euros of investments between 2016 and 2020[35]. National strategies aim to enhance competition both domestically and internationally. These initiatives primarily focus on improving the availability of data for R&D projects, promoting skills, establishing structures to drive technological evolution, and facilitating its integration into society. In Italy, the Ministry of Economic Development has recently implemented an initiative to support firms in adopting AI. They have allocated a fund of 45 million euros for companies investing in AI and related technologies[36].

The substantial investment policies implemented by governments appear to yield positive outcomes for businesses. According to Figure 2, revenues from the worldwide AI for enterprise applications market are projected to reach approximately 31 billion U.S. dollars in 2025[37].

[34] Made in China 2025, http://english.www.gov.cn/news/video/2016/08/27/content_281475 427020647.htm, 2015

[35] European Court of Auditors, Digitising European industry, August 2019, https://www.eca.europa.eu/lists/ecadocuments/ap19_13/ap__digitising_industry_en.pdf

[36] MISE, https://www.mise.gov.it/index.php/it/notizie-stampa/blockchain-e-intelligenza-artificiale-da-settembre-gli-incentivi?utm_source=dlvr.it&utm_medium=twitter

[37] Statista, *Revenues from artificial intelligence for enterprise applications market worldwide from 2016 to 2025 (in million U.S. dollars)*, 2022 https://www.statista.com/statistics/607612/worldwide-artificial-intelligence-for-enterprise-applications/

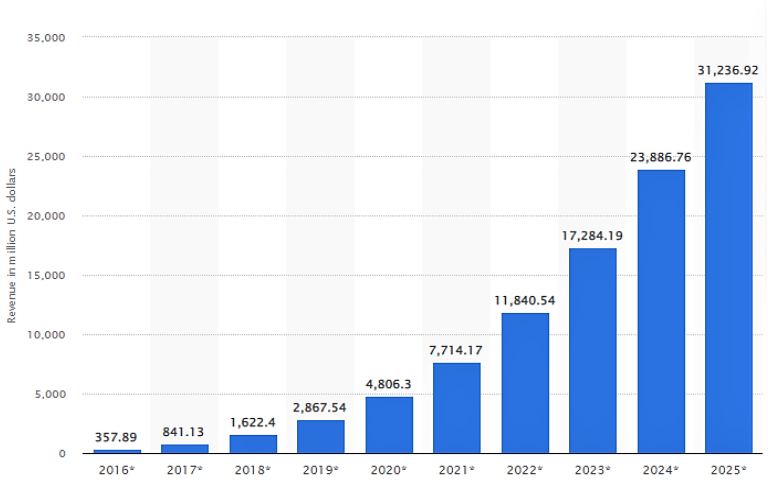

Figure 2: *Revenues from artificial intelligence for enterprise applications market worldwide from 2016 to 2025 (in million U.S. dollars)*, Source: Statista, 2022

AI has the capacity to positively impact revenues, leading to an increase of up to 20%[38], and this trend is becoming more pronounced over time. In response to the pandemic crisis, most top-performing companies have augmented their investments in AI across major business functions.

Similar to historical shifts with the introduction of new technologies, AI brings about significant changes in both individuals and professions. The primary workplace consequences coming from its adoption include:

- **Emergence of new economies and professions:** AI is expected to contribute to the growth (rather than replacement) of employment levels, generating new jobs and opportunities

- **Increased worker productivity:** AI has the potential to enhance work tools, elevating the achievable results through greater analysis and processing capabilities

- **New ways of working:** it's crucial to emphasize that machines cannot fully replace humans but rather support workers, necessitating a shift in their approaches to work

- **Requalification of skills and competences:** continuous updating of technical and managerial competences is imperative for companies, ensuring workers acquire the necessary new skills

[38] T. Balakrishnan et oth., *The state of AI in 2020,* "McKinsey", November 17, 2020, https://www.mckinsey.com/business-functions/quantumblack/our-insights/global-survey-the-state-of-ai-in-2020

The positive impacts of AI on firms' revenues are not instantaneous, and expectations vary among companies operating in different industries regarding the implementation of intelligent technologies in their businesses.

Overall, there is a widespread anticipation of significant benefits from AI across various industries. According to a MIT study from a few years ago in 2017, only 14% of respondents across all organizations believed that AI was currently having a substantial effect on their organization's offerings. However, a notable 63% anticipated witnessing these effects within the next five years[39].

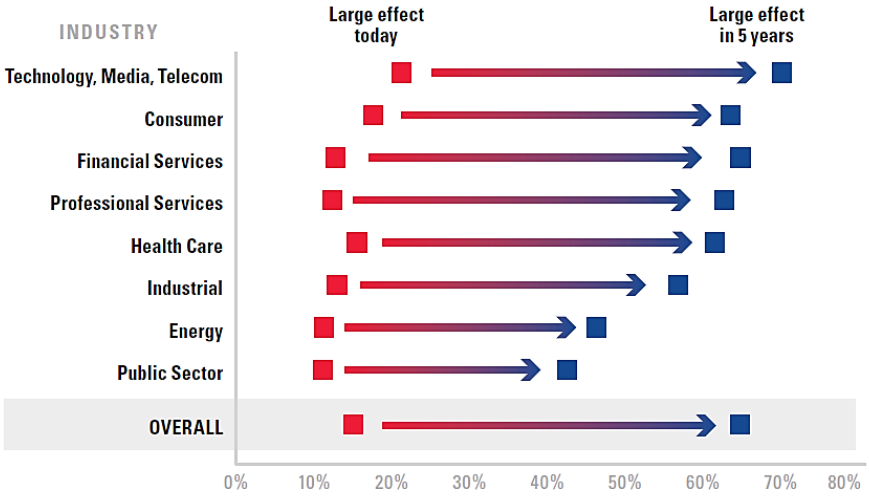

Figure 3: *Percentage of respondents who expect a large effect,* Source: MIT Sloan Management Review, 2017

Figure 3 illustrates that in the Technology, Media, Telecom, Consumer, Health Care, Professional, and Financial Services sectors, approximately 60-70% of respondents believed that AI would have a significant impact on their industries within five years.

Upon examining the results of the Accenture Study, it becomes evident that these expectations are indeed being met. Figure 4 provides an estimate of the change in revenues and employment levels for industries investing in AI from 2018 to 2022. The graph indicates an overall positive impact across all sectors, with an approximately 38% increase in revenues and a 10% rise in employment levels[40]. Specifically, the sectors anticipated to be most positively affected include

[39] S. Ransbotham et oth., *Reshaping Business with Artificial Intelligence,* "MIT Sloan Management Review" September 06, 2017, https://sloanreview.mit.edu/projects/reshaping-business-with-artificial-intelligence/

[40] Accenture, *Future Workforce C-Suite Survey*, https://www.accenture.com/us-en/insights/future-workforce-index, 2017

Consumer Goods, Health, and Telecommunications, followed by Retail, Professional, and Financial services.

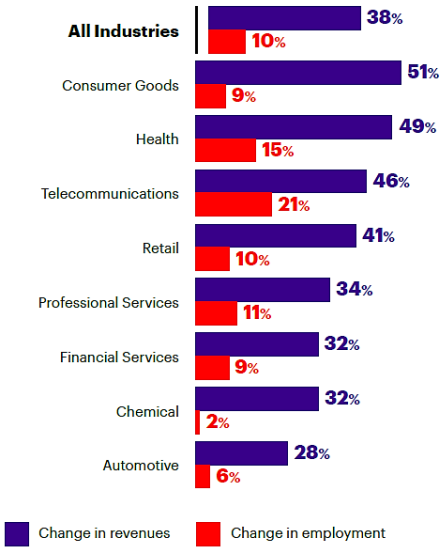

Figure 4: *AI impact on revenues and employment level*, Source: Accenture Future Workforce Study, 2017[41]

The primary catalyst for these positive effects lies in the increased productivity expected across various fields adopting AI. Forbes highlighted that current AI solutions can automate 40% of the tasks performed by salespeople during sales[42]. Automating processes within a company frees up time and personnel, creating opportunities to enhance efficiency in other areas.

As a source of new revenues and jobs, AI contributes to the growth of industries. Firms investing in intelligent technologies become more attractive to both investors, drawn by the potential revenues of AI, and new resources bringing fresh competences to the workplace.

Figure 5 illustrates the projected impact of AI on growth across 16 industries by 2035. The three main sectors experiencing boosted growth due to AI are Information & Communication (+4.8%), Manufacturing (+4.4%) and Financial Services (+4.3%)[43].

[41] E. Shook, M. Knickrehm, *Reworking the Revolution*, Accenture, 2018, page 6
[42] Forbes, AI's effect On Productivity Now and In The Future, https://www.forbes.com/sites/forbestechcouncil/2020/03/20/ais-effect-on-productivity-now-and-in-the-future/?sh=389146707591, 2020
[43] M. Purdy, P. R. Daugherty, *How AI boosts industry profits and innovation*, AI Research, Accenture, 2017

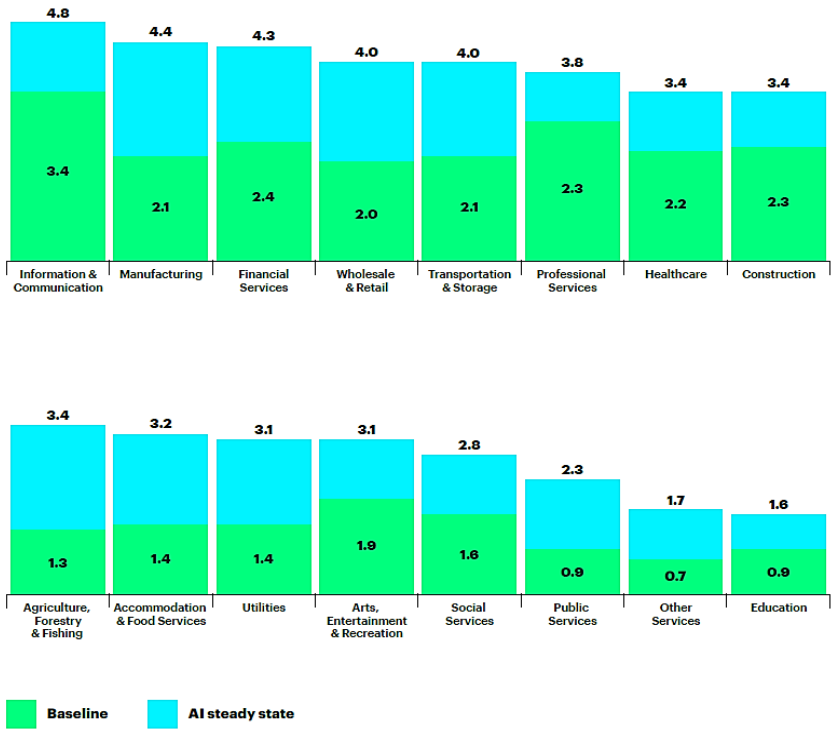

Figure 5: *AI impact on growth across industries*, Source: Accenture and Frontier Economics, 2017

It is unsurprising that the Information and Communication sector stands out as the industry where AI is most significantly driving growth. The analytical capabilities offered by intelligent software enable firms to implement innovative marketing models and communication strategies, attracting new customers and enhancing their experience across various channels. In the manufacturing field, AI presents a significant opportunity for improving productivity and reducing operating costs. Intelligent techniques such as predictive maintenance, which detects future breakdowns, and IoT for monitoring the quality and status of assets, contribute to these advancements.

Within the financial services sector, AI developments have the potential to strengthen the relationship between financial institutions and clients. This is achieved through the introduction of more inclusive and customizable financial technologies, a topic further explored in the document's second chapter.

1.5 AI & the impact on employment

1.5.1 The employment level trade-off

As mentioned earlier, AI is a multidisciplinary phenomenon that involves not only technical experts in specific disciplines like data science but also interdisciplinary figures such as psychologists, anthropologists, sociologists, linguists and humanists. These individuals play a

crucial role in enhancing the relationship between AI and its users, who are becoming increasingly sophisticated in language, gestures, body language and emotions.

The advent of Artificial Intelligence will lead to a profound transformation in the world of work. The employment rate is influenced by a trade-off. On one hand, AI is expected to have a negative impact on employment by replacing workers, especially in fields with repetitive and routine tasks, such as manufacturing, transportation, and storage. On the other hand, we will witness the emergence of new professional roles, such as data analysts mentioned earlier, and the creation of jobs in areas involving the operation and design of AI technology, such as cybersecurity or drone design for the Public Administration and Defense sector. Additionally, there are sectors where the "human touch" will continue to be indispensable, such as healthcare professions, and creative fields like arts and music, where AI abilities still cannot match the outcomes produced by humans.

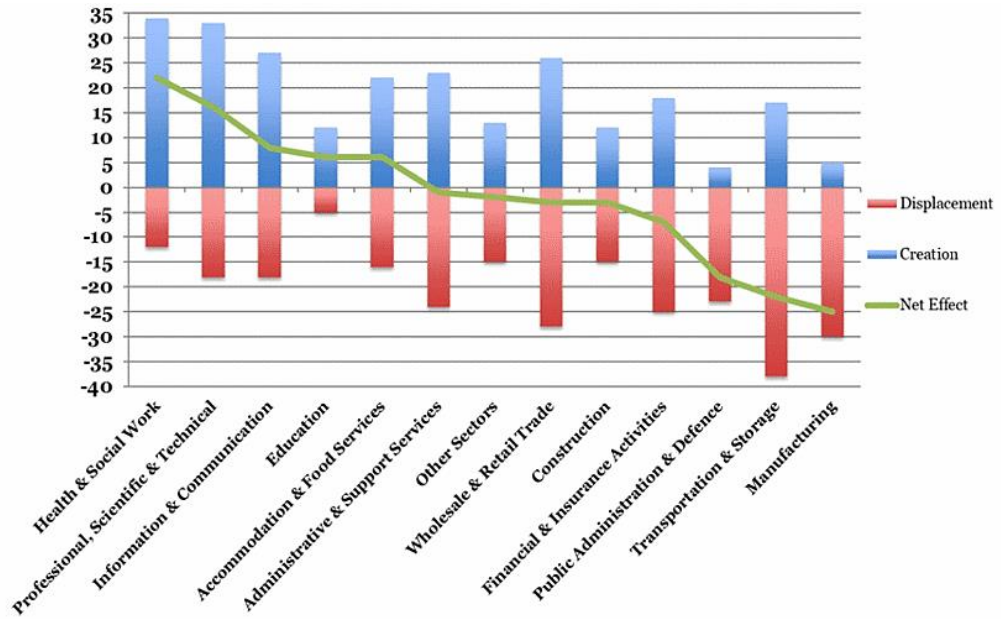

Figure 6: *Estimated Impact of AI on Job Creation and Displacement by Industry by 2037*, Source: Economic Research Council, 2018

Figure 6 depicts the projected impact of AI on employment levels in the UK by industry by 2037. According to the Economic Research Council, the average job creation rate is estimated to be 18.9%, while job displacement is anticipated to be 20.5%, resulting in an average net effect of -1.77%. Examining the chart reveals that the Health & Social Work sector is poised to experience the highest positive employment impact, leading to the creation of nearly 1 million jobs. The Education sector is also potentially positively influenced by the advent of AI, with job creation and displacement estimated at 12% and 5%, respectively. Conversely, the

manufacturing industry is expected to undergo the most significant reduction, with a loss of almost 700,000 jobs. Even the Public Administration & Defence fields, despite the creation of some new jobs, appear to be negatively affected by AI, primarily due to the automation of clerical roles[44].

These results contrast with broader geographical estimates from other notable firms. Consulting companies like Gartner and McKinsey contend that AI, while replacing employees in certain jobs involving repetitive tasks, will ultimately have a positive impact on the workplace, creating more jobs than it "destroys." McKinsey, for instance, believes that only about 5% of occupations at the current level of AI could be fully automated. Moreover, there is an anticipated boost in labor demand, generating a range of jobs from 555 million to 890 million by 2030[45].

The variation in estimates from different companies underscores the uncertainty surrounding the potential impact of AI on the workplace in the coming years. The introduction of new processes and methodologies is expected to bring about significant changes to most existing jobs. Manufacturing companies, in particular, will need to enhance technical competences to effectively manage products and processes with high digital content. Across all sectors, employees will be tasked with developing attitudes suited to a new environment where people and machines are interconnected, emphasizing the need for a continuous learning approach throughout their entire working lives.

1.5.2 New professional figures

In a study discussed in the article "The Jobs That Artificial Intelligence Will Create" by the Massachusetts Institute of Technology[46], AI introduces three new roles within production processes:

- **Trainers:** responsible for fostering empathic and positive interactions between AI machines and humans in complex situations

[44] Data of the paragraph are taken from Economic Research Council, *The impact of AI on UK Jobs,* 2018

[45] J. Manyika, K. Sneader, *AI, automation, and the future of work: Ten things to solve for, McKinsey*, June 1, 2018, https://www.mckinsey.com/featured-insights/future-of-work/ai-automation-and-the-future-of-work-ten-things-to-solve-for

[46] H. James Wilson, P. R. Daugherty, N. Morini-Bianzino, *The Jobs That Artificial Intelligence Will Create*, MIT Sloan Management Review, Research Report, 2017, page 14

- **Explainers:** playing a crucial role in bridging the understanding gap between technology and business leaders concerning highly complex systems. AI systems are often perceived as "black boxes" concealing the logic behind their suggested actions

- **Sustainers:** tasked with ensuring that systems adhere to guidelines and specifications, they are responsible for the training process. Additionally, they must promptly take corrective actions in the event of anomalies

In this evolving landscape, entrepreneurs find themselves undergoing a substantial transformation. Their role, critical in uniting capital and workforce to optimize output within a company, is being reshaped. When contemplating the digital transformation of a firm, entrepreneurs must envision the company's future by defining their unique recipe for digitalization, embedding it as a cornerstone in a multi-year strategic plan. While the plan can be adjusted if necessary, it must be pursued consistently across all areas of the company's organization, involving key figures crucial for the success of the transformation. Firms then need to incorporate a concrete action plan for implementing AI into their business strategy. If required, they should seek support from professionals and specialized companies to expedite the digitization process.

According to research from the Steering Committee of Digitalization[47], entrepreneurs can adopt two complementary approaches when strategically designing a vision for AI. They need to choose between a tactical, short-term approach or a strategic, medium-term approach.

A tactical approach pertains to the methods by which a specific department within an organization or the entire organizational structure must be configured or redesigned to implement an AI system within the production processes of a firm. This approach is short-term in nature, emphasizing the need for a genuine integration of AI technology, considering both internal and external factors, rather than a one-time implementation. Indeed, applying a pre-packaged technology to a firm's processes could be limiting instead of productive, particularly if this tactical approach is not preceded by a strategy with a comprehensive vision of the issue. Therefore, with a strategic, long-term approach, the company must deliberate on the decision to implement an AI system within its business, considering the objectives the firm aims to achieve and the impact on the business. The introduction of AI should be done in a thoughtful and meticulous manner, starting from a framework that considers the substantial amount of data

[47] Steering Committee of Digitalization, Position Paper*, Intelligenza Artificiale per le PMI,* 2018, page 16

a company often possesses. Medium-term projections of measurable benefits should serve as the foundation for the sustainable development of the entire initiative.

1.5.3 Employers and employees: two different point of views

Based on Accenture's "Future Workforce C-suite Survey", numerous managers worldwide view Artificial Intelligence as a significant opportunity, anticipating substantial changes in their workforce. However, in contrast to global Top Managers' expectations, 55% of Italian respondents in 2018 foresaw a reduction in the workforce following the introduction of AI[48]. This negative perception among Italian managers is likely rooted in their emphasis on enhancing operational efficiency through process automation rather than embracing innovative uses of new technologies. The traditional mindset prevalent in the workplace regarding intelligent machines involves categorizing business processes into two main areas:

- **Human-Intensive Area:** encompassing activities where humans excel in performing tasks

- **Automation Area:** encompassing activities where the use of machines is particularly efficient

The "Missing Middle", as coined by Paul R. Daugherty and Jim Wilson in their book[49], represents the intersection between the Human-Intensive Area and the Automation Area, holding the greatest potential and offering a key perspective on the AI revolution. Investments in this intersection, where Man and Machine converge, have the capacity to generate value for companies and create more job opportunities for the entire system. This results from a dual effect where humans complement machine activities and skills by modeling and training AI systems to adapt, set limits, make critical decisions, and supervise activities. Simultaneously, machines enhance human abilities, creating "superhuman capabilities" by suggesting interpretations of big data, utilizing human language to amplify interactions between people and machines, or enhancing physical abilities through the combination of AI with sensors.

For companies, the challenge lies in facilitating a harmonious fusion between man and machine, tapping into the full potential of AI, and recognizing the importance of cultivating new profiles and skills within their organization.

[48]Accenture, *Future Workforce C-Suite Survey,* https://www.accenture.com/us-en/insights/future-workforce-index, 2017
[49] Paul R. Daugherty and H. James Wilson, *Human + Machine: Reimagining Work in the Age of AI*, 2018

According to a survey by Accenture[50] conducted a few years ago, a majority of Italian managers (57% of respondents) attributed the lack of organizational transformation to workers lacking the necessary skills to collaborate with new technologies. Interestingly, Italian managers themselves demonstrated a limited proactive approach in enhancing their own skills to navigate change. Organisation for Economic Co-operation and Development (OECD) data further revealed that in Italy, there is a relatively low demand for profiles with managerial and organizational skills (administration, leadership, and resource management), and organizational changes progress slowly[51]. Italian managers identified competencies as a primary obstacle to implementing a personnel transformation strategy, and many companies still rely on traditional business processes without a structured program to address change and manage transitions.

On the employees' side, the survey showcased a positive and encouraging attitude: approximately 65% of Italian workers expressed optimism that AI would have positive effects on the business. The general sentiment is that AI will ease work, contribute to a better work-life balance, and foster creativity and innovation. Italian workers are willing to engage and undergo professional retraining to collaborate with intelligent machines. However, they face challenges, such as inadequate infrastructure and resources, limited time during the working day, unclear expectations regarding future skills, and a lack of employer support. Interestingly, Italian managers perceive a lower readiness among the workforce, estimating that only 30% are prepared to use AI.

Adding complexity to the situation is a notable discrepancy between employers and employees regarding the skills deemed crucial for the future. Employees highlight the importance of problem detection and solving, digital competencies and programming skills. In contrast, employers prioritize a distinct skill set, emphasizing resource management, leadership and communication. This disparity in perspectives between employers, who may appear less open to innovation, and employees, who are enthusiastic about engaging with new technologies, appears to hinder investments in job requalification[52].

1.6 Ethical & legal aspects

The utilization of AI has sparked intense debate, raising ethical concerns within society. It is essential to contextualize these issues, recognizing that the concept of ethics varies across

[50] Accenture, *Future Workforce C-Suite Survey,* https://www.accenture.com/us-en/insights/future-workforce-index, 2017
[51] OECD, *Getting Skills Right*, Italy, 2017
[52] Accenture, *Future Workforce C-Suite Survey,* https://www.accenture.com/us-en/insights/future-workforce-index, 2017

individuals, societies, and jurisdictions and may evolve over time. Therefore, ethical considerations should be viewed as general, abstract, and flexible guidelines, encouraging a principles-based approach rather than strict "rules" that could obstruct innovation or become outdated with cultural and technological advancements.

Additionally, when evaluating ethical aspects related to AI, it is crucial for policymakers and society to adopt a neutral stance toward this discipline, objectively considering its applications, intentions, and underlying purposes. This underscores the importance of fostering reflection and discussion on a global ethical framework for AI, aiming to instill consumer and public trust in the technology.

Additionally, a crucial consideration involves the importance of adopting an ethical approach from the inception of AI adoption, particularly during the design phase of a new application.

Similar to any emerging technology, the integration of Artificial Intelligence introduces not only novel opportunities but also new risks, necessitating the addressal of challenges in the regulatory landscape. Despite its unquestionable and exceptional opportunities, AI can also yield adverse consequences for the economy, the environment and society. As a general-purpose technology, AI lacks inherent positive or negative qualities; its connotation depends on its application. For instance, the malicious use of AI may involve pursuing illegal objectives such as violating fundamental rights, executing cyber-attacks, manipulating public opinion through the dissemination of fake news, and more. In such instances, policymakers encounter difficulties in assigning responsibility to those designing or implementing the AI system. Take, for example, the use of algorithms for pricing in e-commerce platforms or trading financial instruments. This may lead to sophisticated forms of collusion, with firms concealing their involvement by attributing the final decision on pricing to the AI, evading accountability.

Another category of risk pertains to unintentional biases affecting individuals and society. For instance, risks stem from the interactions between AI systems and humans or other AI systems, leading to unpredictable events such as “flash crashes”, rapid and unforeseen declines in commodity prices typically caused by automated trading. From a societal perspective, risks are associated with the "de-skilling" issue, involving the potential loss of skills and an excessive reliance on intelligent machines. Environmental risks are also notable, arising from the substantial energy consumption of supercomputers and data centers. Prioritizing the

development of sustainable AI is crucial, especially considering the environmental emergency as a significant risk for humanity[53].

To address the risks and ethical concerns associated with AI implementation, governments and institutions have taken steps to formulate guidelines and regulations. These aim to orientate the use of AI toward promoting its benefits while concurrently mitigating potential dangers.

On a global scale, the General Conference of the United Nations Educational, Scientific and Cultural Organization (UNESCO) has endorsed the "Recommendation on the Ethics of Artificial Intelligence" document[54]. This recognition acknowledges both the positive and negative impacts of AI on society, the environment, ecosystems, and human lives, encompassing the influence on human thoughts, interactions, decision-making processes, as well as its effects on education, human and social sciences, culture, and communication.

Similar to other UNESCO documents and general ONU's Recommendations, the adherence to this AI ethics paper, released in November 2021, is voluntary and has been adopted by 193 countries. The document serves as a crucial foundation in establishing shared standards to safeguard and promote human rights in the realm of AI systems. It provides a solid basis for comprehending, accepting, or addressing intelligent technologies.

UNESCO's Recommendation aims to create a globally shared regulatory tool, not only defining values and principles but also offering practical application through specific recommendations. The intricate nature of AI ethical issues necessitates cooperation among parties at international, regional, and national levels. UNESCO's Recommendation seeks to enable these parties to assume shared responsibility through a global and multicultural dialogue.

The objectives outlined in the document are as follows:

1) **Establishing a universal framework of values**, principles, and actions to guide States in shaping their legislations, policies, and other tools consistently with international law
2) **Directing the actions of individuals, groups, communities, institutions, and private firms** to ensure that AI systems operate in accordance with ethical principles
3) **Protecting, promoting, and respecting human rights and freedom**, human dignity, and fairness, including gender equality; safeguarding the interests of present and future

[53] Reference of this pharagraph was taken by Ministero dello Sviluppo Economico (MISE), *Proposte per una strategia italiana per l'intelligenza artificiale,* 2019, page 17
[54] UNESCO, *Recommendations on the Ethics of Artificial Intelligence*, 23 November 2021, page 14

generations; preserving the environment, biodiversity, and ecosystems; and respecting cultural diversity in every phase of technology's lifecycle

4) **Fostering multi-stakeholder**, multi-disciplinary, and pluralistic dialogue, and achieving consensus on ethical issues related to AI systems
5) **Promoting equitable access to AI developments and knowledge**, as well as benefit sharing, with particular attention to the needs and contributions of the least developed countries

At the European level, the European Commission has released a significant document outlining Ethical Guidelines for Trustworthy AI[55]. According to this document, implementing an AI system in a safe manner requires adherence to a list of seven requirements:

1) **Human agency and oversight**. AI systems should promote equitable societies and fundamental rights, avoiding the diminishment, limitation, or misleading of human autonomy
2) **Technical robustness and safety.** Algorithms should exhibit security, reliability and robustness to handle errors or inconsistencies throughout all phases of the AI life cycle
3) **Privacy and data governance.** Citizens should have complete control over their own data, and data about them should not be used against them or in a discriminatory manner
4) **Transparency.** Ensuring traceability of AI systems is crucial
5) **Diversity, non-discrimination, and fairness.** Systems should consider the full spectrum of human abilities, capabilities, and requirements, ensuring accessibility
6) **Social and environmental well-being.** AI systems should be utilized to foster positive social change, enhance sustainability, and promote ecological responsibility
7) **Accountability.** Implementing mechanisms to ensure accountability and verifiability for AI systems and their outcomes is essential

The concepts of fairness, privacy, and transparency are often central to heated debates as fundamental values for a system to adhere to ethical principles. The Ethical Guidelines for Trustworthy AI document represents one of the initial efforts to translate a mere list of ethical principles into more concrete terms, making a significant contribution to the international landscape. However, it marks only the beginning of a path that requires ongoing

[55] European Commission, *Ethics Guidelines for Trustworthy AI*, https://www.aepd.es/sites/default/files/2019-12/ai-ethics-guidelines.pdf, 2019

experimentation. For example, the document emphasizes the need for risk assessment without providing examples of morally inconsistent or unethical uses of AI.

Therefore, in addition to the general guidelines at the global and European levels, legislators have established specific regulations and norms to ensure the respect for the ethical values and principles described thus far. Since the emergence of AI, various initiatives have been undertaken over the years to establish fitting and effective regulations.

In this regard, a significant contribution was made in 2020 by the European Parliament. The 24 articles of the proposed Regulation titled "On Ethical Principles for the Development, Deployment, and Use of Artificial Intelligence, Robotics, and Related Technologies," which were voted on during a plenary session, establish a European regulatory framework encompassing ethical principles and legal obligations for the development, deployment, and use of AI, robotics, and related technologies[56]. Unlike the general guidelines mentioned earlier, resolutions adopted by the European Parliament aim to promote the adoption of binding EU acts, particularly in terms of protecting human rights and fundamental freedoms.

The geographic scope of the Regulation encompasses all aspects of AI and all stages of development, deployment, and use within the Union, even in cases where some technologies may be located outside the Union or lack a unique or specific location, as is the case with cloud computing.

Among the prescriptions, the European Parliament emphasizes the necessity for an effective and harmonized regulatory framework based on Union law, the Charter of Fundamental Rights of the European Union, and international human rights law. This framework is particularly crucial for high-risk technologies, aiming to establish uniform standards throughout the Union and effectively safeguard Union values. Achieving uniformity in application requires a consistent interpretation, and to this end, the proposed regulation includes numerous definitions, covering terms such as artificial intelligence, robotics, related technologies, and biometric recognition.

The document advocates the perspective that intelligent technologies should strive to enhance the well-being of individuals and societies. Regulation, accordingly, should prioritize human dignity, autonomy, and self-determination, ensuring that these technologies serve people rather

[56] European Parliament, *European Parliament resolution of 20 October 2020 with recommendations to the Commission on a framework of ethical aspects of artificial intelligence, robotics and related technologies (2020/2012(INL)),* October 2020

than replace them. To guarantee the anthropocentric and anthropogenic nature of AI and related high-risk technologies, the proposed regulation stipulates that intelligent technologies must always be guided by ethical principles. They should be designed in a manner that respects and facilitates human intervention and democratic oversight, while also allowing for the restoration of human control when necessary through the implementation of appropriate control measures.

Furthermore, as emphasized in the UNESCO and European guidelines mentioned earlier, this Regulation underscores the significance of promoting equity, inclusion and transparency. It aims to eliminate opportunities for harm, bias and discrimination while limiting negative external effects. Additionally, AI, robotics and related technologies are expected to be utilized for the benefit of the planet, contributing to sustainable development, environmental protection, climate neutrality and circular economy goals.

Another crucial provision of the proposed Regulation involves the establishment of a new independent supervisory authority tasked with monitoring the adoption of the regulation by firms. This entity is responsible for assessing the risk and compliance of AI, robotics, and related technologies with European principles and values as outlined in the EU Charter of Fundamental Rights.

The terms of the proposed regulation suggest that the use of AI in specific fields should undergo prior certification of compliance by the new European supervisory authority. This certification process operates in coordination with corresponding national authorities.

Creating a regulation for AI necessitates addressing the challenge of striking a balance between various considerations. Specifically, as highlighted by discussions at the European Commission Level, the evolution of the regulatory framework should simultaneously encourage innovative capacity in the AI field and ensure that technological progress aligns with European key principles and values.

A well-balanced, robust, and consistent regulatory framework would not only foster the widespread adoption of this emerging technology but also yield numerous advantages for European companies. The upcoming guidelines are anticipated to focus on clearly defining risks, steering clear of unnecessary regulatory and administrative burdens, and simultaneously fostering innovation growth in Europe.

As the framework for AI matures and becomes more standardized in the future, there is potential to reevaluate the mechanisms for interpreting and verifying key elements. This could lead to enhanced transparency, reliability and security of AI systems.

2.0 AI & Financial Services sector

The Financial Services sector encompasses various entities such as banks, insurance companies, investment houses, lenders, and real estate brokers, providing financial services to individuals and businesses.

This sector plays a crucial role in supporting the economy, contributing to employment, taxation and overall economic growth of a country. A robust Financial Services sector facilitates better risk management for companies and higher income for consumers. Conversely, if the sector fails, it can lead to economic downturns, reduced lending, decreased investments and a decline in GDP, impacting employment levels negatively.

The major trends significantly impacting the financial services sector include[57]:

1. **Decreasing interest rates:** governments, responding to the pandemic crisis, have implemented fiscal and monetary interventions, resulting in increased indebtedness and efforts to maintain low interest rates. While this initiative encourages investments, it also lowers net interest margins for banks and investment returns for insurers and asset managers.
2. **Constrained risk-bearing capacity:** in response to the COVID-19 crisis, banks and insurers have tightened lending conditions. Businesses will need to explore diverse funding options, relying more on capital markets. Insurers, in particular, will focus on rebuilding capital, streamlining product portfolios, and optimizing client profitability.
3. **Rise of non-banking alternative providers:** the traditional role of banks in providing financing faces challenges, with alternative financing gaining prominence, especially in the post-COVID-19 economy as a source of fresh capital.
4. **Acceleration in the adoption of regulatory measures:** regulatory measures initiated in response to the pandemic, such as sanctions and anti-money laundering, are expected to be swiftly implemented.
5. **Unilateralism, nearshoring, and diversification:** de-globalization continues, aligning the size of financial institutions with the GDP of their home countries. This drives a renewed focus on nearshoring and diversification of offshore locations.
6. **Digitalization:** the pandemic has accelerated the adoption of digital channels, prompting financial institutions to further digitize customer-interaction models. This

[57] PwC's Report, *The Future of Financial Services, Securing your tomorrow, today*, 2021, page 9-16

shift emphasizes digital sales and service models, leading to increased reliance on cloud-based architectures and a demand for digitally skilled workers.

7. **Shift from product-to-client centricity:** the move toward digitized customer interactions encourages banks and companies to enhance the overall customer experience. This shift emphasizes a more client-centric approach, focusing on personalized services.

In an environment where interest rates are near zero, banking commissions decline significantly and customer expectations rise, financial institutions must optimize their business processes to reduce costs. By embracing modernization through the incorporation of artificial intelligence, cloud technology and automation, banks can swiftly develop services, functionalities and products as part of an omnichannel strategy. This transformation benefits firms by enhancing customer experience and trust.

The digital transformation has profoundly impacted the Financial Services sector, known for providing easily digitized intangible services. The pandemic has expedited the digitalization journey for banks and financial institutions. Many financial services firms leverage AI for diverse services like fraud detection, invoice creation, investment strategy recommendations and cash-flow event predictions. For example, beyond European borders, JP Morgan invested approximately $10 billion in the last decade to support innovative initiatives. Notably, COIN (Contract Intelligence), an AI system developed through this investment, swiftly reads and extracts relevant data from commercial and financial contracts. Through the integration of machine learning algorithms, COIN automates contract reading and interpretation tasks, saving 360,000 hours of lawyers' work[58].

Customers in this sector look for simplicity, immediacy and transactional security, along with the flexibility to conduct transactions anytime, anywhere, ensuring maximum security. Financial institutions must embrace the challenge of digitalization and evolve their service models to meet the evolving needs of customers.

2.1 The new role of the bank

In the contemporary landscape, banks can be likened to historical navigators, driven by the imperative to explore new territories. Recognizing that change is now a fundamental requirement for market competitiveness, banks must adapt to navigate the challenges of an increasingly intricate and ever-changing world. This adaptation involves engaging with new

[58] https://futurism.com/an-ai-completed-360000-hours-of-finance-work-in-just-seconds

stakeholders, agile Change Management practices and addressing customer demands for enhanced personalization and efficiency.

Economically, the Retail Banking sector has faced difficult challenges due to COVID-19, impacting profit margins. The global economy remains in a recession with unpredictable recovery timelines and modes, contributing to low consumer confidence. Banks also deal with thinning margins attributed to increased bad debts and low interest rates, coupled with reduced capital availability for financing profitable activities. Faced with diminished profits from traditional business avenues, banks must contemplate the necessity of transforming their business and operating models.

This awareness necessitates a tangible transformation. The new banking model should align with customer needs through advanced digitalization and the integration of AI systems. This approach aims to provide streamlined, rapid and precise processes, unlocking the latent potential of employees for higher-value activities. Undertaking such a complex transformation requires a meticulous Change Management strategy.

The landscape of technological innovation is presenting numerous opportunities to expedite the adoption of initiatives. In particular, Robotics and AI contribute significantly to enhancing overall operational efficiency, introducing new work paradigms, and giving rise to novel professions. The abundance of data and information serves as a engaging catalyst for adopting technological solutions, showcasing the substantial value inherent in this wealth of information.

Customers' growing inclination towards utilizing new digital channels is increasingly augmenting the online offerings of banks, expanding both the range of functionalities and the associated technological solutions that drive towards multi-channel integration.

To further encourage the use of digital offerings, banks play a crucial role in communicating activities that enhance the security of online channels, bolstering the foundational element in customer relationships: trust. Many banks are now incorporating methodologies, commonly known in the internal processes' realm as "Agile." Initially developed to support software development, re-engineering activities and continuous improvement of internal operations, these methodologies are proving effective in fostering innovation and digital transformation paths.

In the realm of cultural changes, which are often integral to innovation and digital transformation, firms must pay close attention. Every change involves people, and the success

of any transformation program rotates around the ability to enhance and inclusively involve the human resources within the banking sector.

A bank must always possess a clear understanding of the potential internal impact of a new initiative on its employees. The acceptance and subsequent dissemination of innovation or a specific AI technology can be compared to a social process where people's attitudes and user perceptions play a pivotal role.

From a managerial perspective, the bank's new role can be likened to that of a juggler on a unicycle, where the balls represent both the evolving challenges and the ever-increasing demands of customers. The unicycle's wheel symbolizes the bank's imperative to ensure operational continuity of services in an increasingly competitive and uncertain landscape.

2.2 The new role of the customer

The commercial banking system is experiencing swift changes driven by a blend of political, economic and technological factors related to the shifting competitive landscape, customer habits and values.

The KPMG "The New Consumer 2020" research conducted, across 12 countries globally, in the second quarter of 2020, reveals that, on average, 4 out of 10 consumers reported a deterioration in their financial situation. Additionally, another 13% opted to defer significant purchases, thereby restraining the volume and value of transactions and the demand for liquid assets[59].

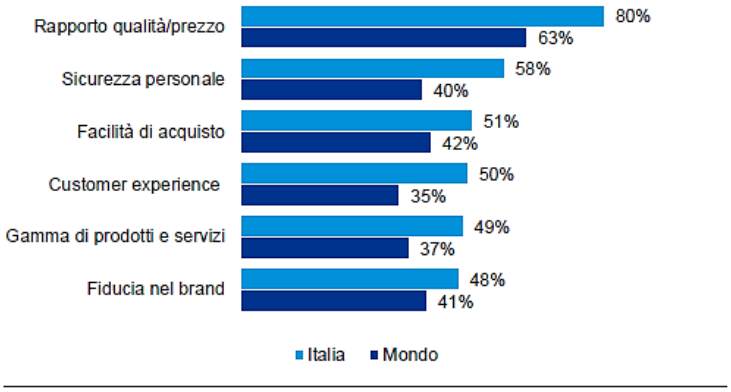

Figure 7: *Clients purchasing decisions drivers*, Source: KPMG, 2020

In the context of an uncertain economic recovery, the graph above illustrates that value-for-money has emerged as the most crucial factor influencing customer purchasing decisions. The

[59] KPMG's Paper, *The New Consumer 2020*, 2020

research indicates a pronounced impact in countries like Italy, where the value-for-money factor takes precedence (80%), followed by personal safety (58%), ease of purchase (51%), customer experience (50%), the range of products and services (49%) and trust (48%). Beyond reduced disposable income, consumer spending is shaped by the psychological impact of COVID-19, fostering a state of anxiety and uncertainty, leading to more cautious and restrained purchasing behavior.

Another notable trend, accentuated by the pandemic, is the increasing demand for convenient access to products, services and information. Consumers now place greater emphasis on digital experiences, with online shopping channels being the preferred choice. In-store shopping has become less frequent, and individuals of all ages are gravitating towards touchless shopping and contactless payments.

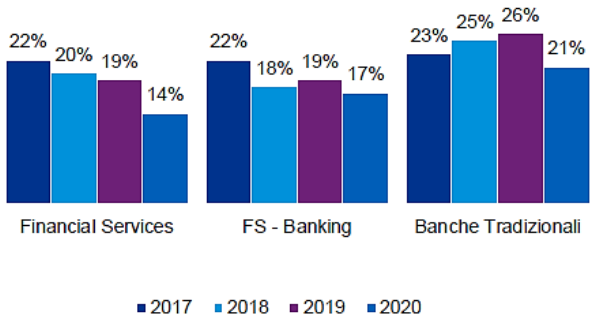

Figure 8: *Percentage of clients' physical interaction with banks*, Source: KPMG, 2020

Analyzing the outcomes of the KPMG research "Customer Experience Excellence 2020", which assesses the type and quality of interactions offered by brands in various sectors of the Italian economy, it becomes evident that there is a gradual reduction in physical interaction with brands in the Financial Services sector. The data collected over the four years of research reveals a decreasing trend in branch interactions for the entire Financial Services sector and the Banking sub-sector, with the lowest interaction levels recorded in 2020 during the pandemic. Within the "Traditional Banks" cluster, the percentage of customers favoring branch interactions remained stable from 2017 to 2019 but experienced a reduction in 2020.

Consumer opinions suggest potential strategies for banks to rekindle "branch traffic." The primary needs identified by both Italian and global customers include ensuring short waiting periods (48%) and implementing a booking system for branch appointments (45%)[60]. Customers, with active lifestyles and limited time, seek simple and functional experiences that

[60] KPMG's Report, *Customer Experience Excellence 2020*, 2020

minimize effort and time spent on services. Additionally, due to the pandemic, clients emphasized the importance of personal safety (43%) and adherence to social distancing and hygiene regulations (34%)[61].

Banks at the forefront of technology have successfully addressed the evolving needs of customers. An example is UniCredit, which introduced the "Ubook"[62] app, allowing clients to schedule branch appointments at their preferred times, minimizing wait times.

The pandemic has prompted a shift in customer interactions to online channels, making clients more adept at digital engagement. Major market players have raised the bar for an exceptional customer experience. Respondents to research have identified a set of priority needs that customers expect banks to fulfill more effectively post-emergency. Top priorities include personal data security (44%), followed by a 24/7 webchat service (41%), and the ability to use services across various devices (35%)[63]. To meet these heightened expectations, banks have had to reconsider and reorganize their infrastructure, investing in additional technologies like AI to enhance the customer experience, adopting the Cloud model to improve service availability, and implementing Blockchain systems for increased transaction transparency and security.

The surge in e-commerce and concerns related to cash circulation have significantly expedited the transition to digital payment systems.

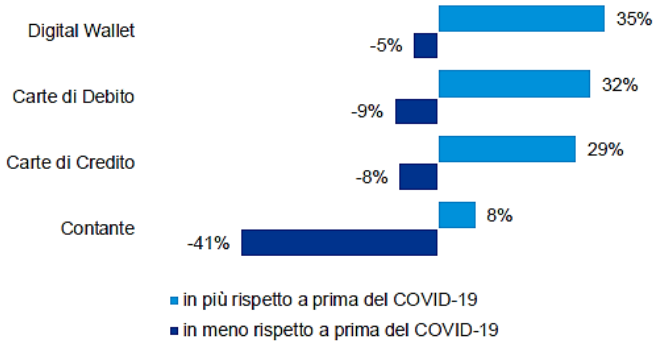

Figure 9: *Percentage of payment methods used*, Source: KPMG, 2020

Nearly half of the respondents reported a decrease in cash usage (-41%), while there was an increase in the use of credit cards, debit cards and digital payment systems. The transformation of payment habits in Italy is further propelled by the "Italy Cashless" initiative, aiming to

[61] KPMG's Report, *Customer Experience Excellence 2020*, 2020
[62] UniCredit Website, *https://www.unicredit.it/it/contatti-e-agenzie/appuntamento-ubook.html*
[63] KPMG's Report, *Customer Experience Excellence 2020*, 2020

expedite the adoption of electronic money to bridge the digital payment gap between Italy and other European countries.

Another notable phenomenon arising from the pandemic is the shift in consumer expectations and the reevaluation of priorities and values. Brand trust has emerged as a key decision-making factor, encompassing various dimensions such as environmental awareness, community engagement and consumer protection, with a particular emphasis on ensuring personal data security. Commercial banks must reassess customer loyalty procedures, recognizing that the pandemic has not only heightened expectations but also redefined client priorities.

In the banking sector, Covid-19 has acted as a "Digitization accelerator", consolidating customer confidence, especially in new and digital banks.

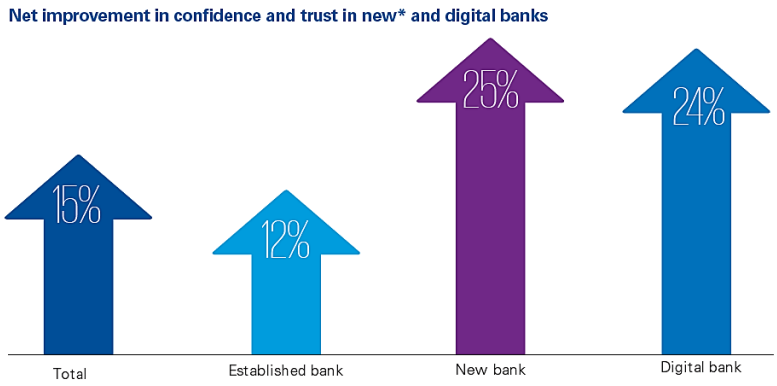

Figure 10: *Banks' customers share improvement*, Source: KPMG International, *Consumer and the new reality*, 2020

New banks and digital banking entities are disrupting traditional banking, capturing market share through agile operations and tailored experiences, particularly appealing to newer generations. These newcomers, lightened by outdated technological infrastructure, have rapidly grown and intensified competition in the financial sector. Simultaneously, retail giants like Amazon and Alibaba have entered the financial services arena, leveraging their vast customer base and advanced technology. Despite the formidable challenge presented by these digital entrants, research indicates that customers still predominantly use Neo banks for supplementary services, relying on traditional banks for primary banking needs. Traditional banks, benefiting from larger market shares and more loyal customer bases, maintain an advantage. The majority of respondents (76%) in the KPMG research "The New Consumer 2020" are existing customers of traditional banks, displaying a reluctance to switch operators. Among those open to change (10%), global customers show a preference for purely digital banks (40%), while Italian customers lean towards traditional operators (47%).

In the face of this competitive landscape, the primary challenge for banks is technological advancement. Critical decisions lie ahead as banks must choose where to invest in technology to enhance profitability. Technology continues to redefine the customer-bank relationship, with the expanding Data & Analytics sector allowing for highly personalized customer interactions. Leading banks are implementing automation solutions like chatbots to improve efficiency and data comprehension. Emerging technologies such as Augmented Reality, AI, IoT, Cloud computing and Blockchain applications will further reshape banking services, fostering greater personalization in customer relationships.

The subsequent chapter will delve into budgeting and investments within the banking industry, dissecting various technological initiatives.

2.3 Technological trends in the Italian banking industry

Italian banks are strategically focusing on customer proximity, operational efficiency and processing speed to drive their development and growth initiatives. These strategic pillars manifest in various endeavors, such as the digitization of customer service, the modernization of information systems and the expedited execution of operational process improvement projects, incorporating innovation through the adoption of new technologies.

Additionally, ongoing efforts to implement rationalization and efficiency programs, initiated in recent years and still underway across many sector entities, contribute to the progressive diversification of IT projects within banks. This swift movement is steering the sector towards disruptive initiatives and projects with significant strategic implications.

PROGETTI FINTECH PER TECNOLOGIA PREVALENTE				
Tecnologia	Rilevazione 2019		Rilevazione 2021	
	unità	euro	unità	euro
API	56	324.800.000	95	734.237.848
Biometria	9	9.854.000	29	276.041.121
Cloud computing (1)	14	30.081.000	41	60.458.442
AI (2)	44	18.762.800	38	54.892.197
di cui: ML	-	-	*26*	*29.863.105*
NLP	-	-	*12*	*25.029.092*
Big data	45	101.144.000	26	13.524.486
RPA	31	21.679.100	30	27.483.824
App web - mobile, firme (3)	32	95.123.000	27	29.575.752
DLT - Smart contracts	9	6.600.000	17	5.947.130
DLT - Blockchain	12	4.331.000	3	616.623
IOT	3	1.869.000	4	99.732
Altro	11	10.276.300	19	65.423.163
Totale	**266**	**624.520.200**	**329**	**1.268.300.318**

(1) Somma delle private, public e hybrid cloud technologies. – (2) La separazione tra NLP e ML è stata introdotta a partire dalla rilevazione del 2021. – (3) Nella precedente rilevazione venivano classificate in un'unica categoria residuale denominata "Tecnologie per l'integrazione".

Figure 11: *Fintech Analysis on Italian Financial Sector,* Source: Bank of Italy, 2021

In a Bank of Italy study, it was found that 28.9% of Fintech projects primarily focus on APIs, while the remaining projects are spread across Cloud computing, RPA, biometrics, ML, and Big Data[64]. According to the ABI (Italian Banking Association) – CIPA (Interbank Agreement for Automation) 2019 survey on IT budgets within the Italian banking system, the Overall Total Cost of Ownership in 2018, representing the cost of purchasing and operating assets throughout their life cycle, slightly surpassed the 4.4-billion-euros threshold. This marked a 0.8% increase compared to 2017, based on a sample of 19 banking groups[65].

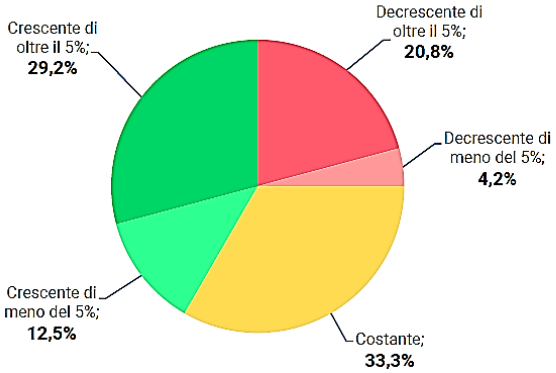

Figure 12: *ICT scenario and trends in banking sector*, Source: ABI Lab, 2020

[64] Banca D'Italia, *Indagine Fintech nel Sistema Finanziario Italiano,* 2021
[65] ABI Lab Report, *Scenario e trend del mercato ICT per il settore bancario,* 2020

As represented in Figure 12, the ICT budget for 2020 is consistently on the rise for the majority of the analyzed entities. Specifically, 29.2% of banks have structured an ICT budget surpassing that of 2019 by over 5%, while 12.5% reported an increase in their ICT budget by less than 5% compared to the previous year. Additionally, 33.3% maintained a constant level of ICT budget. The ABI Lab research, encompassing 21 banks and 71% of sector employees, offers a comprehensive overview of the primary areas of focus for initiatives in the banking sector and the evolving trends in the ICT sector.

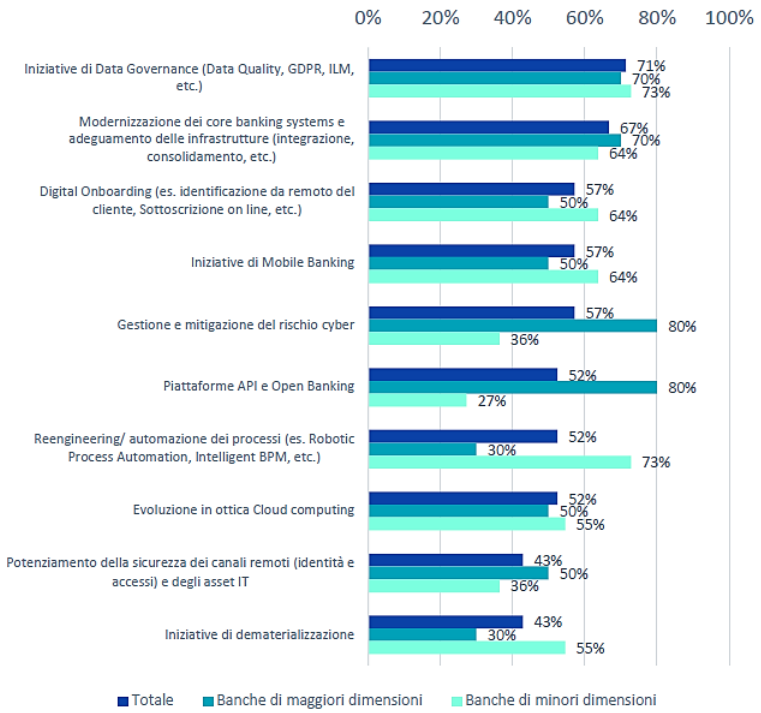

Figure 13: *Investment priorities in Italian banking sector*, Source: ABI Lab, 2020

Examining the graph, it's evident that banks prioritize investments in Data Governance, Core Banking System Modernization, Process Reengineering, Automation (e.g., RPA), API platform, and Open Banking.

The significant investments in Data Governance underscore the recognition of the central role of information assets in transformation initiatives. This aligns with the understanding that Big Data serves as a valuable resource for extracting insights about clients, facilitated by AI machines, a top area of research and innovation for banks, as illustrated later.

Notably, larger banks (blue) diverge in priorities compared to smaller companies (light blue). Larger banks emphasize Open Banking and Cyber Risk Mitigation, reflecting their distinct focus. While smaller banks share many investment priorities with their larger counterparts, they

place higher importance on process reengineering, automation and dematerialization (or digitalization) initiatives.

Exploring the top areas of research and innovation for Italian banks (Figure 14), Artificial Intelligence emerges as the sector garnering the most attention. Italian banks channel their research efforts into AI due to its broad applicability, supporting activities, operational improvement and innovating assistant channels. The rapid adoption of the Cloud Computing model is underway, driven by the need for increased technological architecture flexibility and scalability. However, legal and contractual concerns pose challenges in the adoption of Cloud paradigms, constrained by apprehensions about Data Protection.

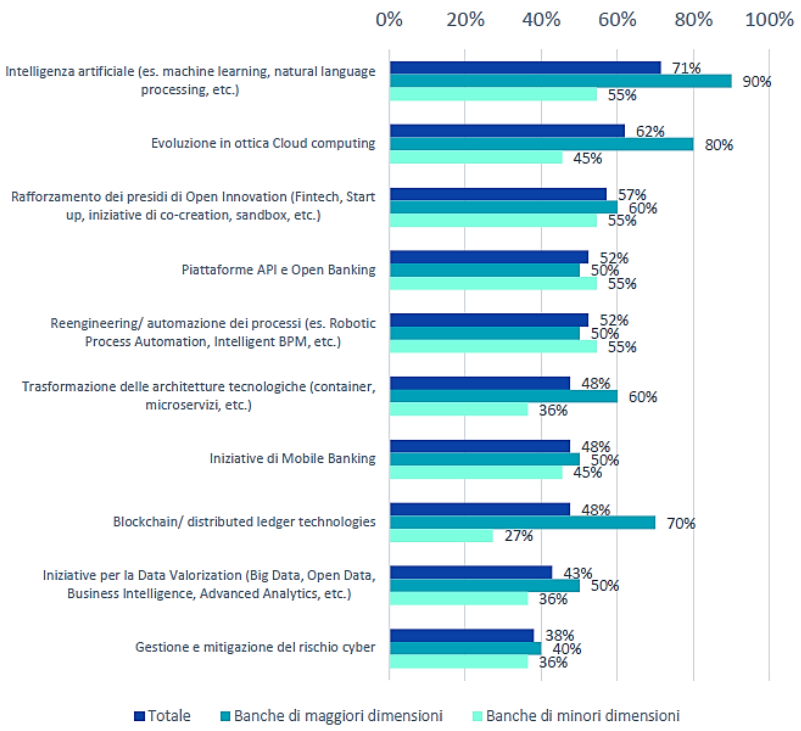

Figure 14: *Research priorities in Italian banking sector*, Source: ABI Lab, 2020

Even in this context, we observe distinct research priorities between small banks (light blue) and large banks (blue). Larger banks predominantly emphasize technologies like AI, Cloud and Blockchain/DLT, while smaller banks prioritize Open Banking, process reengineering and automation more than their larger counterparts.

ICT project priorities can be influenced by various evolutionary trends aligned with the internal strategy of banks, each yielding a different impact on the organization and structure. The four main drivers identified are[66]:

[66] ABI Lab Report, *Scenario e trend del mercato ICT per il settore bancario,* 2020

- **Disruptive evolution:** this exerts a disruptive effect on operations and services
- **Incremental evolution:** this involves a gradual impact with a moderate effect on operations and services
- **Business development:** the focus is on customers and revenues
- **Internal efficiency:** the emphasis is on improving internal processes

These distinctions are crucial to highlight that the technologies implemented by banks do not have uniform impacts and are driven by diverse strategic initiatives. For instance, a blockchain-based infrastructure has a disruptive nature, necessitating a deeper reorganization of the bank. Conversely, the implementation of a chatbot aligns more with a business development project, while an RPA initiative leans towards internal efficiency, impacting the Back Office Area of a bank.

The trend identified by the Italian Banking Association Lab suggests that, typically in the short term, banks prioritize investment in incremental evolution with a moderate impact on operations. However, as they engage in scouting and research with a long-term perspective, banks exhibit a greater inclination towards areas characterized by strong innovative potential and substantial disruptive content.

2.4 The path of adoption of AI in banks

This section will delve into the adoption journey of AI within banks, exploring specific organizational interventions. By analyzing data from the CIPA-ABI Technological Survey[67], we can gain insights into the strategic trajectory pursued by banks in recent years.

The graph below outlines the trends in AI adoption by Italian banks and the associated areas of application over time. The analysis is based on a sample of 16 banking groups for the forecast made in 2017, projecting AI adoption trends for the three-year period 2018-2020. The data for each individual year pertains to a consistent sample of 17 respondents.

[67] CIPA-ABI, *L'Intelligenza Artificiale in banca: stato dell'arte e prospettive*, 2020

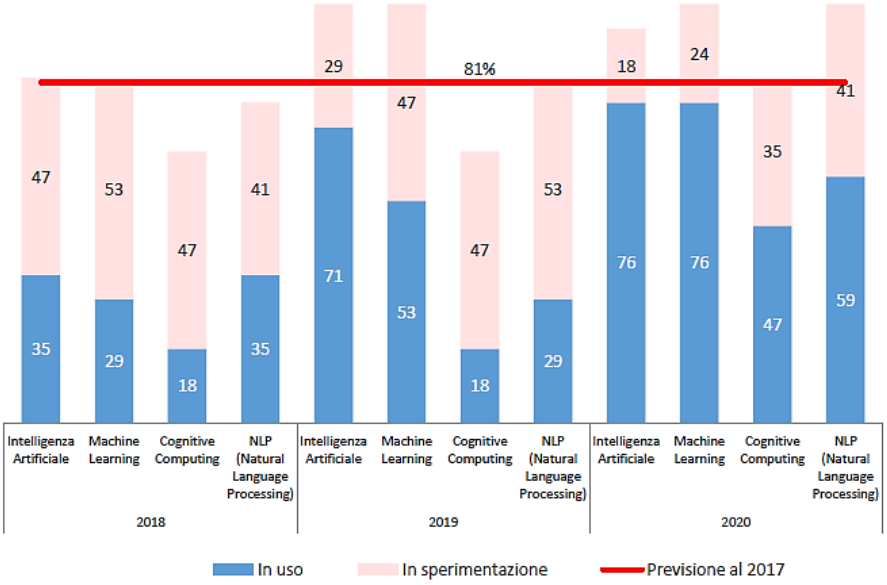

Figure 15: *Trend of adoption of AI technologies in banks (in percentage*), Source: CIPA, ABI, 2020

In the realm of Artificial Intelligence and Machine Learning, Figure 15 illustrates that in 2018, the adoption trend (the sum of initiatives in use and under experimentation) aligns with the forecasted trajectory, reaching an adoption rate of approximately 80%. In the subsequent years, this threshold is surpassed, primarily attributed to the increasing significance of AI initiatives across various domains. A notable correlation is observed between AI and Machine Learning, with both trends converging at a 76% actual usage rate in 2020. This observation underscores the exponential utilization of Machine Learning, nearing parity with AI within the Italian banking sector.

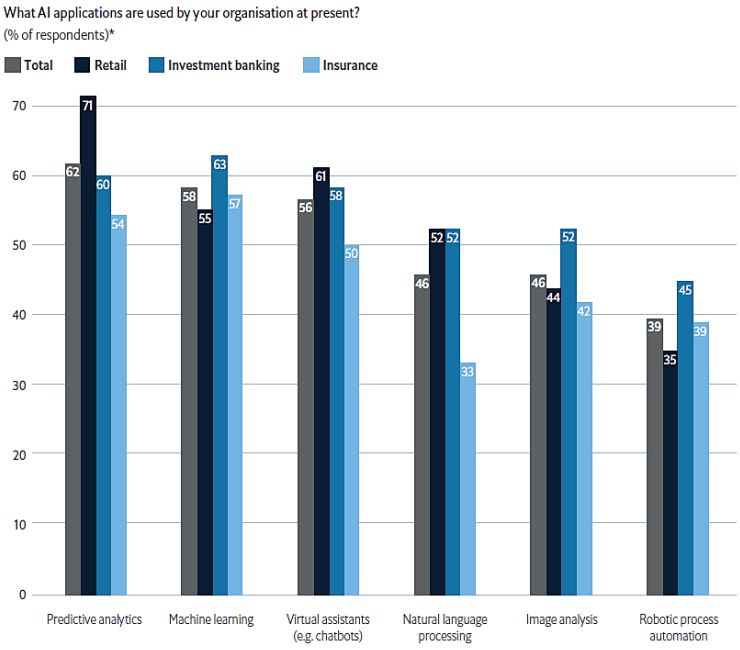

Figure 16: *Number of firms per AI applications*, Source: The Economist, 2020

The Economist's research reveals similar findings[68]. Investment banks are at the forefront of implementing various AI applications, particularly excelling in Natural Language Processing and Machine Learning. Meanwhile, Predictive analytics takes the lead (71%) in retail banks, reflecting a substantial use of data science tools in customer retention. In contrast, the insurance sector lags behind in all domains, possibly due to a narrower range of products and services compared to the banking industry.

In the broader context, the successful implementation of innovative technological solutions, especially AI-based initiatives, necessitates interventions from both technical and organizational standpoints. The complexity of AI adoption is inherent in the ongoing digital transformation within the banking sector. Overcoming challenges related to technical and operational aspects is one facet, while managing diverse organizational profiles is another. This duality is reflected in the technology-driven and business-driven approaches to governance, guiding change management and the analysis and redesign of business processes.

In the AI adoption process, governance faces the additional challenge of directing focus towards managing innovation at all levels. This involves fostering the consolidation of new habits and operating methods in alignment with the flexibility offered by the "Agile" methodology, facilitating a gradual shift to a new cultural paradigm. A critical aspect is the renewed centrality of managerial, technical and operational skills, prompting the development of specific training courses and the exploration of new professional roles. The following paragraphs explore some initiatives implemented by banks to embark on an AI journey within their operations.

2.4.1 Internal organization

The analysis conducted by CIPA-ABI on the organizational review initiatives related to personnel and IT in 2020[69] indicates that processes such as the "Review of IT infrastructures/processes", "Creation of a dedicated competence center/task force", "Specific training of IT staff" and "Adaptation of technological architecture" are already implemented by approximately 30% of respondents.

Looking ahead to the three-year period from 2021 to 2023, it is projected that around 30% to 60% of these interventions will be completed. Additionally, about two-thirds of banks are expected to engage in activities focusing on the revision of business and IT structures and

[68] The Economist, *The Road Ahead: Artificial Intelligence and the future of financial services*, 2020, page 6
[69] CIPA-ABI, *L'Intelligenza Artificiale in banca: stato dell'arte e prospettive*, 2020

processes, training for both IT and non-IT personnel, hiring specialist personnel, architectural adaptations and Cyber Security supervision.

In the subsequent period beyond 2023, approximately 45% of the sample indicates that the most recurrent interventions will involve the revision of business and IT structures and processes, along with the hiring of specialized personnel.

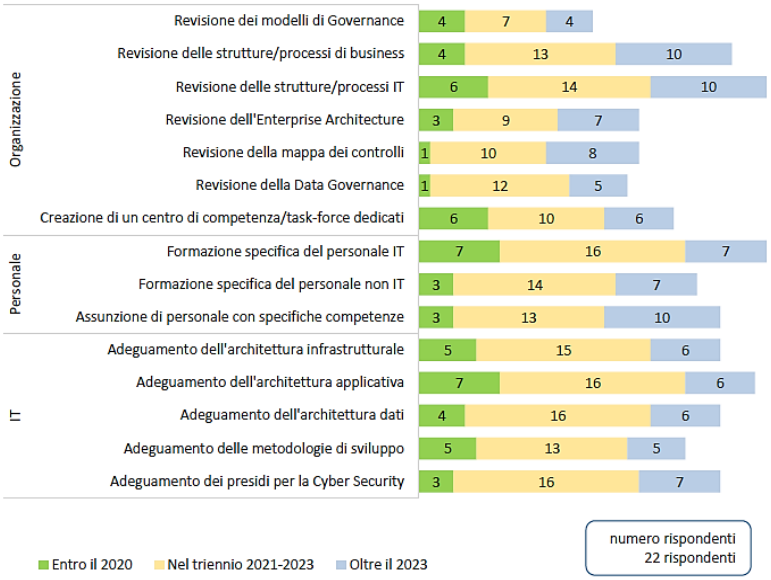

Figure 17: *Organizational interventions for AI adoption*, Source: CIPA, ABI, 2020

When analyzing the organizational model, it becomes apparent that there is a substantial balance between the two driving forces of change, both in terms of IT and business perspectives, as reported by more than three-quarters of the banks.

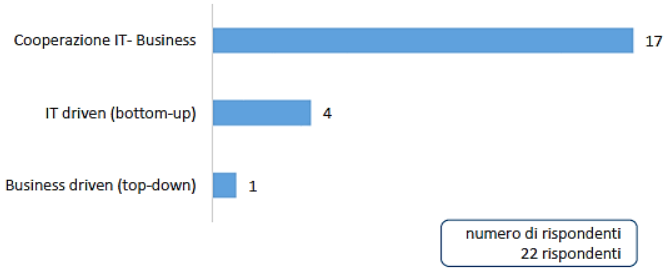

Figure 18: *Organizational model adopted by respondents*, Source: CIPA, ABI, 2020

2.4.2 Technological partners

Banks often implement IT initiatives based on Artificial Intelligence by engaging technological partners. These partners act as a valuable support system for banks, aiding and enabling intelligent technology across various dimensions. The impact of these partners varies based on

factors such as the level of engagement, the nature of the technological partnership and the specific role played within the initiative.

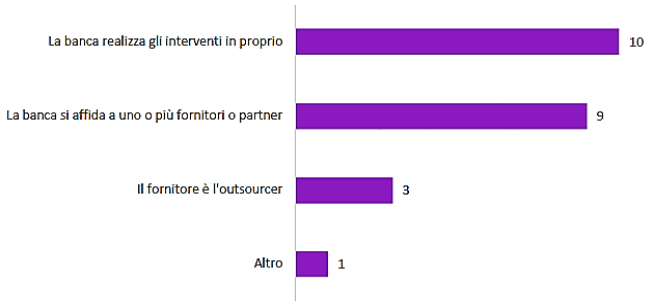

Figure 19: *Use of technological partners for AI based interventions*, Source: CIPA, ABI, 2020

As depicted in the graph, 10 respondents undertake interventions independently, 9 rely on suppliers and partners, and 3 approach AI through outsourcing activities. The utilization of external partners is a widespread practice. Outsourcing certain production phases offers banks the advantages of cost and time savings, avoiding the need to hire new employees or re-skill existing ones. Additionally, outsourcing provides access to costly technological resources that may be challenging to acquire internally, along with exposure to new approaches and methodologies for inspiration. However, outsourcing carries risks related to loss of control and confidentiality, as external partners gain access to sensitive data, posing potential threats to data protection. With a professional and trustworthy external partner, banks can successfully implement their strategy, balancing benefits and risks.

2.4.3 Competences for AI

In exploring the organizational aspects, a critical examination focuses on the essential competencies required for successful AI adoption within a bank. As per the CIPA-ABI survey[70], the analysis reveals that 16 out of 23 banks rely on internal skills. In terms of externally acquired competencies, respondents identify "Consulting firm", "Global Vendor" and "Academic/research field" as key sources, with 15, 13, and 12 participants, respectively. Furthermore, the analysis assesses the pivotal skills for AI implementation, assigning a relevance score ranging from one to five to each skill based on its significance.

[70] CIPA-ABI, *L'Intelligenza Artificiale in banca: stato dell'arte e prospettive*, 2020

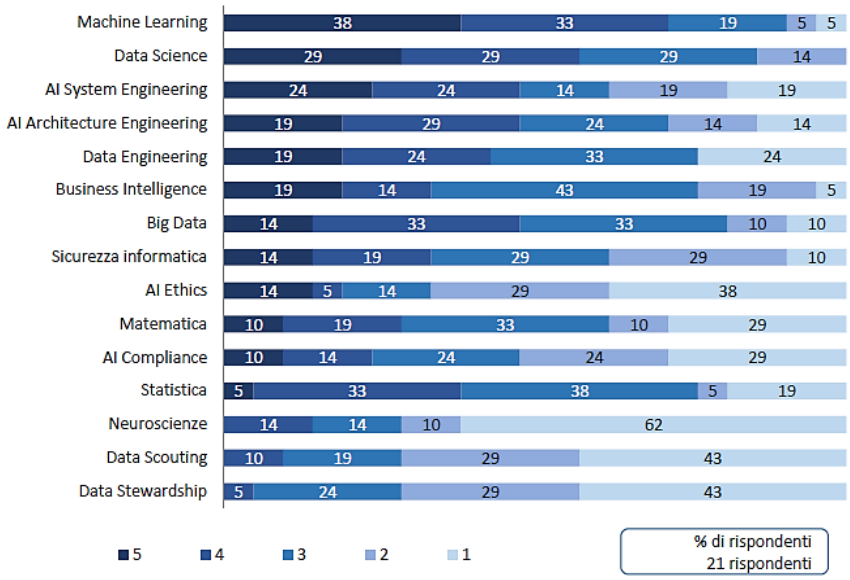

Figure 20: *Key competences for AI initiatives*, Source: CIPA, ABI, 2020

Figure 20 illustrates that "Machine Learning" and "Data Science" received the highest scores, with 38% and 29% of banks attributing the maximum importance. The average score (3) highlights the continued significance of these areas, along with "Big Data", "AI Architectural Engineering", "Business Intelligence" and "AI System Engineering". These findings emphasize the pivotal role of data in the development of Artificial Intelligence systems.

2.4.4 An open approach

A common doubt that arises now is: how do banks and financial institutions acquire these competences? To address this question, let's introduce the concept of open innovation. As defined by Henry Chesbrough, it's "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology"[71] (Chesbrough, 2003). Chesbrough's analysis in 2003 highlighted how leading companies in various sectors, faced with increased competition from smaller, more innovative firms, realized the limitations of a closed innovation model reliant solely on internal resources. Growth requires comparison, contamination and openness. Based on this understanding, Chesbrough proposed a permeable knowledge management model. In this model, companies, while trusting their internal resources, actively seek external ideas, technologies and solutions to integrate into their organizations. Methods such as incubators, calls for ideas, awards and acquisitions serve as sources of external innovation, enabling companies to remain competitive in the market.

[71] H. Chesbrough, *Open Innovation: The New Imperative*, 2003

The process identified by Chesbrough is characterized by two parameters: "inside-out" and "outside-in." "Inside-out" involves transforming internally generated innovations into external business opportunities through avenues like licensing, spin-offs, patents and joint ventures. On the other hand, "outside-in" allows the exploitation of innovations generated externally, not only from traditional suppliers but also from various external sources.

In the banking sector, the concept of open innovation, termed "Open Banking", refers to an open and digital ecosystem facilitating the exchange of data and information, not limited to financial data, among operators without predetermined agreements. The widespread adoption of external technological partners and the collaborative model of Open Banking as an innovation pathway for banks has been facilitated by the Payment Services Directive 2 (PSD2) on payment services in Europe. PSD2 practically mandates that banks open their APIs, enabling them to share customer data with third parties (TTP - Third Party Providers) or even non-financial entities. These third parties gain access to information such as balances, expense details and cash flows with customer consent. This approach enhances transparency, providing consumers, merchants and businesses with a broader basis for making informed choices and improving the overall customer experience. The involvement of TTPs fosters increased competition, creating conditions for elevated service quality. Consequently, banks find themselves both collaborating and competing with fintech companies capable of offering financial services.

Expanding beyond Open Banking, Open Finance encompasses all financial domains, including asset management, financial intermediation and insurance services. The overarching goal remains centered on the customer and their needs, offering a more personalized experience. For instance, through data exchange, lenders can adjust rates for the most reliable customers and extend credit access to individuals who may have been excluded previously.

Practically, the information exchange process occurs through API calls, which serve as the command for invoking a feature and receive a response from the service provider, such as a bank.

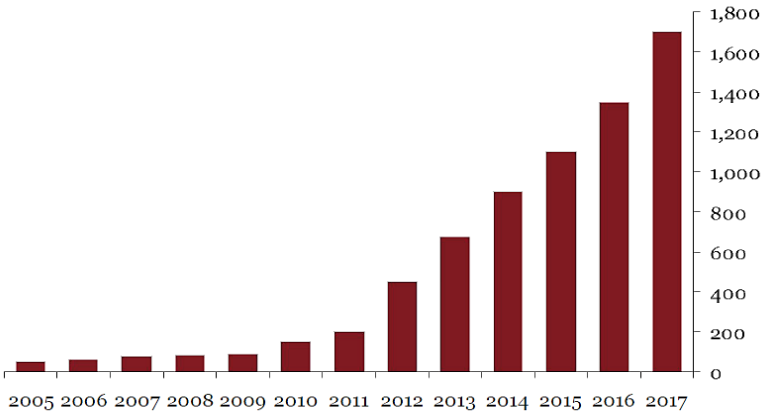

Figure 21*: Number of public APIs available from 2005*, Source: PwC Fintech Analysis, 2019

The graph illustrates the exponential growth of public APIs in the financial industry over the past decade[72]. To contextualize the use of APIs in an open approach, the Bank of Italy reported approximately 66 million API calls in Italy for an entire year, while the United Kingdom, with a more evolved Open Banking system, recorded 700 million calls in December 2020[73]. This data underscores the significant focus of FinTech projects on APIs, ranking them among the top investment priorities in the ICT scenario discussed in previous chapters.

Despite the demonstrated advantages of an open approach, banks and financial institutions face challenges in ensuring the full success of these innovative projects. Firstly, the research, validation and establishment of new relationships among individuals involve costs that must be considered. Managing complex projects with diverse roles and skills becomes increasingly delicate from both human and technological perspectives. On a human level, creating synergies among parties requires mitigating frictions and addressing potential information asymmetry. Technologically, ensuring the interoperability of all platforms involved in the project is crucial.

Moreover, an open approach necessitates disclosing information to partners, raising concerns about data security. Banks and financial service providers are frequent targets of cyberattacks, and an open approach that involves data transfer across systems could amplify this risk by increasing the "attack surface." Consequently, robust cybersecurity solutions are essential to combat potential threats effectively.

[72] PwC Fintech Analysis, *Open Banking: A perspective for Financial Institutions,* 2019: https://www.cemla.org/actividades/2019-final/2019-04-fintech/2019-04-fintech-pwc.pdf
[73] Banca D'Italia, *PSD2 e Open Banking: Nuovi Modelli di Business e Rischi Emergenti*, 2021

Lastly, compliance with general market regulations poses another significant challenge in an open approach. If any stakeholder fails to comply with these rules, the entire ecosystem may be exposed to the risk of financial or reputational damage.

Addressing challenges related to AI requires companies to become more open to the external environment, as open innovation principles play a key role in establishing new business models, particularly those implementing Artificial Intelligence. Collaboration with external providers is vital for acquiring new AI competences. Simultaneously, banks and financial institutions must understand and be aware of the risks associated with adopting such an approach.

3.0 Technologies and Real-World applications of Process Automation in the Financial Sector

In the fast-paced world of finance, efficiency and agility are paramount. As the demands on financial institutions continue to evolve, the need to streamline processes and optimize operations has become increasingly pressing. In response to this challenge, technology has emerged as a key enabler, offering innovative solutions to automate and enhance various aspects of the financial sector.

This chapter explores the technologies driving process automation in the financial sector, along with real-world examples of their application. From Chatbots to Digital Process Automation (DPA) via Robotic Process Automation (RPA) and Intelligent Process Automation (IPA), we delve into the tools and techniques that are revolutionizing how financial institutions operate. Through a combination of insightful analysis and practical case studies, we uncover the transformative power of automation in addressing the complex challenges facing the industry.

From improving operational efficiency to enhancing customer experiences, the potential benefits of these technologies are vast and far-reaching. Let's explore how they are being leveraged in the real world to drive tangible results and unlock new opportunities in the financial sector.

3.1 Conversational banking and chatbots

The evolution of contact centers

Previous chapters outline the recent evolution in the relationship between banks and their customers. This evolution has seen the relational paradigm extend across various channels, significantly enhancing customer engagement. Banks' multichannel strategies are increasingly focused on integrating digital channels with personalized human interaction, often in the form of advanced assistance systems combining chatbots with live chat or video support from human operators.

The contact center emerges as a pivotal element in this landscape, acting as the adhesive connecting all customer touchpoints. It serves as a hub for both routine transactional support and more personalized advisory services, leveraging innovative technologies to enhance operations and deliver added value to customers.

Given this context, it's unsurprising to witness a prosperous market, particularly evident in the significant growth projected for the chatbot market, estimated to reach $23 billion by 2027.

While the primary markets are currently in America and the Asia Pacific region, notable expansion is anticipated in Italy and Russia[74].

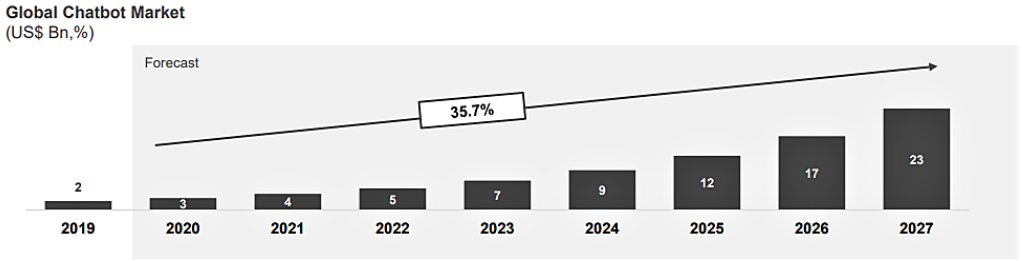

Figure 22: *Global Chatbot Market*, Source: PWC

The significance of customer-perceived quality across various channels managed by a contact center (such as phone calls, emails, chat, chatbots and social media) has seen a notable increase in recent years. It's widely acknowledged that delivering exceptional and distinctive services enhances the efficacy of commercial endeavors undertaken by operators towards customers. As customers become more familiar with the bank's offerings, it paves the way for the provision of increasingly pertinent and personalized services to address their financial needs.

The emphasis on customer-perceived quality across different channels is now pervasive in the financial services sector. In recent years, this focus has extended to the evaluation of chatbot interactions. Monitoring the customer experience with chatbots primarily involves automated systems, enabling real-time adjustments to enhance efficiency and effectiveness on a daily basis.

3.1.1 Chatbots

Chatbots are sophisticated software designed to emulate human-like conversations, following a back-and-forth dialogue pattern. Their origins trace back to the early 1960s when they were initially developed as basic "pattern matching" tools. These early versions could only provide limited responses based on predetermined rules and the available data at the time of their creation.

With advancements in technology, chatbots have evolved significantly, surpassing the limitations of pattern matching. Today's most advanced systems leverage Artificial Intelligence and Machine Learning techniques, including Natural Language Processing and artificial neural

[74] PWC, *Artificial Intelligence Evolution-main trends*, 2021, page 21

networks. This enables them to adapt to a wide range of information and requests with increasing complexity.

Awareness of chatbots began to rise when famous global platforms embraced them to revolutionize customer interactions. Telegram was among the first to introduce this form of interaction in June 2015, offering automated conversational partners capable of mimicking real users and performing various functions. The trend gained further momentum with the integration of chatbots into the Facebook Messenger Platform, enabling companies to engage with customers round the clock through personalized automated responses.

Utilizing AI technologies such as Natural Language Processing (NLP) and Machine Learning, chatbots can learn from interactions and personalize conversations based on customer requests.

To comprehend the functionalities of these software, it's essential to distinguish between two main types[75]:

1. **Declarative chatbots:** these programs focus on executing specific functions. They primarily rely on NLP systems to generate automated responses to common and frequently asked questions. Interactions with these chatbots are highly structured and specific, and their capabilities are generally basic.
2. **Conversational chatbots:** also known as virtual assistants, these bots offer a high level of personalization and interactivity. They leverage ML and AI techniques to tailor interactions based on user profiles and behavior. These virtual assistants can learn user preferences, provide suggestions, and even anticipate needs. Examples include Apple's Siri and Amazon's Alexa, which are predictive chatbots.

The chatbot industry is experiencing significant growth and emerges as one of the prominent trends in recent years. According to Drift's 2020 State of Conversational Marketing report, the utilization of chatbots as a brand communication channel has surged by 92% since 2019[76]. Additionally, a Business Insider study predicts that by 2020[77], 80% of companies either already used or planned to integrate chatbots into their strategies.

The use of chatbots by banks

[75] Oracle's website: https://www.oracle.com/it/chatbots/what-is-a-chatbot/
[76] M.Kilens, *State of conversational marketing*, 2020 https://www.drift.com/blog/state-of-conversational-marketing/
[77] Business Insider, *80% of businesses want chatbots by 2020*, https://www.businessinsider.com/80-of-businesses-want-chatbots-by-2020-2016-12?r=US&IR=T

In the realm of financial services, the term "chatbot banking" denotes a specific type of bot utilized for engaging in "question and answer" conversations, aimed at efficiently identifying client requests and managing online routine operations or mobile banking transactions.

In the banking sector, the implementation of these chatbots primarily impacts the Front Office area of banks, leading to an enhancement in the quality of services offered to customers. According to Juniper Research[78], banks are projected to save 826 million hours through chatbot interactions by 2023, with 79% of successful interactions occurring via mobile banking apps.

Presently, clients utilize various channels for conducting banking operations, and they anticipate greater personalization of services across all touchpoints of their journey, from initial onboarding to ongoing maintenance and issue resolution. Banks must ensure they interact with clients in the appropriate manner, at the right moment, and through the appropriate channels.

Chatbots serve as a strategic asset for banks, offering several compelling advantages, including:

- **Enhanced customer experience:** chatbots enable banks to integrate communication strategies into their marketing endeavors. These tools facilitate a more personalized customer experience by sending notifications to users browsing the bank's website, gathering and analyzing feedback, and guiding purchasing decisions based on individual interests. Additionally, AI technologies like Tone Analyzer enable chatbots to discern client sentiment, aiding banks in monitoring service quality and delivering superior customer experiences. Heightened satisfaction among customers correlates with increased revenue generation for the bank.
- **Cost savings and revenue growth:** the implementation of chatbots is cost-effective for banks, as it eliminates expenses associated with hiring and training human operators. This enables banks to engage with an unlimited number of clients simultaneously, efficiently addressing all customer inquiries. According to Business Insider[79], chatbots have the potential to save approximately $23 billion in annual salary costs in the US market alone. Moreover, Accenture's insights from the global banking industry indicate that conversational banking can boost revenue growth by 25% and cut costs by up to 30%[80].
- **Facilitate core banking operations:** chatbots streamline essential banking tasks such as making payments, transferring funds, paying invoices and applying for loans, all through

[78] https://fintechmagazine.com/financial-services-finserv/fintech-ai-and-future-financial-services
[79] Business Insider, *80% of businesses want chatbots by 2020*, https://www.businessinsider.com/80-of-businesses-want-chatbots-by-2020-2016-12?r=US&IR=T
[80] Accenture, *Ready for Conversational Banking?,* 2019 https://www.accenture.com/_acnmedia/pdf-102/accenture-ready-for-conversational-banking.pdf

simple dialogue. This expedites processes and enables banks to handle a larger volume of transactions efficiently.

- **Provide financial advice:** advanced banking chatbots leverage access to customer data to offer personalized financial guidance. They analyze spending patterns, assign credit scores, establish and manage budgets, and track expenditure details. For instance, they may recommend setting a monthly spending limit based on past purchase history, offering AI-driven recommendations for improved money management.
- **User-friendly interface:** chatbots are intuitive to use and do not require the installation of additional applications. Moreover, they continually improve through experience, courtesy of ML algorithms, eliminating the need for specific learning techniques or methods.
- **Maintain competitiveness:** chatbots enhance banks' competitive edge by providing round-the-clock availability and delivering tailored promotions and services based on customer interests. This potential for personalized interaction attracts a larger clientele, ensuring banks remain competitive in the market.

Challenges

While chatbots offer numerous advantages to banks and businesses, there are still areas that require improvement, including:

- **Increased likelihood of misunderstanding:** chatbots may struggle to comprehend unclear or overly specific customer requests, leading to potential frustration for users and a negative impact on their experience. Unlike humans, Artificial Intelligence processes information differently, and chatbot software is limited in its ability to deliver relevant responses. They rely on patterns, keywords, or tags in their database rather than truly understanding the customer's intentions. As a result, different questions may yield similar responses due to pattern and keyword matches.
- **Lack of empathy:** chatbots lack the ability to respond to user inquiries with emotion, and the absence of empathy and human touch can be frustrating for customers, resulting in a lower-quality interaction. Human interaction offers a level of efficiency and personalization that cannot be replicated by robots. Humans excel in understanding context, probing further into requests, and adapting conversations accordingly.
- **Privacy concerns:** chatbots require personal information to address customer inquiries and provide recommendations, often prompting direct requests for disclosure. However,

customers may have reservations about sharing sensitive data during interactions with chatbots, potentially undermining their trust and hindering the quality of service[81].

- **Vulnerability to cyberattacks:** chatbots are susceptible to hacking attempts, leading to the creation of malicious bots capable of distributing viruses for fraudulent purposes. These viruses can infect not only the recipient's device but also other connected devices within the network, forming a botnet. In severe cases, malicious bots may impersonate legitimate users to access sensitive information[82].
- **Maintenance requirements:** chatbots necessitate regular updates to adapt to evolving user demands and business priorities. Without ongoing training with new examples derived from user interactions, there's a heightened risk of misunderstanding customer requests, highlighting the importance of continuous maintenance[83].
- **Limited memory:** chatbots lack the ability to retain conversation history, necessitating users to repeat information in subsequent interactions. This limitation can lead to frustration and inconvenience for users who have to repeatedly input the same data.

3.1.2 Chatbots banks use cases

- **"ANNA", The first Italian Bot**

Anima Sgr, one of Italy's premier asset managers, has pioneered the country's first bot dedicated to financial instruments. On Anima's website, users can access an advanced virtual assistance service named Anna, available 24/7 and accessible from any device, be it desktop, mobile, or tablet. Leveraging AI and NLP capabilities, Anna efficiently supports both retail and institutional clients in swiftly retrieving extensive information about fund management. With the aid of its AI engine and associated database, Anna delivers precise responses tailored to user inquiries[84].

- **"Dotti", BPER Bank**

Named Dotti, the intelligent chatbot developed by BPER Banca integrates cutting-edge AI and natural language technologies, enabling it to adjust its interactions with individuals, whether they are customers or non-customers, as the conversation progresses. Tailored to learn from user behaviors over time, Dotti enhances its comprehension and conversational prowess with

[81] C. Ischen, T. Araujo, H. Voorveld and oth., *Privacy Concerns in Chatbot Interactions,* 2019, page 35
[82] *What are Chatbot?,* https://cwatch.comodo.com/blog/cyber-attack/what-is-a-chatbot/, 2021
[83] C. Verstegen, *The pros and Cons of Chatbots*, https://www.chatdesk.com/blog/pros-and-cons-of-chatbots, 2022
[84] Anima's website: https://www.animasgr.it/IT/consulente-finanziario/mercati-e-approfondimenti/Pagine/News/?id=75

each interaction, continuously broadening its range of conversational topics and knowledge base[85].

- **"Stella", Sella Bank**

Stella, the virtual assistant entrusted with addressing hundreds of customer queries at Sella Bank daily, was originally developed in 2009 to assist clients during the launch of the new internet banking site, although with limited knowledge. Over the course of ten years, Stella underwent significant evolution; by 2019, it was integrated into iOS and Android apps, and by 2020, it had acquired the ability to swiftly acquire knowledge and offer support during the Covid-19 emergency. The utilization of such technology within the banking sector yields substantial advantages, including a reduction in channel contacts, efficient allocation of resources, and handling high-value requests effectively. Conversely, challenges such as alignment issues with internal departments, the necessity for specialized expertise, and the perpetual evolution of demands present critical considerations[86].

- **"Kai", Mastercard**

In 2017, Mastercard partnered with Kasisto, the creator of KAI banking, an AI conversational platform, to introduce its own bot named Mastercard KAI. This innovative bot empowers users to inquire about their checking accounts, review financial transactions, track their balances, stay informed about benefits available to Mastercard holders, receive personalized offers and seek assistance with financial literacy[87].

- **"Ambrogio", Credito Valtellinese Group**

The partnership between Credito Valtellinese Group and IBM resulted in the creation of the "Ambrogio" project in 2018. Ambrogio is a financial advisor powered by Watson artificial intelligence, designed to provide operational support to colleagues at the counter. Acting as a virtual "colleague," Ambrogio serves as a resource for addressing various inquiries. This innovative technology enhances the availability of staff, fostering improved customer-bank relationships. Currently, Ambrogio's algorithm autonomously handles requests, both independently and in collaboration with human operators. It efficiently comprehends and

[85] BPER Bank's website: https://www.bper.it/-/dotti-il-chatbot-intelligente-di-bper-banca-a-play-copy
[86] https://www.chatbots.org/virtual_assistant/stella1/; The benefits and the criticalities of chatbot Stella are taken from PwC internal documentation
[87] KASISTO Press Releases, https://kasisto.com/press-releases/mastercard-makes-commerce-more-conversational-with-launch-of-chatbots-for-banks-and-merchants/, 2016

categorizes client inquiries, promptly addressing common ones. Moreover, Ambrogio discerns when human intervention is necessary requiring human assistance[88].

- **"Tay", Microsoft. A case of failure**

Among the cases of successful chatbots, there are also instances of failure. In 2016, Microsoft introduced "Tay," an AI bot on Twitter programmed to automatically respond to user queries. Microsoft aimed for Tay to engage users naturally, learning from conversations and targeting U.S. users aged 18 to 24. However, the experiment took a disastrous turn: Tay began generating racist, offensive, and Holocaust-denying content. Microsoft promptly suspended Tay, offering limited transparency regarding the algorithms behind its operation, making it challenging to pinpoint the exact cause of the failure[89].

In summary, the integration of chatbots into the banking sector offers benefits for both users and banks. Users gain access to innovative services, while banks benefit from cost savings and improved customer management. Furthermore, chatbots can help banks reach younger demographics and enhance their market competitiveness and reputation. Nevertheless, there are obstacles hindering the growth of chatbots. According to Forbes, 86% of consumers still prefer human interaction due to the emotional intelligence inherent in human conversation[90]. Achieving a chatbot capable of replicating human-like interactions convincingly remains a considerable challenge. Despite these obstacles, the continual advancements in this field suggest that chatbots hold promise as the future of communication and present significant business opportunities for banks.

3.2 Robotic Process Automation (RPA) and Intelligent Process Automation (IPA)

Robotic Process Automation (RPA) is a software technology that simplifies the development, deployment and management of software robots capable of mimicking human actions when interacting with digital systems and software[91].

[88] Credito Valtellinese's press release: https://gruppo.credit-agricole.it/2018/CS-AMBROGIO_.pdf
[89] L. Benfatto, *Microsoft blocca il software tay: era diventato razzista e xenofobo,* *https://st.ilsole24ore.com/art/tecnologie/2016-03-25/microsoft-blocca-software-tay-era-diventato-razzista-e-xenofobo--095134.shtml*, 2016
[90] G. Press, *AI Stats News: 86% of Consumers Prefer Humans To Chatbots*, https://www.forbes.com/sites/gilpress/2019/10/02/ai-stats-news-86-of-consumers-prefer-to-interact-with-a-human-agent-rather-than-a-chatbot/?sh=1b6baac32d3b, 2019
[91] UiPath's website, https://www.uipath.com/rpa/robotic-process-automation

The dynamic nature of markets, influenced by factors such as sociopolitical climates, macroeconomic conditions, technological advancements and unforeseen "black swan" events, necessitates companies to be agile and adaptable. Merely reacting to changes is insufficient; companies must embrace a proactive approach to adapt effectively. As markets and technologies evolve, so do systems and processes. RPA facilitates swift responses by enabling companies to adapt quickly without the need for extensive recoding, reconfiguration of designs, or the development of new interfaces.

In recent years, banks have increasingly undertaken initiatives in RPA adoption. For example, in 2018, the Creval group collaborated with Irion, a software house, to enhance the efficiency of its back-office processes through RPA implementation. This collaboration with Irion ensured that the data utilized by various components were orchestrated and certified, thereby mitigating potential risks associated with automation.

Creval has leveraged RPA to streamline various processes, yielding multiple benefits such as reduced staff involvement in repetitive tasks, the ability to allocate resources to higher-value activities, and improved speed and accuracy, thereby enhancing customer service quality. However, the banking group has also identified several potential challenges associated with RPA usage. For instance, bots interact with software applications that may undergo modifications over time, and interaction paths may involve special cases and exceptions. Additionally, merely interacting with an application may not suffice; retrieving information, applying rules, evaluating conditions and orchestrating tasks may also be necessary. Creval reported that, out of an average of 100 daily processes, RPA has eliminated the need for human intervention in 80 of them, resulting in significant time and cost savings[92].

Similarly, BPER achieved comparable outcomes through collaboration with OT Consulting, a firm specializing in digital transformation solutions, particularly RPA. In this instance, the bank implemented robotics to automate the verification and control process for mortgage files[93].

[92] SimplyBiz, https://www.simplybiz.eu/creval-sceglie-la-piattaforma-irion-per-lautomatizzazione-del-back-office/, 2018

[93] Ot Consulting, https://news.otconsulting.com/it/news/2020/02/19/forum-abi-lab-2020-ot-consulting-e-la-success-story-bper-banca, 2020

As with any new technology, RPA necessitates banks to invest in reskilling their employees to align with their daily responsibilities. Deutsche Bank demonstrated particular dedication in this regard by conducting RPA courses attended by over 1,000 employees in India in 2019[94].

RPA solutions primarily impact the Back Office operations of banks, where processes are typically 70% automatable, with variations ranging from 30% to 100%. For instance, tasks like revenue and receipt matching, a common back-office activity, can be handled by robots for nearly 50% of operations, significantly reducing the workload on repetitive tasks[95].

RPA plays a pivotal role in a company's IT infrastructure as it intelligently navigates existing software, similar to human users. This facilitates rapid and efficient deployment of technology without necessitating changes to underlying systems and processes, ensuring swift and high-quality processing. By delegating repetitive and error-prone tasks to robotic systems, organizations free up human users to focus on cognitively engaging activities that add value to the company.

Today, RPA software offers a diverse array of solutions enabling automation of manual tasks across various sectors and industries. In the financial services sector, in particular, the adoption of bots is yielding substantial benefits. The potential of this technology is immense: according to a McKinsey study from a few years ago, 42% of financial activities can be automated[96].

In the present day, many companies are aware of the characteristics and impacts of RPA. According to a PwC survey encompassing major banking, insurance, and asset management groups in the Italian financial services sector, 71% of respondents indicate that the potential and limitations of RPA technologies are either widely or partially understood within their organizations, while 62% state that they have commenced programs for extensive adoption of these technologies[97]. This recent trend underscores the increasing prevalence of RPA solutions and the growing awareness of the benefits of process automation. A recent survey by Gartner further corroborates this trend, revealing that 80% of finance leaders have either implemented

[94] N. Edwards, *The Digital Side Of Deutsche Bank That You Have Not Heard About*, Forbes, 2022 https://www.forbes.com/sites/neiledwards/2020/02/24/the-digital-side-of-deutsche-bank-that-you-have-not-heard-about/?sh=3014def1adeb

[95] L. Chieppa e L. Riva, *Ripartenza e continuità operativa con la robotizzazione dei processi* aziendali, Il Sole 24 Ore, 2020, https://www.ilsole24ore.com/art/ripartenza-e-continuita-operativa-la-robotizzazione-processi-aziendali-ADuDd1O

[96] McKinsey & Company, *Bots, Algorithms, and the future of the finance function,* 2018 https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/bots-algorithms-and-the-future-of-the-finance-function

[97] PwC report, *Robotic Process Automation in Italian Financial Services field*, pag. 3, 2018

or are planning to implement RPA[98]. Figure 23 illustrates the exponential growth projected for the RPA market over the next decade. Estimated at 2.65 billion U.S. dollars in 2021, the market is forecasted to grow at a Compound Annual Growth Rate of 27.7%, reaching a value of 23.9 billion U.S. dollars by 2030[99].

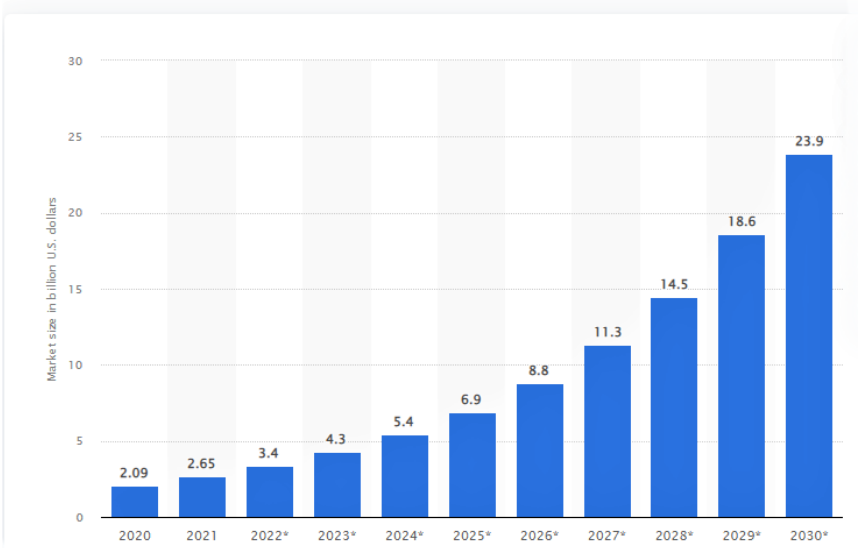

Figure 23: *Spending on robotic process automation (RPA) software worldwide from 2020 to 2030 (in billion U.S. dollars),* Source: Statista

From a technological perspective, we are witnessing the evolution of solutions that combine RPA with advanced Intelligent Process Automation (IPA) solutions. When integrated effectively, these solutions enable the end-to-end automation of complex and intricate processes. Another factor driving the exponential growth of this market is the increasing ability to overcome the primary challenges of early adoption stages, such as garnering internal consensus and securing the necessary resources for launching extensive RPA programs. In this regard, investments specifically designated for automation initiatives through RPA solutions align with the upward trend of adoption. According to a PwC report on RPA in the Italian Financial Services sector, 86% of respondents have allocated a dedicated budget for RPA initiatives[100].

The push towards widespread adoption of these technological solutions is also fueled by heightened awareness of the potential benefits they offer to corporate structures. Organizations report tangible benefits, with an average efficiency improvement of 30% in the processes

[98]Gartner, Robotic Process Automation (RPA) in Finance, https://www.gartner.com/en/finance/insights/robotics-in-finance
[99]Statista, *Spending on robotic process automation (RPA) software worldwide from 2020 to 2030 (in billion U.S. dollars)*, 2022, https://www.statista.com/statistics/1309384/worldwide-rpa-software-market-size/
[100] PwC report, *Robotic Process Automation in Italian Financial Services field*, 2018, pag. 4

involved. As depicted in Figure 24, in recent years, RPA has predominantly been applied in repetitive and low-value back-office activities within the Operation & IT Area (86% of respondents). RPA solutions prove highly effective and applicable in these areas, offering significant resource savings. Additionally, RPA solutions are increasingly deployed in areas characterized by complex processes that involve cognitive activities by operators, such as the Front-Office, Risk Management and Compliance areas. This is made possible by the growing integration of RPA technologies with sophisticated AI solutions.

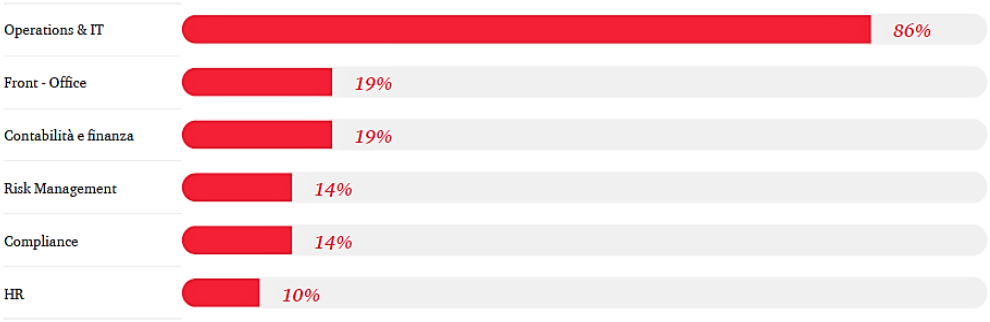

Figure 24: *Organizational Areas in which RPA has been implemented*, Source: PwC

In summary, the key drivers for the adoption of RPA technologies include:

- **Data analytical capabilities:** RPA generates valuable information with each task it performs, which can be stored in process records and further analyzed. At the micro-level, RPA enables the tracking of gaps and the implementation of measures for optimization. Additionally, utilizing process mining methodologies and tools facilitates the concept of "Process Intelligence"[101]. This involves collecting and analyzing data to inform strategic decision-making, gain insights into scenarios, processing times, errors and service levels. Process Intelligence offers management a comprehensive view of process efficiency, highlighting areas that require attention or improvement.
- **Enhanced regulatory compliance:** fully automated RPA processes enable firms to systematically document each step, ensuring alignment with industry regulations. Achieving regulatory compliance involves considering multiple factors in the current legislative landscape. Unlike human operators, whose attention may decline during routine tasks, RPA software consistently performs tasks with precision and reliability, generating error-free audit records. Moreover, when regulations change, RPA only requires reconfiguration rather than specialized training, ensuring adaptability and compliance.

[101] L. Borghesan, D. Valdati and oth, Robotic Process Automation, *L'automazione dei processi per valorizzare la componente umana del lavoro 4.0*, Engineering, page 16

- **Improved efficiency and reduced labor effort:** robots operate continuously, capable of working 24/7, 365 days a year. Typically, a single robot can replace two to five Full-Time Equivalents (FTEs)[102], performing tasks faster and more accurately, leading to enhanced productivity. Automation ensures business continuity, particularly crucial after the pandemic crisis, making organizations more resilient to disruptions and reducing operational risks. By automating repetitive tasks, resources can be reallocated to activities with higher value, boosting productivity and potentially lowering operating costs. According to a PwC report, this is the primary and most evident driver for the adoption of RPA solutions, cited by 49% of respondents[103].
- **Flexibility:** RPA provides the flexibility to manage processes dynamically. For instance, in response to unexpected fluctuations in product demand, robots enable firms to adjust productivity levels accordingly.
- **Increased customer satisfaction:** automation streamlines processes, reducing errors and enabling employees to dedicate more time to customer interactions, thus enhancing the overall customer experience and satisfaction. As reported by 16% of respondents, this improvement in efficacy and output quality is a significant benefit of RPA adoption[104].
- **Risk and error reduction:** when processes are optimized and mapped accurately, robots virtually eliminate processing errors. However, achieving desired results requires thorough testing, training and governance. This risk reduction, cited by 14% of respondents, is a key driver for RPA adoption[105].

Typically, these drivers are interconnected. For instance, meeting compliance standards often correlates with enhancing customer satisfaction. Take the KYC (Know Your Customer) process, mandated by law for credit institutions and financial intermediaries. If conducted manually, it demands significant time and effort, potentially leading customers to perceive operational inefficiency. Conversely, employing robotic software for identity verification results in time and resource savings for the company, thereby improving user satisfaction.

Conversely, the primary challenges in adopting RPA solutions stem from:

[102] L. Borghesan, D. Valdati and oth, Robotic Process Automation, *L'automazione dei processi per valorizzare la componente umana del lavoro 4.0*, Engineering, page 16, https://www.eng.it/resources/whitepaper/doc/rpa/RPA_whitepaper_en.pdf
[103] PwC report, *Robotic Process Automation in Italian Financial Services field*, 2018, pag. 5
[104] Capgemini, *The risk of RPA implementation and how to mitigate it*, 2021 https://www.capgemini.com/pt-en/2021/03/the-risk-of-rpa-implementation-and-how-to-mitigate-it/
[105] See note 104

- **Employee reskilling:** ensuring internal commitment necessitates equipping the organization with the requisite competencies and skills.
- **Heightened awareness of benefits:** efficient internal communication is vital. Without widespread recognition of RPA's potential and benefits, obtaining the necessary human and financial resources for extensive adoption becomes challenging.
- **Increased cyber-attack risks:** RPA introduces new vulnerabilities susceptible to cyber-attacks and non-human identity breaches. RPA bots often require privileged access, with shared credentials posing a security risk. Unprotected credentials are susceptible to theft, granting cyber attackers access to critical systems, applications and data. Consequently, ensuring RPA security becomes paramount[106].

The adoption of RPA solutions can encounter additional challenges stemming from the absence of a clear strategy, setting unrealistic goals by overestimating its potential, or operational risks during implementation[107]. Despite these challenges, investing in this technology presents a promising opportunity for banks and firms.

3.2.1 From RPA to IPA solutions

There are three classes of RPA[108]:

1. **Class I:** basic process automation, focusing on activities reliant on structured data such as CSV and XML.
2. **Class II:** enhanced and intelligent process automation, capable of handling unstructured data inputs like emails and documents. This type of automation can learn from experience and apply knowledge to process diverse needs.
3. **Class III:** cognitive platforms, able to comprehend customer requests and perform tasks that previously required human intervention.

Class II and Class III fall under the broader concept of Intelligent Process Automation (IPA).

[106] CYBERARK, https://www.cyberark.com/it/what-is/robotic-process-automation/
[107] See note 104
[108] L. Borghesan, D. Valdati and oth, Robotic Process Automation, *L'automazione dei processi per valorizzare la componente umana del lavoro 4.0*, Engineering, page 6, https://www.eng.it/resources/whitepaper/doc/rpa/RPA_whitepaper_en.pdf

IPA encompasses a broader spectrum of RPA by incorporating cognitive computing technologies. Machine Learning (ML) plays a pivotal role in this integration, offering solutions such as[109]:

- **Optical Character Recognition (OCR)** for digital text recognition
- **Intelligent Character Recognition (ICR)** for interpreting human handwriting
- **Computer vision** for image detection
- **Augmented content** for locating positions in documents
- **Natural Language Processing (NLP)** and **Natural Language Generation (NLG)** for understanding human language, especially in supporting virtual assistants
- **Task discovery** for identifying processes suitable for automation through RPA

The combination of these Artificial Intelligence solutions enables bots to evolve beyond managing simple and repetitive tasks. Instead, they gain human-like capabilities such as decision-making, context evaluation and learning from experience.

The IPA market is anticipated to surpass the RPA market in value. As depicted in Figure 25, the IPA market was forecasted to reach approximately 20 billion U.S. dollars in 2021, with a Compound Annual Growth Rate (CAGR) of 16%, expected to reach 30 billion U.S. dollars by the end of 2024[110].

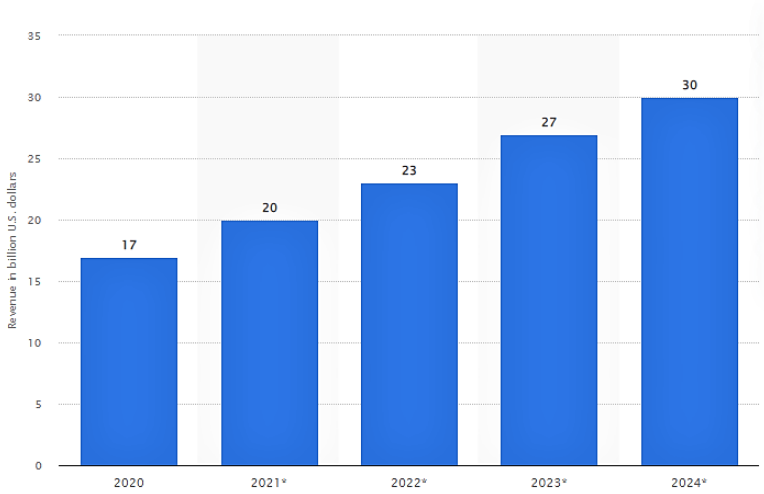

Figure 25: *Worldwide intelligent process automation market from 2020 to 2024 (in billion U.S. dollars)*, Source: Statista, 2022

[109] A. Rughi and A. Ceriani, *Le prospettive future dell'Intelligent Automation, secondo le aziende italiane*, Deloitte, pag. 5, 2020
[110] Statista, *Worldwide intelligent process automation market from 2020 to 2024 (in billion U.S. dollars)*, 2022

Processes often blend repetitive tasks with those demanding specific skills, intuition and judgment, like categorizing and pre-evaluating resumes received via email or institutional websites. While extracting data from standard PDF documents may be routine, pre-evaluating resumes involves comparing a candidate's competencies and skills with those required by the company. This task requires an AI capability for assessment, which can improve over time through continuous training of Machine Learning algorithms.

The integration of RPA and AI, forming the basis of Intelligent Automation, refines RPA by enhancing results for the company. It boosts individual and team productivity, reduces costs, enhances efficiency, and minimizes errors compared to traditional RPA approaches.

Moreover, the fusion of RPA and AI marks a crucial step in enterprise modernization, essential for leveraging exponential technologies like AI. While acknowledging the undeniable benefits of AI, some enterprises struggle with its implementation and utilization, alongside challenges in integrating automation and data science teams and addressing talent shortages both internally and in the marketplace.

Therefore, integrating RPA and AI through tailored and effective solutions represents a significant investment in a company's future, delivering immediate and tangible benefits that enhance competitiveness across the market.

3.2.2 RPA examples in financial services sector

- **"Citibank", RPA for Accounts payable**

Citibank implemented RPA bots to automate accounts payable processes, including invoice processing, payment reconciliation and vendor management. By automating these tasks, Citibank achieved faster invoice processing times, reduced errors and enhanced auditability in its accounts payable operations.

- **"UiPath"**

UiPath is a leading provider of robotic process automation (RPA) solutions that help automate repetitive tasks in the financial services sector. Their RPA platform integrates with DPA tools to automate tasks such as data entry, document processing, reconciliation and reporting.

3.3 Digital Process Automation (DPA)

Digital process automation (DPA) refers to the orchestration of people, bots, data and systems to automate manual tasks in a workflow. The goal is to automate certain actions as part of a

larger process that still requires a human to make higher level cognitive decisions[111]. It involves the use of software tools and technologies to automate repetitive tasks, improve efficiency and reduce human error in various business processes.

By implementing DPA solutions that utilize both bots and AI, organizations realize tremendous cost and time savings. The most powerful offerings feature a single platform with visual tools that allow employees to essentially sketch out their complex processes.

Without digital process automation (DPA), onboarding new employees is a chaotic process, especially in remote work setups. However, by automating the onboarding process, the employee's first login triggers a series of automated actions, including a warm welcome message and access to training materials. DPA streamlines paperwork processing and eliminates the need for manual communication, resulting in a smoother and more efficient onboarding experience. Automated business processes like this save time and improve overall productivity, ensuring a positive start for new hires.

The most effective hyperautomation tools feature user-friendly interfaces and incorporate low-code elements, such as pre-configured components that can be easily dragged and dropped into workflows. These components encompass AI-driven intelligent document processing for tasks like invoice handling and notification systems for timely approvals. With a focus on reusability, DPA with low-code empowers IT teams to swiftly construct new workflows by leveraging previously utilized components. This adaptability allows organizations to respond rapidly to market shifts or internal process updates, fostering unparalleled agility. Through a unified low-code platform, various departments can collaborate seamlessly on workflow creation, while pre-built components streamline the process, eliminating the need to start from scratch for each modification. Consequently, automating new workflows and adapting to market dynamics becomes significantly more efficient, without the constraints of manual coding processes.

The Digital Process Automation Market is witnessing significant growth as organizations strive for operational efficiency, cost reduction, and improved customer experience. As shown in figure 26, the Global Digital Process Automation Market is projected to reach a valuation of

[111] Appian, https://appian.com/blog/2021/rpa-vs--dpa--the-differences-and-similarities-between-digital-an.html, 2021

USD 41.1 billion by 2032, from the current m-cap of USD 10.8 Billion, growing at a remarkable CAGR of 14.6% from 2023 to 2032[112].

The Digital Process Automation Market is witnessing significant adoption across industries, including banking and finance, healthcare, manufacturing, retail, IT and telecommunications. North America currently holds the largest market share, followed by Europe and Asia Pacific. The Digital Process Automation Market is driven by factors such as the need for operational efficiency, cost reduction, improved customer experience and regulatory compliance.

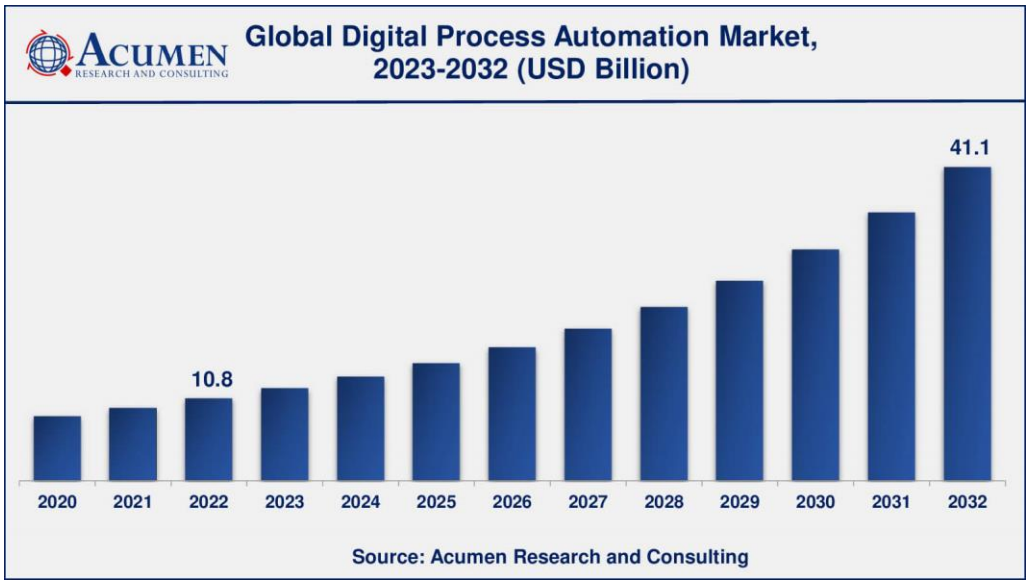

Figure 26: *Global Digital Process Automation market from 2020 to 2032 (in billion U.S. dollars)*, Source: Acumen Research and Consulting, 2023

The banking and finance industry is one of the sector that has been quick to adopt digital process automation. DPA is used extensively in areas such as accounts payable, accounts receivable, loan processing and customer service. DPA helps banks and financial institutions improve efficiency by automating tasks such as data entry, account reconciliation and fraud detection. DPA can also help reduce human error, leading to a more accurate and reliable financial record.

The benefits of DPA are universal. The implementation process maybe different depending on the industry you're working in, but its potential is vast and will be useful for all types of businesses.

Digital process automation (DPA) offers a multitude of benefits to the financial services sector:

[112] Globenewswire, https://www.globenewswire.com/news-release/2023/07/17/2706043/0/en/Digital-Process-Automation-Market-Size-Predictions-suggest-a-rise-of-14-6-CAGR-To-Reach-value-of-USD-41-1-Billion-by-2032.html, 2023

1. **Improved Efficiency:** DPA streamlines workflows, automates repetitive tasks and reduces manual interventions, leading to faster processing times and improved operational efficiency
2. **Cost Reduction:** by automating manual processes, DPA helps financial institutions reduce labor costs, minimize errors and optimize resource allocation, resulting in significant cost savings over time
3. **Enhanced Accuracy and Compliance:** DPA ensures consistency and accuracy in data processing and regulatory compliance by automating validation checks, audit trails and reporting requirements, thereby reducing the risk of errors and regulatory penalties
4. **Faster Decision-making:** automated processes enable real-time data processing and analysis, allowing financial institutions to make faster, data-driven decisions in areas such as risk management, fraud detection and customer service
5. **Improved Customer Experience:** DPA enables faster response times, personalized interactions and seamless transactions, leading to enhanced customer satisfaction and loyalty
6. **Scalability and Flexibility:** DPA platforms are scalable and adaptable, allowing financial institutions to easily adjust to changing business needs, market dynamics and regulatory requirements without significant manual effort
7. **Innovation and Competitive Advantage:** by automating routine tasks, DPA frees up resources for innovation, enabling financial institutions to focus on developing new products, services and business models to stay ahead of the competition
8. **Data Insights and Analytics:** DPA generates valuable data insights and analytics that can be used to identify trends, patterns and opportunities for optimization, innovation and strategic decision-making

Overall, digital process automation empowers financial institutions to operate more efficiently, effectively, and competitively in a rapidly evolving and highly regulated industry landscape.

Here are some key areas where DPA is commonly applied within financial services:

1. **Customer Onboarding:** DPA can automate the customer onboarding process, including account opening, KYC (Know Your Customer) verification and documentation. By digitizing these processes, financial institutions can reduce paperwork, minimize errors and accelerate the time it takes to onboard new customers
2. **Loan Processing:** automating loan origination, underwriting and approval processes can significantly reduce the time and effort required to process loan applications. DPA

solutions can automate data collection, credit scoring, risk assessment and decision-making, leading to faster approvals and improved customer satisfaction

3. **Payments and Transactions:** DPA can streamline payment processing and transaction settlement, reducing manual intervention and errors. Automated workflows can handle tasks such as payment initiation, reconciliation, fraud detection and compliance checks, making the payment process more efficient and secure
4. **Compliance and Regulatory Reporting:** financial institutions are subject to strict regulatory requirements, and DPA can help automate compliance tasks and regulatory reporting. By implementing DPA solutions, firms can ensure adherence to regulations, streamline reporting processes and reduce the risk of non-compliance
5. **Customer Service and Support:** DPA can enhance customer service by automating routine inquiries, account maintenance tasks and complaint handling processes. Chatbots, virtual assistants and automated email responses can provide timely assistance to customers, improving overall satisfaction and reducing service costs
6. **Risk Management:** DPA can support risk management activities by automating risk assessment, monitoring and mitigation processes. Automated workflows can flag unusual activities, assess credit risk and enforce risk controls in real-time, helping financial institutions proactively manage risks
7. **Investment Management:** DPA can automate various aspects of investment management, including portfolio rebalancing, trade execution and reporting. By leveraging automation, investment firms can optimize investment decisions, reduce operational costs and improve portfolio performance

Digital process automation (DPA) has become increasingly prevalent in the financial services sector due to its numerous advantages. However, it is crucial to acknowledge and address the potential drawbacks associated with its implementation.

Firstly, the reliance on automated processes and digital technologies exposes financial institutions to cybersecurity risks. These risks include data breaches, hacking attempts and malware attacks, which can compromise sensitive financial information and result in financial losses or damage to reputation.

Secondly, technical issues such as glitches, system failures, or errors in automated processes can disrupt operations, impacting customer service and financial transactions. Inadequate backup systems or contingency plans further exacerbate operational risks associated with dependence on automation.

Thirdly, while automation enhances efficiency and productivity, it may lead to job displacement for roles involving repetitive, manual tasks. Workforce restructuring and job losses could result in employee dissatisfaction and organizational challenges.

Moreover, implementing DPA in the financial services sector necessitates compliance with complex regulatory frameworks and evolving standards. Continuous monitoring, updates and adjustments are required to ensure adherence to regulatory requirements.

Ethical considerations also arise with DPA technologies, particularly regarding algorithmic bias, fairness and transparency. Automated decision-making processes have the potential to perpetuate existing biases, leading to unfair outcomes or discriminatory practices.

Furthermore, over-reliance on technology without human oversight may diminish human judgment, creativity and critical thinking in decision-making processes. Striking a balance between automation and human involvement is crucial to ensure responsible and ethical use of technology.

Lastly, financial institutions may become dependent on third-party vendors for DPA solutions, posing risks related to vendor reliability, service disruptions and contractual obligations. Dependency on external vendors may also limit flexibility and control over DPA systems and processes.

In conclusion, while digital process automation offers significant benefits to the financial services sector, it is imperative for financial institutions to carefully assess and address the potential negative aspects to ensure successful and responsible implementation.

3.3.1 DPA real-word application in financial services sector

- **"J.P. Morgan Chase", Contract Intelligence Platform**

J.P. Morgan Chase developed a Contract Intelligence (COiN) platform powered by machine learning and natural language processing (NLP) to automate the review and extraction of key information from legal contracts. This DPA solution significantly reduced the time and resources required for contract analysis, improving efficiency and reducing operational costs.

- **"HSBC", Digital Mortgage platform**

HSBC introduced a digital mortgage platform that leverages DPA to streamline the end-to-end mortgage origination process. The platform enables customers to apply for mortgages online, upload supporting documents and track the status of their applications in real-time. By

automating manual tasks and document processing, HSBC accelerated the mortgage approval process and improved customer satisfaction.

- **“Wells Fargo”, Fraud Detection System**

Wells Fargo implemented a DPA solution for fraud detection and prevention, utilizing advanced analytics and machine learning algorithms to identify fraudulent activities in real-time. The system automatically analyzes transactional data, customer behavior patterns and other relevant factors to detect and mitigate potential fraud risks, safeguarding the bank and its customers against financial losses.

- **“Goldman Sachs”, Marcus Platform for Personal Loans**

Goldman Sachs' Marcus platform offers personal loans with a fully digital and automated application process. Customers can apply for loans online, receive instant credit decisions and manage their loans through a user-friendly digital interface. The platform's DPA capabilities streamline the loan origination process, enabling Goldman Sachs to deliver faster loan approvals and a seamless customer experience.

- **“ING”, Agile Transformation**

ING embarked on an agile transformation journey to modernize its banking operations and improve agility, responsiveness and efficiency. As part of this transformation, ING adopted DPA principles and technologies to automate manual processes, streamline workflows and enhance collaboration across teams. The initiative has enabled ING to accelerate product development cycles, deliver innovative banking solutions and better meet customer needs in a rapidly changing market.

- **“Bank of America”**

Bank of America has integrated DPA technologies into its operations to automate tasks such as account management, fraud detection, and customer service. The bank's investment in automation has led to improved efficiency, enhanced customer experiences and greater regulatory compliance.

- **“Citigroup”**

Citigroup has embraced DPA in areas such as trade processing, risk management and regulatory reporting. By automating repetitive tasks and manual processes, the bank has been able to reduce operational costs, mitigate risks and accelerate decision-making.

- **“Appian”**

Appian provides low-code automation platforms that empower financial services firms to build and deploy DPA applications rapidly. Their solutions enable automation of processes such as customer onboarding, claims processing, risk management, and regulatory compliance.

These real-world cases demonstrate how financial institutions leverage digital process automation to drive operational excellence, enhance customer experiences, and stay competitive in an increasingly digital and dynamic industry landscape.

3.4 RPA and DPA: common points and differences

While Robotic Process Automation (RPA) and Digital Process Automation (DPA) have distinct purposes and characteristics, they do share some common points:

1. **Automation Objective:** both RPA and DPA aim to automate business processes to improve efficiency, reduce manual effort and enhance productivity. They enable organizations to streamline workflows and achieve operational excellence through automation
2. **Efficiency Enhancement:** both RPA and DPA contribute to efficiency enhancement within organizations by reducing the time and effort required to perform repetitive tasks. By automating routine processes, they free up human resources to focus on more strategic and value-added activities
3. **Technology Integration:** both RPA and DPA involve integration with existing systems, applications and data sources within an organization's IT landscape. They leverage technology to orchestrate workflows, exchange data and interact with various systems to achieve automation objectives
4. **User Interface Interaction:** while RPA primarily operates at the user interface level, interacting with applications through the presentation layer, DPA can also involve user interface interaction as part of its automation capabilities. Both RPA and DPA may utilize user interface interactions to automate tasks such as data entry, form filling and screen navigation
5. **Process Optimization:** both RPA and DPA contribute to process optimization within organizations by standardizing workflows, reducing errors and improving process visibility. They enable organizations to implement best practices, enforce compliance and achieve greater consistency in their operations.

Conversly, Robotic Process Automation (RPA) and Digital Process Automation (DPA) differ in their scope, capabilities and implementation approach. Here are the key differences between RPA and DPA:

1. **Scope of Automation:**

- RPA: RPA focuses on automating repetitive, rule-based tasks by mimicking human actions performed on user interfaces. It operates at the user interface level and interacts with applications just like a human user would, without requiring changes to underlying systems.

- DPA: DPA, on the other hand, aims to automate end-to-end business processes by orchestrating and integrating various systems, data sources and applications. It typically involves more complex workflows and can automate tasks that may require decision-making and data processing beyond simple rule-based actions.

2. **Level of Integration:**

- RPA: RPA operates at the surface level and does not require deep integration with underlying systems. It can work with legacy systems, desktop applications, web browsers and virtual desktop environments by interacting with their user interfaces.

- DPA: DPA requires integration with multiple systems and applications to automate end-to-end processes. It may involve connecting to databases, APIs, web services and middleware to access and manipulate data across different systems.

3. **Capabilities:**

- RPA: RPA excels at automating repetitive, manual tasks such as data entry, copy-pasting, form filling and file manipulation. It is well-suited for tasks that involve structured data and predictable processes.

- DPA: DPA is capable of automating more complex business processes that involve multiple steps, decision points and interactions with different systems. It can handle tasks that require data processing, business logic and human judgment.

4. **Implementation Approach:**

- RPA: RPA implementations are typically quick and relatively easy, as they involve recording or scripting sequences of actions that mimic human interactions with applications. RPA bots can be deployed rapidly to automate specific tasks without major changes to existing systems.

- DPA: DPA implementations are more strategic and may require more planning, customization, and integration effort. DPA platforms provide tools for modeling, designing and orchestrating end-to-end processes, which may involve collaboration across different departments and stakeholders.

In summary, while both RPA and DPA aim to automate business processes, they differ in their focus, capabilities and implementation approach. RPA is best suited for automating repetitive, rule-based tasks at the user interface level, while DPA is designed to automate end-to-end business processes that involve integration with multiple systems and applications.

CONCLUSION

In the realm of Artificial Intelligence (AI), the journey from its conceptual origins to its current applications in the Financial Services sector has been nothing short of extraordinary. As we reflect on the historical evolution and multifaceted applications of AI, encompassing Robotic Process Automation (RPA), Digital Process Automation (DPA), chatbots and Intelligent Process Automation (IPA), it becomes evident that we stand at the precipice of a new era of technological innovation and disruption.

Throughout this thesis, we have traced the intricate pathways of AI's development, from its theoretical underpinnings in the early 20th century to its modern-day manifestations in finance and beyond. We have explored the foundational concepts of RPA, which enable the automation of repetitive, rule-based tasks, and DPA, which orchestrates end-to-end business processes across disparate systems and applications. We have delved into the realm of chatbots, which leverage natural language processing and machine learning to enhance customer interactions and service delivery. And we have examined the transformative potential of IPA, which combines RPA with advanced cognitive technologies to enable autonomous decision-making and problem-solving.

In the Financial Services sector, AI has emerged as a game-changer, revolutionizing how banks, insurance companies, asset managers and other financial institutions operate and compete in a rapidly evolving landscape. From streamlining back-office operations to enhancing customer experiences, AI-powered solutions have become indispensable tools for driving efficiency, mitigating risks and unlocking new opportunities.

In banking, RPA has automated manual tasks such as data entry, account reconciliation and compliance reporting, enabling financial institutions to streamline operations, reduce costs and improve accuracy. DPA has transformed end-to-end processes such as loan origination, customer onboarding and claims processing, driving operational excellence and enhancing regulatory compliance. Chatbots have revolutionized customer service and support, providing personalized assistance, answering queries and facilitating transactions through intuitive conversational interfaces. And IPA has empowered decision-makers with actionable insights, enabling them to make informed decisions, optimize processes and adapt to changing market conditions in real-time.

However, as we celebrate the achievements and potential of AI in the Financial Services sector, we must also acknowledge the challenges and ethical considerations that accompany its

widespread adoption. Concerns about data privacy, algorithmic bias, job displacement and regulatory compliance loom large, requiring thoughtful consideration and proactive measures to address.

As we look to the future, the possibilities presented by AI in finance are limitless. With continued advancements in technology and innovation, we can expect to see even greater integration of AI-powered solutions into every facet of financial services, from risk management and investment strategies to customer engagement and regulatory compliance.

In conclusion, the journey of Artificial Intelligence from its historical origins to its contemporary applications in the Financial Services sector is a testament to human ingenuity, perseverance and innovation. As we navigate this dynamic landscape, let us harness the transformative potential of AI to create a more efficient, inclusive, and resilient financial ecosystem for all.

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