

Corso di laurea in Strategic Management

Cattedra Corporate Strategy

Automation of internal processes: an AI strategic approach

Prof. Luigi Nasta

Prof. Paolo Boccardelli

CORRELATORE

Francesco Oliva Matr. 760081

CANDIDATO

Anno Accademico 2023/2024

TABLE OF CONTENTS

1	IN	TRODUCTION	
	1.1	CHALLENGES RELATED TO AI	
2	AI	I AND THE "INNOVATOR'S DILEMMA"	
	2.1 2.2	AI and "disruptive technologies" Present scenario	
3	ST	TRATEGIC INTEGRATION OF AI	
	3.1 3.2 3.3 3.4 3.5	Context analysis Business examples of AI implementation AI impact assessment Risk analysis AI organizational changes	
4	FC	OCUS ON AI AND HRM: EFFECTS ON LABOR FORCE	
	4.1 4.2	WHY AI IS BEING USED IN HR? Isolating Mechanisms	
5	TH	HE FUTURE OF MANAGEMENT	
	5.1 5.2	REDEFING PURPOSE AND STRATEGY PERFORMANCE ANALYSIS: HR vs AI	
6	CO	ONCLUSIONS	
7	RE	EFERENCES	

INDEX OF FIGURES

Figure 1 A neural network	6
Figure 2 Deep Neural artificial network	7
Figure 3 Sustaining vs Disruptive Innovation	9
Figure 4 Credit Card vs. mobile Payment Adoption Rate	13
Figure 5 General representation of a digital twin system	17
Figure 6 General digital twin model for a product	18
Figure 7 Predictive maintenance model	19
Figure 8 Prediction methods classification	20
Figure 9 Telemetry data over the first fifteen days of January 2015, Machine 1	23
Figure 10 Part and packaging correlation model	
Figure 11 ML model for optimal packaging type identification	31
Figure 12 Random forest structure	31
Figure 13 IBM Human resource process	49
Figure 14 ChatGPT response to prompt regarding trust	54
Figure 15 Key Roles to Organizing AI	59

1 INTRODUCTION

It could be useful to begin with the historical interpretation of the word "intelligence," starting with the theories of the ancient Greek philosophers who acknowledged its complexity, to have a better understanding of the idea of artificial intelligence. The Greeks distinguished between two forms of intelligence: *metis* and *logos*. Plato, Socrates, and Aristotle all held that *metis*, or practical intelligence or cunning, was symbolic of the kind of ingenuity exhibited by the mythological figure Odysseus, and that logos is the way by which reason is utilized to comprehend and rule the world. While metis is focused on dealing with real-world problems or finding solutions to tangible ones as they emerge, logos is linked to solving abstract difficulties.

Some people have excellent abstract reasoning skills, which allow them to solve challenging mathematics or comprehend philosophical concepts, but they might not have the necessary problem-solving talents to put together a piece of furniture out of separate parts.

These days, we understand that intelligence can take many different forms, including creativity, verbal intelligence, and memory. As a result, we ought to refrain from stating something as basic as "That person is not intelligent." Rather, we ought to identify the many kinds of intelligence people have and the areas in which they use their problem-solving skills. Put otherwise, we should be clear about the type of intelligence we mean when we remark, "That person is not intelligent."

Dictionary definitions of intelligence that are current can also be useful. For instance, these are the definitions given by the Webster's New World Dictionary:

- "The capacity of the mind to absorb and retain information; the capacity to learn from experience".
- "The capacity to adapt swiftly and proficiently to novel circumstances; the application of logic to resolve issues efficiently".

Similar definitions can be found in other dictionaries. The Oxford Dictionary defines intelligence as "the ability to learn, understand, and think logically about things, and to do this well." The Cambridge Dictionary defines intelligence as "the ability to learn and understand things."

Prior to diving into an overview of artificial intelligence (AI), it is helpful to take into account Robert Sokolowski's viewpoint of the possible misconceptions that may result from the term "artificial." In a 1988 paper [1], Sokolowski notes:

"One of the first things that must be clarified is the ambiguous word 'artificial.' This adjective can be used in two senses, and it is important to determine which one applies in the term 'artificial intelligence.' The word 'artificial' is used in one sense when it is applied, say, to flowers, and in another sense when it is applied to light. In both cases, something is called artificial because it is fabricated. But in the first usage, 'artificial' means that the thing seems to be, but really is not, what it looks like. The artificial is merely apparent; it shows how something else looks. Artificial flowers are only paper, not flowers at all; anyone who takes them to be flowers is mistaken. But artificial light is light, and it does illuminate. It is fabricated as a substitute for natural light, but once fabricated, it is what it seems to be. In this sense, the artificial is not merely apparent, not simply an imitation of something else. The appearance of the thing reveals what it is, not how something else looks."

Given this distinction, we could argue that in the case of artificial intelligence, we are dealing with something that, while fabricated or artificial, is nevertheless real. It possesses reasoning capabilities, however limited or primitive, and represents something that genuinely exists and operates in terms of reasoning, albeit within the constraints imposed by technological progress, much like human beings.

We can then turn to more recent definitions, such as those by Russell and Norvig [2], who in their seminal book categorize AI in four ways:

- Thinking humanly.
- Acting humanly.
- Thinking rationally.
- Acting rationally.

The National Institute of Standards and Technology (NIST) and the Organization for Economic Co-operation and Development (OECD) have also given their definitions on what they consider a proper AI system. An artificial intelligence system is defined by the OECD [3] as a "machine-based system that, for explicit or implicit objectives, infers from the input it receives how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments." In the meantime, NIST defines AI as "a branch of computer science devoted to developing

data processing systems that perform functions normally associated with human intelligence, such as reasoning, learning, and self-improvement." [4].

These definitions emphasize the coupling of processing systems, and the implementation within them of learning methods also called "machine learning methods" that seek to simulate and mimic more and more the workings of the human mind, in terms of reasoning and information acquisition.

There are two primary categories within the subject of artificial intelligence (AI): narrow AI and general AI. Narrow artificial intelligence, sometimes referred to as weak AI, refers to systems built to perform particular jobs or address specific issues. IBM's "Deep Blue" chess computer, which is renowned for defeating the world champion Garry Kasparov, in 1997 [5], is an illustration of restricted artificial intelligence. This shows that although computers are more capable than humans in certain categories, such as chess, their talents aren't universal. Conversely, general AI, often known as strong AI, aims to build robots that can perform at a level similar to humans in a variety of jobs and display a wide range of human-like characteristics [6]. Replicating the entire range of functions seen in the human brain would be necessary to achieve general AI. True general artificial intelligence (AI) is still a long way off, despite notable advances in the field, as demonstrated by programs like ChatGPT.

Overview of AI's Disciplines

A wide range of academic fields that examine different facets of computer capabilities and how much they mimic human intelligence are together referred to as artificial intelligence.

Machine Learning (ML) is a departure from standard programming techniques in which computers learn by doing rather than by explicit instruction [7]. In short, Machine Learning (ML) processes data to enable computers to recognize patterns and adjust to changing circumstances. Algorithms, which are numerical processes created to solve issues based on prior examples, are the means by which this learning takes place. There are various methods used in machine learning. An algorithm is trained using a dataset in supervised learning, where each input is matched with a known result. The algorithm's objective is to discover this association and produce precise forecasts on fresh, unobserved data. An algorithm can be trained to recognize and categorize new photos by using annotated photographs of animals, for instance. Unsupervised learning, on the other hand, uses unlabeled data. Without preset results, the computer must find patterns and groups on its own. Since there are no clear answers to direct the learning process, this method presents evaluation challenges. Using an alternative method, Reinforcement Learning (RL) lets an agent engage with its surroundings and pick up knowledge through trial and error. RL, which draws inspiration from behavioral psychology, gives the agent feedback in the form of incentives or penalties in response to its behaviors, with the goal of gradually increasing total rewards. In contrast to supervised learning, reinforcement learning (RL) lets the agent learn from the results of its actions rather than giving it explicit instructions. Deep RL, the combination with deep learning techniques, has achieved significant importance in the development of complex tasks like autonomous driving and conversational systems [8]. Another field of application for Machine Learning and AI is the so-called "Artificial neural networks", or ANNs, that represents a crucial part of deep learning. Layers of linked artificial neural networks. Since each layer takes in inputs and produces outputs, the network may learn from its previous performance and adapt to new circumstances [9].



Figure 1 A neural network

ANNs mirror the brain's capacity for learning and adaptation, even though they are not an exact clone of the brain. Deep learning, which uses multi-layered networks, is very good

at tackling difficult tasks like audio and picture identification and natural language processing.



Figure 2 Deep Neural artificial network

The role of NLP, or natural language processing, is aiming to enable computers to understand and generate human language. This field of study combines concepts from speech recognition, computational linguistics, and language technology to perform tasks including translation, summarization, and question answering. The development of large language models (LLMs) led to the creation of ChatGPT and other NLP innovations. Deep learning is used by these models to handle challenging linguistic tasks.

Another field, computer vision (CV) focuses on teaching machines to comprehend visual data. Applications in this discipline include object detection, in which computers identify and classify items, like faces or cars. Among other businesses, consumer technology and security employ face recognition, a specialized computer vision application, to identify people based just on their face traits [10]. Instead, Emotion AI, or affective computing, aims to recognize and respond to human emotions. Affective Computing recognizes emotional states based on information from psychology and neuroscience, oftentimes

through analysis of facial expressions. This field of study develops AI systems with emotional intelligence, which helps enhance human-computer interactions.

Lastly, the goal of automated reasoning (AR) is to create machines that can reason and carry out jobs that are normally done by people, like responding to inquiries and coming to conclusions from data that has been stored. The goal of AR is to imitate human thought processes in computer systems. Common sense reasoning is still hard to come by since these kinds of systems are more complicated than ones made for specialized jobs, like chess playing algorithms or diagnostic systems.

1.1 CHALLENGES RELATED TO AI

The corporate sector is facing some significant issues as a result of AI.

First, there's the quality of decision-making and the ability to combine massive data sets with ever-more-advanced algorithms and processing power to help make better judgments along the road. Will these algorithms be able to make better business decisions than managers? How well such decisions come out will depend on a number of factors, including the quality of the data utilized, the algorithms used to produce them, the possibility of internal biases in the algorithms, and the quality of the learning the algorithms do as they make more decisions. One may argue that in this case, the value of human judgment will take precedence.

The second issue is how CEOs and general managers function in AI-based businesses. It seems that past knowledge and experience may become less relevant in the future given that big data and artificial intelligence (AI) will provide in-depth knowledge about specific business insights as well as customer and employee behavior. But it seems like some qualities of a successful leader will be more important now than they were in the past. The topics include, but are not limited to, how to give an organization a sense of direction that keeps it cohesive and long-term focused; how to inspire and engage professionals and give them purpose in their work; how to develop and retain high-performance professionals; how to think strategically and long-term in such a rapidly changing landscape; how to build trust both inside and outside the organization; how to encourage accountability in front of the various stakeholders; and how to ensure that businesses respect human dignity and ethical values. The recent Facebook trust crisis around its users' data is a clear example of the new complex challenges in this rapidly changing business context driven by big data and algorithms.



Figure 3 Sustaining vs Disruptive Innovation

The roles that CEOs must play in an AI-driven environment are evolving quickly, and so do the jobs, abilities, and requirements placed on them. The third major issue facing businesses and general managers is this. Future leaders' development must be restructured, and organizational structures will change. In many years, firms and society will have slightly different expectations for the knowledge, skills, talents, and attitudes that general managers should possess. Providing theories, frameworks, and policy recommendations on how general management and organizations should adapt to the emerging AI world is obviously necessary.

The fourth challenge is how organizational design, team coordination, execution and management systems will need to evolve in this world dominated by data. Will strategic decisions, control and compensations systems still require human judgment? How to offset the potential bias or discrimination coming from AI algorithms that recommend specific decisions on people hiring and promotions, or assessing business performance? How will boards of directors assume responsibilities for the oversight of the company in a world where more decisions, including control and oversight, will be made by machines?

2 AI AND THE "INNOVATOR'S DILEMMA"

2.1 AI AND "DISRUPTIVE TECHNOLOGIES"

Theory of disruptive innovation, introduced for the first time in '97 by Clayton Christensen, helps us identify the size of how AI and Machine Learning will most likely impact businesses. His book "The innovator's dilemma" made him, citing "The Economist", "the most influential management thinker of his time" [11] and in it, it explained the power of disruption, why oftentimes, market leaders are set up to fail while markets and technologies keep evolving and give influential tips on how incumbents can try to secure a long-lasting market leadership. The same book is the only one about business and entrepreneurship that Steve Jobs, the guy who created one of the most valuable companies in the world, put in his personal favorite books' list. in the publication, the academic proves his point by basing his thesis on three main lessons:

- We can identify two types of innovations: sustaining and disruptive
- If a company's procedures, beliefs, and assets do not match the demands of the market, no management team can rescue the situation.
- Leaders' way out to solve the dilemma is to acquire or fund in-house

FIRST LESSON

Christensen distinguishes between two kinds of innovations: sustaining and disruptive. The first group focuses on growing existing technologies by augmenting the size and/or the quality of their functionalities or capacities, leading to an enhancement in overall performance of the product or service.

Disruptive technologies, instead, change entirely the landscape of the industry or create one from the ground up by solving existing issues in entirely new ways and/or for a new group of people.

Economies of scale and scope, the amount of resources invested and the knowledge market leaders and established businesses thrive when impacted by sustaining technologies: the impact of the efficiency built naturally creates a scalable growth pattern.

SECOND LESSON

A challenge posed by innovation is aligning capabilities and resources, internal and external processes and communicating through culture and action the values. The reason why start-ups are faster to adapt and can take over the industry giants, is because they usually start by referring to a low-margin, niche market. Big companies, given their higher degree of formalization and their structure constraints, usually only tick one of the three main criterias for market targeting: even if they've plenty of resources, lacking a fixed set of values and having hard processes rarely make the leader match the new target market. At least in the short-term.

THIRD LESSON

For Christensen, the way managers solve the innovator's dilemma is by equipping a subsidiary with the appropriate number of resources and letting it create its own values and processes: sustaining and disruptive technologies cannot be developed by the same "source". First of all, the company should assess what types of constraints it's being affected with. In order not to be destined to fail in the long term, Christensen suggests, either they try to force customers to a new market, or they can fund or acquire a subsidiary. The lesson here is to compensate through the resources available for the lack of the other two.

Businesses used to take their time transitioning from paper to digital, frequently through large-scale initiatives meant to completely change the way they conducted business. After their data was digitized, they would organize their tactics and make sense of it using a variety of tools and models. Going digital and making strategic plans were frequently viewed as two distinct activities.

AI has become the link between these two steps [12]. It's like having an incredibly smart assistant that not only accurately collects and stores data, but also provides real time tips to make better decisions. Integration here is the buzzword.

The more we investigate what are all the possible fields and departments that could be severely interested by the adoption of these technologies, the easier it becomes to realize that innovations like this affect transversally different business areas. The use of digitization has made it easier to implement strategies since data is now integrated into the plan rather than just serving as a support tool. For instance, skill-based HR strategies will become possible when AI-driven capabilities are able to capture and enable the dynamic matching that is required between employees' talents and capacity and the demands of the enterprise; analyzing real time data from multiple sources such as warehouse stock levels, historical buying trends and even weather patterns, allow companies like Walmart and Procter & Gamble to predict more precisely the demand curve, plan their supply chain strategy and, as a result, reducing costs and increasing efficiency. More examples can be made about competition and market analysis: Netflix uses AI to break down customer behavior and preferences and cultural trends that can affect demand for certain types of content helping them decide where to launch. Moreover, customer reviews, social media and competitor's public records set the data points for a firm in order to decide if there are potential market gaps, areas for differentiation and emerging consumer needs. The last two areas of potential development are sustainability and financial risk: AI is being used by businesses like Unilever to evaluate customer attitudes about sustainability and environmental statistics. This helps businesses create new, environmentally friendly product lines and sustainability activities that appeal to their target market, which in turn affects their longterm strategy. Financial institutions employ artificial intelligence to evaluate social media sentiment, geopolitical events, and market movements to determine the degree of risk associated with various investment options. This influences the overall investing strategy in addition to specific investment selections.

More importantly, and that's the most interesting thing about a disruptive innovation, AI enables the so-called "*leapfrogging*" development process [13].

LEAPFROGGING

When mobile phones were introduced for the first time, countries with poor landline infrastructure could bypass the lagging connections issue. People in Africa were the early adopters of mobile payments while the rest of the western countries were still swiping debit or credit cards. In fact, while in the US, always considered at the edge of technological advancement, the traditional methods of payment (cash, debit and credit cards) are still preferred, in two other countries, China and Kenya, digital currencies and mobile payments are widely popular. Four years after the latter became available to the public, "70 percent of Kenya's population was using M-Pesa, the SMS based mobile payments platform" [14].



Figure 4 Credit Card vs. mobile Payment Adoption Rate

In China, indeed, "Between 2013 and 2018, China's two major mobile payment platforms, AliPay and WeChat, completely bypassed credit cards as the dominant payment scheme. AliPay's active users increased from 100 million in 2013, to 900 million in 2018. WeChat grew from 350 million to 1.1 billion." 90% percent of residents in the biggest cities have WeChat and Alipay installed and in use at the beginning of 2020. Apart from traveling straight from point A to point C, these two nations also share the distinction of being the first to fully embrace cryptocurrencies. Decentralized finance was a great way to avoid all of the problems associated with a traditional, centralized banking system. The African nation, in order to avoid remittance fees and to protect local currency from inflation, took the lead globally in P2P cryptocurrency trading. In areas like Ghana and the Philippines that experienced the same type of leapfrogging as Kenya, non-bank wallets are nonetheless performing well. Generally speaking, there are societies or "systems" that result more prone to adopting or leapfrogging onto other technologies. Moreover, the secret of the success of a transformative technology is the effective transformation, and later fidelization, of non-transactors, turning them successfully into transactors. The authors make an easy-to-comprehend example by comparing Uber and Lyft to the traditional cab drivers. Instead of just having an incremental effect on the size of the market, in this case, those companies made anybody owning a car, a potential cab driver. Given these facts, in order to analyze how AI could leapfrog other technologies, it should be analyzed who are its non-transactors. It can be done by looking at markets where there's a very low adoption of Softwares as a Service (SaaS): legal, agriculture, manufacturing but also hospitality are prime examples. Several issues affects these business:

- One of the biggest sectors of the world economy is construction. Yet, it is among the hardest to digitize and is incredibly fragmented.
- Due to technological, security, and cultural constraints, LegalTech was infamously slow to catch on and develop (but is currently speeding into a leapfrog event).
- The hospitality sector is rife with negative attitudes, which presents numerous opportunities for seamless digital products to enhance customer experience.
- Furthermore, the digitalization of production processes has reached a standstill in "pilot purgatory."

As a general rule, "the value of the change must outweigh the burden of changing". So, how can switching costs be lowered at a level for which people turn in transactors?

Generative AI removes the tedious and time-consuming tasks from the day-to-day to do list. It probably could end the complex processes related to learning new unintuitive workflows that have kept in the past switching costs so high. It also represents the first time we had an opportunity to link cost effectiveness, intuitiveness, and full automation together. The reduction of the burden of digitization and the incremental increase in value create a convenient tipping point for implementing the technology. The only constraint remaining, especially in the industries mentioned above, could be represented by the reluctance for the actors to adopt AI, after having to tear down the existing multigenerational infrastructure. But, if the objective is long-term, rewards will show. That's very true particularly in those environments where the Customer Acquisition Costs (CAC) are high. CAC is associated with the costs of acquiring an additional unit of consumer, including all marketing and sales expenses. This happens because competition is stronger, the market is saturated, advertising is costly, consumers' elasticity to price is higher or they are more educated and require personalized services or high-quality contents.

The same way, firms that are starting their "data journey" just now, can bypass several layers of analytics products, arriving at the solution faster. This is true especially for start-ups and SMEs, skipping on expensive and time-consuming data collection phases. Managers are focused on applying Artificial Intelligence on already "prepared" industries

and processes while, initially, AI will probably leapfrog on techs that don't have any good enough alternatives. The last software revolution, that the world has undergone in the last 20 years, has surprisingly interested "only" big tech, media and finance. Industries including manufacturing, construction, hospitality, education and agriculture are well-suited for "AI leapfrogging." AI has the ability to reach user demographics that were not reached by past software revolutions if implemented properly. AI can go where no software has gone before if it is packaged intuitively.

2.2 PRESENT SCENARIO

CEOs are giving generative AI investments more priority than ever, according to 2023 KPMG research [15] on disruptive technologies. Notably, 70% of CEOs are investing significant resources in this technology with the aim of obtaining a competitive advantage in a world that is digitizing and automating at a rapid pace. These company executives are placing their faith in generative AI's capacity to completely reshape their industries by relying on it to foster innovation and increase operational effectiveness. Remarkably, 52% of CEOs believe they will get their money back in the next three to five years, which shows how confident they are in AI's immediate effects.

They expect to obtain, through greater integration of generative AI, a significant increase in the profitability of their companies. The fact that already today 22% of CEOs cite this increase as the main benefit deriving from the introduction of AI, testifies to it. This focus on financial benefits reflects a growing trend, as companies increasingly use artificial intelligence to optimize their operational activities, cut costs and seek new sources of revenue.

Despite their optimism, CEOs are also mindful of the risks that come with advanced technologies like AI. Concerns over the ethical ramifications and the lack of adequate legislative frameworks for AI are expressed by a noteworthy 57% of respondents. The necessity for robust governance and precise legislation grows as AI develops more and finds more uses. Businesses must create strong policies and processes to handle these moral issues and guarantee that AI is applied appropriately.

Generative AI raises cybersecurity vulnerabilities in addition to ethical and legal issues. Although artificial intelligence (AI) has the potential to be an effective instrument for identifying and reducing cyberthreats, it also creates new risks since malevolent actors can use it to create intricate attack plans. The dual nature of AI in cybersecurity is creating a complex environment, with closely connected benefits and risks. Security professionals are challenged greatly because navigating the fine line between protecting defenses using AI and preventing its abuse for negative ends.

Executive officers are becoming increasingly concerned, as 82% of them acknowledge that AI may allow adversaries to create new techniques for cyberattacks. More than a quarter of them (27%) feel unprepared to respond to a possible cyberattack, up from 24% the year before despite the increased focus on cybersecurity. This emphasizes how critical it is for businesses to strengthen their cybersecurity defenses and make sure they are prepared for the always changing threat landscape. It is imperative that CEOs carefully steer their organizations through the challenges of adopting AI.

The establishment of robust governance structures that guarantee the ethical application of AI while safeguarding the company from possible threats must be given top priority. CEOs may position their businesses for long-term success in the digital age by doing this and guiding them through the difficulties associated with implementing AI.

3 STRATEGIC INTEGRATION OF AI

3.1 CONTEXT ANALYSIS

AI in general and machine learning algorithms are the catalyst for a new revolution. Innovative approaches are being tried and tested in production mechanisms in almost all sectors, with varying degrees of success and penetration. The goal is to achieve savings and benefits in terms of lowering logistics costs, directly productive costs like material employment and working hours, or, ultimately, lowering intervention times and workforce use, which will have an impact on the number of working hours used.

3.2 BUSINESS EXAMPLES OF AI IMPLEMENTATION

3.2.1 DIGITAL TWINS

The term Digital Twin represents "a projection of physical space into a virtual space", NASA defined it in 2010 as follows: "An ultra-realistic, highly scalable simulation, using the best available physical models, sensor data and historical ones for mirroring one or more real systems".

Again, according to NASA, the main tasks of a Digital Twin can be described as follows

- Prediction: predictive analysis is carried out while the system is running.
- Security: constant monitoring and control of the system guarantees its safety
- Diagnosis: the system analyzes any unpredicted disturbances.



Figure 5 General representation of a digital twin system

The concept of digital twin has seeded effectively in the industry, for two main reasons [16]:

- Simulating the operation of a component or the system of which it is part allows us to predict possible failures and optimize the project, as well as reduce maintenance costs even before putting it into operation
- Because it allows you to replace the old and burdensome concept of scheduled or fault maintenance with a new approach based on the use of big data and machine learning algorithms.

Furthermore, the use of the digital twin gives the possibility of simulating the short and long-term effects of the use of more or less complex equipment on individual elements (you can go from the smallest mechanical or electronic component, up to the robot of a production line or more complex systems such as an airplane or ship).



Figure 6 General digital twin model for a product

More complex equipment and/or systems may find themselves operating in more or less "fatigue" conditions than those estimated during the design process, and this affects their remaining operational life, therefore the Remaining Useful Life (RUL) factor can be estimated more effectively and predict any failures, providing the digital twin with operating data from its physical twin.

The calculation of the RUL is useful for carrying out suitable repair measures in advance, in order to avoid interruptions in the normal functioning of the system.

The economic impact of maintenance depends on the costs of the assets used (human and otherwise) and their scarcity, and on the possible consequences of failures on safety and the environment. Predictive maintenance is one of the three main maintenance strategies used by companies. The others are the more traditional strategies such as corrective maintenance, which addresses faults after they occur, and preventive maintenance, which consists of predefined maintenance plans to reduce the probability of faults occurring and which in any case involve machine downtime.

Because predictive maintenance is proactive, it improves preventative maintenance by providing continuous information about the actual condition of the equipment. Rather than relying on the expected condition of the equipment based on historical reference. With predictive maintenance, corrective maintenance is performed only when necessary, thus avoiding incurring unnecessary maintenance costs and machine downtime.

Predictive maintenance uses a time series of historical data on failures in order to predict their occurrence in advance. This allows companies to optimize maintenance planning, improve system reliability and minimize machine downtime [17].



Figure 7 Predictive maintenance model

To obtain a prediction with a high degree of confidence, it is necessary to have a digital twin reproduced with great fidelity.

Only at this point is the digital twin able to correlate the data coming from the physical twin, such as measurements or alarms, with the data prediction and analysis model, producing a report on the status of the physical equipment and a prediction of possible failures.



Figure 8 Prediction methods classification

3.2.2 AI IN AVIATION INDUSTRY: GE'S CASE

Aviation industry is being revolutionized by AI integration. One of the most worrying and unpredictable aspects for companies operating in the sector, is maintenance. Traditionally, aircraft maintenance has always been treated reactively, trying to solve issues as soon as they arise, or by prevention, based on following predetermined schedules. These methods though are costly, ineffective and time consuming, leading most of the time to unexpected failures and unnecessary procedures. are significantly different from predictive maintenance, which uses AI-powered real-time data and advanced analytics to predict possible problems before they become catastrophic failures. The study "Application of Predictive Maintenance Concepts Using Artificial Intelligence Tools" by Diogo Cardoso and Luís Ferreira [18] looks into how predictive maintenance in industrial settings can be enhanced by machine learning, a subset of artificial intelligence. Maintenance is a crucial component of an organization's competitiveness because the tasks carried out at this level immediately impact variables like costs, timelines, and the quality of the products or services provided. Because maintenance affects the productivity of productive assets, it is an integral part of a company's operational area and cannot be separated from it. In order to ensure the availability and prompt reaction of material and human resources to operational issues, as well as the attainment of objectives while optimizing the use of existing resources, these two domains, maintenance and operation, must function simultaneously. Aiming to anticipate equipment breakdowns before they happen, predictive maintenance is becoming more and more important as a result of Industry 4.0's increased automation and complexity of industrial processes. AI-driven predictive maintenance makes use of large information gathered from multiple sensors installed throughout the aircraft as well as machine learning algorithms. These sensors continuously provide streams of data both on the ground and during flight, monitoring a wide range of characteristics like vibration levels, temperature, engine performance, and fluid pressure. Real-time artificial intelligence (AI) systems examine this data to find trends and abnormalities that can point to early component wear or malfunction. For instance, minute variations in engine vibrations may indicate that a component is deteriorating long before conventional checks would pick it up. The two key words here are Industry 4.0, as mentioned earlier, and Internet of Things: Industry 4.0 increases the levels of automation and digitization in manufacturing and industrial processes by utilizing the tools made accessible by ICT advancements. The objective is to manage the entire value chain process to improve the quality of products and services and production efficiency. One of the key elements of this technological evolution is data, which can now be read, processed, stored, analyzed, and shared more easily between humans and robots. In addition, IoT is described as an ecosystem in which the equipment and things placed within it are fitted with sensors and other electronic devices, enabling them to collect and share data in a networked system. A simultaneous drop in the costs and an increase in the reliability of those sensors and of data transmission and storage devices used, have incentivized business in applying monitoring systems in the industrial environment. With the capacity to gather data and conduct an efficient, comprehensive analysis of it, this breakthrough presents a fantastic opportunity to apply condition monitoring data inside predictive maintenance.

Thus, we can strive for increased system availability, lower maintenance costs, improved operational performance and safety, and the capacity to assist decision-making regarding the best time and course of action for performing maintenance interventions thanks to the potential of artificial intelligence tools, particularly machine learning. Unfortunately, since these machine learning models are costly to design and represent an incredible competitive advantage for companies, and sharing information on these topics is very rare, there is not a great availability of models. Furthermore, to not be too technical, and to not lose sight of the objectives of this paper, the steps of the process will be explained without the theoretical implications behind the model. A comprehensive data set relevant to the authors study that was published in and made available by Microsoft is available in an industrial setting.

This dataset includes information from five distinct sources:

- maintenance history
- fault history
- error log
- real-time telemetry
- machine-related data.

All of the data for one hundred machines were collected over the course of a year (2015), with the exception of the maintenance history, which also includes records for 2014.

The data collection includes 876,100 hourly telemetry records for one hundred computers, corresponding to 8761 records per machine, over four different models. The maintenance history is 3286, and the failure records are 3919 entries long. There are 761 records in the failure history for the year 2015, which translates to an average of roughly 8 failure records per system. Every machine has four parts that need to be analyzed and four sensors that monitor rotation, tension, pressure, and vibration. The system is watched over by a controller, which can notify you when five different kinds of faults occur. As a result, measurements from four separate sensors per machine, along with the corresponding date and time, make up real-time telemetry data. Real-time data are obtained for voltage ("volt"), rotation ("rotate"), pressure ("pressure"), and vibration ("vibration"). These measurements are averaged over an hour. Then, a statistical analysis is conducted, so it can better understand the behavior of each sensor: mean, standard deviation, minimum and maximum values are computed for the parameters mentioned above. The figure below, as an example, shows the graphical evolution over time for

"Tension", "Rotation", "Pressure", and "Vibration" over 15 days at the beginning of January 2015.



Figure 9 Telemetry data over the first fifteen days of January 2015, Machine 1

The error log is the second source of data. These mistakes prevented the machine from failing right away since it continued to function. There are five different kinds of errors: 1, 2, 3, 4, and 5. Time and dates have been rounded to the closest hour. Every record includes the machine, fault type, and date/time.

The third source is maintenance records: it contains data of components replacements coming from "scheduled and unscheduled maintenance intervention, periodic inspections, or performance degradation". A fault record is also created if a component fails and requires maintenance intervention. This data collection includes details on four different component types for each machine: comp1, comp2, comp3, and comp4. Even in this case, the time and date have been rounded to the closest hour. Each entry includes the machine, the date/time, and the kind of replaced component. The maintenance records also include entries for 2014, as was previously mentioned. It is evident that in this instance, there are roughly the same number of substitutions for each of the four component kinds.

Lastly, in the fault records is contained the replacement records for the component, resulting from the maintenance intervention, due to an occurrence of a failure. The data collected is related to the 4 components: comp1, comp2, comp3, comp4.

A Machine Learning project like this, has to start with a clear and rigorous choice of what the objectives of the model are. In this example case, predicting the likelihood that a failure will occur within the specified time window was the primary goal. More precisely, the likelihood that one of the components, components 1, 2, 3, or 4, will experience a machine failure during the next 24 hours, which is the span of the time window selected for this application. These objectives are called features. Feature engineering, in fact, is the most crucial step for extracting value out of the data collected. Features are needed in the process of building machine learning models. Setting the right ones is a difficult task to accomplish. Usually they are modified by scaling (normalization or standardization), by encoding categorical variables (like converting text into numeric values) or by applying mathematical transformations (e.g., taking the logarithm to a skewed variable). Moreover, correlation analysis and statistical tests are one of the techniques used to identify, select, and retain the most relevant features that could have the greatest impact on the target variable.

Going back to the aerospace and airline industry, applying AI to ML models could, for example, track temperature, pressure, vibration, and revolution per minute (RPM). The AI picks up on the appearance of typical operating conditions and can identify minute variations from the norm that could point to a developing problem. For instance, a modest temperature anomaly and an increase in vibration levels could indicate that a certain component is beginning to break. The AI may forecast that a failure is likely to happen within a specific timeframe if it finds patterns that correspond with those of past failures. For example, the system will notify the maintenance team if an engine bearing is anticipated to fail within the next 50 flying hours. Having these predictive insights, airline companies can schedule repairs between a flight and the other without being affected by all the drawbacks related to experiencing a failure mid-flight such as emergency repairs, delays, or cancellations. Lastly, the more the model acquires data, the more it becomes accurate, reducing operating risks, unnecessary maintenance and, as mentioned earlier, optimizing further scheduled maintenance.

General Electric (GE) uses Artificial Intelligence in their aviation engines to perform predictive maintenance. Thanks to the help of their AI-powered technology, which allows them to track thousands of data points in real-time, airlines can more accurately anticipate their maintenance needs, enhancing safety and operational efficiency.

The company operates in sectors as aviation, manufacturing and energy in which reliability and uptime result critical in maintaining their competitiveness. Across its fleet of jet engines, GE Aviation, a division of General Electric, is one of the first companies to have instituted predictive maintenance. They can monitor engine performance in realtime and predict maintenance needs with exceptional precision by utilizing digital twins and artificial intelligence. This lowers total operating expenses by extending the lifespan of crucial components and being assured that their aircrafts are always ready for service. Digital Twins [19], in the words of the chief technology officer and senior vice president of GE Digital, Colin Parris, "allow organizations to create "living models" that not only monitor the performance of systems but also consider "changes in state" that could affect them. A Digital Twin is an electronic replica of a real asset, like a windmill, power plant, or jet engine. These digital copies mimic and forecast the equipment's performance, state, and maintenance requirements using real-time data from sensors integrated into the original assets. "This creates value today by giving industrial companies more accurate early warnings of performance degradation, availability issues, or potential failures so issues can be addressed in the most appropriate times and places", and "You make it a living model in the sense that you bring data in continuously and let the model evolve as the state of something evolves." In order to make the process more effective, Parris suggests keeping the objective focused, start small and avoid trying to solve every issue

that confronts the organization at a given time. The program finds problems and offers suggestions for improving operations. For instance, GE's digital twins may assist in planning maintenance tasks and enhancing asset usage, both of which can result in substantial cost savings. Thanks to increased operational savings, General Electric's digital twin technology has allegedly saved clients over \$1.5 billion. Using "living models" that adapt to real-time data, GE helps businesses adapt quickly to changing circumstances and efficiently maximize their operations. The main benefit of it is that application of this real-time monitoring program is quite limitless. They have applied it successfully in the sector the company operates. The most interesting aspect of it is that it doesn't just apply in the industrial environment: with applications targeted at enhancing clinical results and patient-specific treatment regimens, the usage of digital twins in the healthcare industry is expanding.

3.2.3 AI TOOLS FOR THE STOCK MARKET

The use of artificial intelligence in stock market investing has been extensively studied since the 1990s, when, for the first time, computational approaches in finance emerged. Automating financial investments using computational approaches gives a fundamental advantage: the capacity to recognize and explore patterns that humans miss, the ability to instantly consume information in real-time, and the elimination of "momentary irrationality," or decisions made based on emotions. We currently refer to this field of study as computational finance. Severe volatility, nonlinearity, and changes in both internal and external environmental factors are characteristics of the stock market. Such nonlinearity may be found using artificial intelligence (AI) approaches, which greatly improves forecast accuracy. Artificial Intelligence is applied in three different areas: portfolio financial optimization, financial asset price or trend prediction, and sentiment analysis of news or social media comments on the firms or assets. Certain works have suggested combining approaches from the many areas, despite the variations and quirks of each field. The control of dynamic systems applied to the financial market, investor behavioral research, network analysis, and clustering of financial assets are a few further computational finance studies.

PORTFOLIO OPTIMIZATION

One of the main ways AI is used in finance is to optimize investors' portfolio: "optimizing" generally refers to managing risks more effectively, improving the accuracy of predictions and the decision-making processes. The act of building portfolios based on an investor's desired degree of risk and reward and then gradually modifying them to optimize returns is known as portfolio management. The three stages of this procedure are planning, execution, and feedback as shown in the figure below.



Figure 10 Stages of Portfolio Optimization

AI could help improve all the three phases. In the last years, for instance, financial institutions have increasingly started to use robo-advisory services to more accurately assess investors' goals, expectations, and overall their inclination to risk. Services such SigFig or BlackRock's Aladdin, target these needs. Blackrock created the platform by leveraging data analytics, to optimize investment decisions and risk management. Here's how it works: large volumes of financial data are first gathered and integrated by Aladdin from a variety of sources, including news feeds, market data, and, very interestingly, alternative data sources like social media. Users get a consolidated picture of their assets and risk exposures thanks to the processing and storing of this data in a centralized system. Blackrock's tool fundamental feature is represented by its powerful risk analytics capacity. The software uses machine learning algorithms to examine past data and spot trends that may be used to anticipate future dangers for the portfolio. It also evaluates new regulatory requirements, market trends and the effects of different scenarios on investment portfolios by simulations and stress tests, allowing for proactive risk management and provides tools for portfolio development, optimization, and rebalancing. Natural Language Processing, which is used also by IBM Watson, which will be part of the dissertation in the later chapters, is one of the competitive advantages of Aladdin. The platform is also up to date in terms of reporting and compliance, and it has extensive reporting features, including customized reports on compliance, risk exposures, and portfolio performance. Aladdin, an evocative acronym that stands for "Asset, Liability and Debt and Derivative Investment Network", is designed to be capable of handling enormous volumes of data and is designed also for institutional investors' requirements. It's a tool useful for companies because the platform's AI-powered insights help identify potential compliance issues and offer recommendations for resolving them [20].

The fact that Aladdin controlled \$21.6 trillion in assets as of 2020, highlights its importance in the asset management sector.

Although AI has great potential for portfolio optimization, there are certain drawbacks to its application. Since biased or insufficient data can result in inaccurate models and bad investment decisions, data quality and accuracy are extremely important. Deep learning AI models may be opaque, making it difficult for investors to comprehend the reasoning behind choices. Given the increased scrutiny in financial markets, organizations must also make sure that their AI-driven plans adhere to ethical and regulatory norms.

3.2.4 INDUSTRIAL PACKAGING

The application of machine learning by the industry has demonstrated that considerable labor, time, and material cost benefits are achievable.

Utilizing a machine learning algorithm to choose the best packaging for a product is one example. This instance is discussed in a paper titled "An automated packaging planning approach using machine learning," which was given at the 52nd CIRP Conference on Manufacturing Systems in Ljubljana,2019.

This study offers a way to automatically assign packaging to a certain part using machine learning, taking into account its attributes.

AI has made a strong impact on the packaging industry in 2019, shaping choices regarding the environmental impact, materials, dimensions, and recyclability of packaging.

The manufacturing sector is being impacted by the faster changes in product life cycles compared to previous times. This rapid transition is also having an increasingly rapid impact on supply chain management. In fact, the number of parts and finished products has increased rapidly, requiring the maintenance of shipping capabilities, transport security, precise product identification, and, importantly, the management of related logistical costs. However, despite the increasing complexity of supply chain management, innovative companies have managed to overcome this challenge through the utilization of AI. This was achieved through the implementation of ML techniques and in-depth data analysis

This study focuses on developing a machine learning model, starting with the physical characteristics of the result and other specific factors such as chemical composition, electrical properties, and fill rate.

In accordance with those requirements, the figure below illustrates a sample of the package planning process discussed in this article.



Figure 11 Part and packaging correlation model

The term packing is defined differently depending on the application.

The ISO 21067:1-2016(en) standard was released in order to standardize the definition, and it may be summed up as follows:

- Products intended for containment, protection, handling, delivery, storage, and transit of commodities—from raw materials to processed items, from manufacturing to end users or consumers, or between—are referred to as packaging products.
- Operations related to containing, safeguarding, handling, delivering, storing, and transporting commodities—from raw materials to finished items, from producer to user or consumer—are referred to as packaging operations.
- Item packing: the items' packing as well as its packaging

For this investigation, supervised learning was selected. Labeled datasets are necessary for supervised learning to train algorithms for precise data classification or outcome prediction.

A feedback mechanism starts an algorithmic optimization process each time the application yields a result that deviates from the intended result. This process continues until the application is able to produce the correct responses at the conclusion of training.

Therefore, to properly supply the correctly labeled data that you wish to send as input to the selected ML algorithm, the data set preparation phase is crucial.



Figure 12 ML model for optimal packaging type identification

The Random Forest (RF) technique, which is frequently employed in industrial settings, was selected in this instance. Lastly, the suggested machine learning model is depicted in the following diagram.



Figure 13 Random forest structure

The random forest algorithm consists of a collection of decision trees, and each tree in the collection consists of a data sample drawn from a training set with replacement According to the definitions provide by IBM [21], this kind of ML algorithm can be used to solve regression or classification problems.

In the classification process, the data is divided into classes (for example, a letter written on a sheet of paper is photographed, sent to the classification algorithm which processes it and associates it with a letter of the alphabet.), in the regression process, the data are associated on the basis of two or more features (for example, a list of properties is inserted into a database by inserting the square meters, the area and the price. The algorithm processes the association between the characteristics. When they are inserted as parameters search, square meters and area, the algorithm outputs the most probable price).

When the algorithm is given one feature as input, the regressor returns the other feature to me. It can be generally stated that the output of a classifier model is a class, while the output of a regressor model is numerical data.

3.3 AI IMPACT ASSESSMENT

The public discussion about AI has grown quickly. A deliberate strategy is needed to address the dangers and concerns associated with artificial intelligence, such as privacy, autonomy, transparency, and cyber security, in addition to its potential advantages. Recent examples could be "smart meters" and the "OV chipkaart".

Smart meters record the electricity, water or gas consumption communicating in real time with the utility provider for monitoring and billing. Since smart meters communicate two-ways with the central system, managing consumption, providing suggestions, detecting and avoiding tampering is definitely easier.

Ov Chipkaart, instead, is a contactless smart card used for public transportation in The Netherlands. These technological advancements highlight the significance of moral and legal issues in IT development. Artificial intelligence's appropriate incorporation into society can be guaranteed by proactively addressing its effects.

Organizations looking to analyze the ethical and legal ramifications of integrating AI into their (service) processes might do so by completing an impact assessment. Companies frequently want to observe the results of their service, both during the planning phase (where costly mistakes can be avoided) and throughout use. Going through the assessment phase means a lot of work for a company, but some of it can be a resource for future technology implementation, since the same impact assessment is made for generic and different technologies, in various sectors and professions. The results of the Impact Assessment may occasionally result in demands for particular features from the technology, organizational measures (such as a fallback for end users who choose human contact or new task distributions to prevent and handle incidents), additional education and training (such as how a lawyer, accountant, doctor, or civil servant can fulfill their professional obligations when AI performs tasks, or how a professional interprets AI's advice and understands its strengths and weaknesses), and the collection of data on the precise outcomes in practice.

In addition to making sure that several technical requirements, such as data integrity, safety, and continuity, are met, the supplier and manufacturer of the AI solution must also provide resources that let the organization using the AI assume accountability and be open and honest about the outcomes.

The technology vendor can assist organizations in making trade-offs and asking the appropriate questions by using the Impact Assessment. Questions are related to the use of the AI, ethical implications, transparency and social issues that could arise.

In order to do that, an extensive framework for the responsible implementation of AI technologies in companies is offered by the AI Impact Assessment (AIIA) Roadmap [22]. The roadmap places a strong emphasis on ongoing observation and modification to make sure AI systems adhere to social and legal standards throughout the duration of their existence. Organizations may adopt AI more responsibly and sustainably by proactively addressing the ethical, legal, and societal ramifications of the technology by adhering to this roadmap.

The roadmap is built in steps: Evaluating the social, political, and technological environment, the first step in the AI Impact assessment process is responding to screening questions to ascertain whether the evaluation is required. In step 2, if the assessment is found to be beneficial, it proceeds to a thorough project description that includes objectives, information, and stakeholders. Setting goals for the end user, the company, and society is the focus of step 3. Step 4 involves outlining the legal and ethical frameworks. In step 5, strategic decisions with ethical ramifications are taken; in step 6, these variables are considered to determine whether to use AI. Step 7 concludes

with the process' documentation, and step 8 involves continuing review and monitoring to adjust to shifting legal and ethical viewpoints.

Since AI tools' implementation started gaining popularity, legislators have felt the need to start to regulate the behavior of companies and private citizens that nowadays engage daily with these technologies. Since it creates a legal framework intended to guarantee that AI systems are utilized responsibly and ethically, it has significant ramifications for companies adopting and evaluating AI technology. The major introductions related to businesses are mainly about compliance measures companies must abide by: AI systems have to be categorized with different levels of risk. Depending on how much "invasive" the system is, for the users or customers, it will be put in one of four different categories:

- 1. Minimal or no risk (like spam filters)
- 2. Limited risk (such as chatbots),
- 3. High risk (requiring thorough documentation, conformity assessments and rigorous safety testing, as in the case of healthcare companies or police enforcements). Organizations in this category must go through a conformity assessment during the launching phase of their product and could need a third-party audit. Artificial intelligence (AI) systems used in the safety components of regulated products, i.e., goods that have already undergone independent evaluations, come under this category. These include AI programs that are incorporated into machines, cars, elevators, and medical equipment, for instance. Annex III [23] of the AI Act specifies exactly additional areas which classify as a stand-alone systems as high risk:

(a) biometric and biometrics-based systems (such as remote biometric identification, categorization of persons and emotion recognition systems)

(b) management and operation of critical infrastructure (such as road traffic, energy supply or digital infrastructure),

(c) education and vocational training (such as assessment of students in educational institutions),

(d) employment and workers management (such as recruitment, performance evaluation, or task-allocation),

(e) access to essential private and public services and benefits (such as creditscoring, risk assessments in health insurance and dispatching emergency services),

(f) law enforcement (such as evaluating the reliability of evidence or crime analytics),

(g) migration, asylum and border control management (such as assessing the security risk of a person or the examination of applications for asylum, visa, or residence permits),

(h) administration of justice and democratic processes (such as assisting in interpreting & researching facts, law, and the application of the law or for influencing elections).

- 4. Unacceptable risk: in this category fall all AI application types that are incompatible with EU rights and fundamental values. In the AI Act they're divided in 8 subcategories:
 - "Subliminal manipulation", that means changing a person's ideas, beliefs or behaviors without them knowing, harming them in some way. An example could be influencing people to vote for a specific political party using these subtle techniques.
 - "Exploitation of the vulnerabilities of persons resulting in harmful behavior", for instance by giving a child a toy that induces him with its voice or sounds to do harmful stuff.
 - "Biometric categorization of persons based on sensitive characteristics" including "gender, ethnicity, political orientation, religion, sexual orientation and philosophical beliefs".
 - "General purpose social scoring", if AI is used to give a rating to individuals based on "personal characteristics, social behavior and activities, such as online purchases or social media interactions", people could be deprived or denied from their work or banned from shopping in a particular shop and so on.
 - *"Real-time remote biometric identification (in public spaces)",* apart from law enforcement engaged in a targeted search for crime perpetrators and in

terrorism prevention, with a pre-approved judicial approval or the European Commission supervisory, biometric surveillance and identification will be completely banned.

- "Assessing the emotional state of a person", applying it in AI systems used in education or at the workplace. If emotion recognition is used for safety purposes (e.g., to detect driver slumber), then it may be acceptable as a high-risk application.
- *"Predictive policing",* when Artificial Intelligence is used to assess the risk of someone committing a crime in the future based on personal traits.
- "Scraping facial images", by "creating or expanding databases with untargeted scraping of facial images available on the internet or from video surveillance footage"

3.4 RISK ANALYSIS

Risk is a measure that's used to assess how an incident or condition might affect a business. It is decided by the seriousness of the possible repercussions as well as the probability that the event will occur. Analyzing threat and vulnerability data is necessary to determine the likelihood and consequences of unfavorable events in order to assess risk. In this procedure, qualitative elements like stress testing, audit findings, and adjustments to the risk environment are taken into account.

Comparatively, essential control indicators, risk indicators, and incidents, both internal and external, are examined in quantitative analysis. Risk assessments give decision makers a meaningful awareness of potential risks, which is crucial for reducing them effectively and "manage" it. The accurateness of the data utilized, and the experience of the manager have a major impact on how precise these evaluations are. With its ability to gather and analyze data, artificial intelligence can improve the accuracy of risk assessments.

QUALITATIVE CONSIDERATIONS AND PREDICTIVE ANALYSIS

The application of AI to unstructured data analysis is a major development for risk management [24]. Artificial intelligence (AI) systems can create predictive indicators of possible threats by looking through historical data and spotting patterns from previous instances. These algorithms have the ability to identify patterns those human analysts would not see right away, which makes it possible to create plausible scenarios that predict future events and evaluate their possible effects. Artificial intelligence is more predictive than just trend analysis. Additionally, it may estimate potential outcomes based on historical and present data, as well as simulate different risk scenarios. Organizations can take proactive steps to mitigate risks by anticipating them before they occur with the support of this forward-looking approach.

Artificial Intelligence has completely transformed traditional auditing techniques. Thanks to materiality thresholds, sample-based audits may overlook important irregularities. AI, on the other hand, allows auditors to examine entire datasets and transactions. This indepth analysis strengthens the ability to spot anomalies that call for additional inquiry and increases the completeness of audits. Because AI can examine every transaction, even smaller, less important transactions are reviewed, something that would be impossible to do with conventional auditing techniques.

Large language models (LLMs) are used in Microsoft's most recent security innovations to offer sophisticated analytical capabilities. Deep learning methods and large datasets are used by LLMs—like the ones included in Microsoft Security Copilot—to understand, synthesize, and forecast new data. Natural language queries can be used to communicate with the Security Copilot, which offers insightful and useful data. Users can get prompt, thorough answers to inquiries such as "Have there been any suspicious logins in the past 10 days?" Threat detection and response efficiency are greatly improved by this feature.

Furthermore, by identifying active attacks, evaluating their extent, and suggesting corrective actions in accordance with accepted security protocols, the Security Copilot is prepared to manage security incidents in real time. By using the knowledge gained from previous events, it gives analysts a thorough understanding of the threats that are now facing them and aids in repelling new attacks. By allowing users to ask precise security

questions and get timely responses, the Security Copilot also facilitates threat hunting. It can produce personalized reports and presentations in addition to providing explanations of security issues and possible risks. To make it simpler to communicate information with stakeholders and support well-informed decision-making, this involves producing PowerPoint slides that provide an overview of security incidents. All things considered, AI-powered solutions, such as Microsoft's Security Copilot, mark a substantial advancement in qualitative risk assessment and predictive analysis, providing enterprises with improved capacity for risk management and mitigation. Because of the advances in AI capabilities, firms may find that creating risk treatment strategies after the risk assessment phase takes less work. Businesses may more accurately and proactively detect future dangers and vulnerabilities by utilizing AI. Businesses are able to better address current risk gaps and put safeguards in place to protect against potential security risks thanks to this improved foresight.

QUANTITATIVE ANALYSIS AND IMPROVED EVIDENCE PROCESSING

These days, the utilization of Internet of Things (IoT) devices enables automatic validation of evidence and proactive verification of controls. Sensing, identifying, and detecting events and people are now all possible with IoT sensors integrated into many areas of organizational assurance. For instance, facial recognition technology tracks staff movements within data centers, biometric identity systems control access to them, and log analyzers examine server logs to look for privilege violations.

For auditors performing a System and Organization Controls (SOC) 2 report audit, machine learning systems can compile data from various monitoring instruments. When abnormalities are found, this aggregated data can show how well security measures are working and offer proof. Auditors still need to enter the proper evaluation criteria even though AI can scan unstructured data and spot trends. It is essential that auditors have the abilities to manage and analyze this data. In addition, while presenting findings to stakeholders, they need to employ data visualization approaches. As a result, auditors' responsibilities now include both analyzing and interpreting the outputs produced by AI.

Citibank's use of AI to increase trade compliance is an illustration of how technology may improve compliance [25]. Over time, more efficient network, unstructured data, and customer behavior research is made possible by the technology's sophisticated analytics and natural language processing capabilities. Trade transaction monitoring is made even more effective and efficient by SAS's sophisticated analytics platform. Better performance, more robust risk insights, lower operating costs, quicker reaction times, and increased risk management capabilities are the outcomes of this.

ADOPTING AI AS A DYNAMIC RISK ASSESSMENT TOOL

A frequent problem in risk assessments is figuring out how appropriate and sufficient the controls that are currently in place are. Until an audit reveals a finding, risk assessors have historically had difficulty predicting if important controls have been disregarded. But AI provides a revolutionary method by facilitating automatic measurement integration into AI-based systems, improving forecast accuracy, and enabling real-time validation of actual data. This means that AI can continuously evaluate and validate the efficacy of controls, freeing risk managers and auditors from the constraints of the evidence presented.

Deep learning algorithms in AI are able to retrieve pertinent and contextual information from a wide range of sources, including contracts, emails, and conference calls. This skill enables the gathering of supporting data that can bolster and validate risk estimates. AI systems are built to quickly assess freshly updated data and transform it into insights that can be used. Deep learning algorithms may dynamically modify their settings based on past results by employing continuous control monitoring systems. This allows for the efficient design, implementation, and maintenance of controls with the least amount of human interaction.

Several aspects need to be carefully considered by enterprises before deploying AI technology. These include deciding which particular dangers to keep an eye on and manage, figuring out what kinds of information to gather, and dealing with data security-related issues. The first step in incorporating AI into a risk assessment plan is to identify the financial, reputational, and regulatory concerns. Determining what information must be gathered and the most effective ways to do so are critical, taking into account the organization's principles and the existing risk framework.

The AI model for processing data sets can be developed using previous risk evaluations as a guide. Choosing the right data sources and types is crucial since the output of the AI system is directly impacted by the quality of the data. A risk management ecosystem powered by AI cannot be successfully deployed without efficient data sourcing at the operational level. To keep AI systems in line with changing risk assessments and management techniques, regular evaluation and modification are crucial. This revolutionary transition from reactive to dynamic and continuous monitoring in risk management is exemplified by this proactive method to control verification. Organizations can improve their capacity to foresee, identify, and address hazards with increased accuracy and efficiency by incorporating AI.

Over time, it will transform the globe. By automating and leveraging machine learning algorithms, numerous financial institutions and organizations may offer user-tailored services and streamline decision-making processes. Because AI analyzes large volumes of data, it considerably improves the ability to recognize information that is important to risk, therefore risk assessment and management will become more dynamic as AI becomes more widely utilized.

3.5 AI ORGANIZATIONAL CHANGES

The effects of artificial intelligence's continued growth on society are distinct and deep. A sign of the impending shifts is the abundance of new ways that businesses might arrange their labor and capital. Thus far, research on AI's impact on organizational structure has mostly come from a technology or a more general decision-making standpoint. But, what are the upcoming AI-driven organizational changes?

As of now, only a few assumptions can be made: one optimistic and one less. In fact, in Francesco Bellini, Aysan Bashirpour Bonab and Ihor Rudko's point of view, authors of "Organizational Structure and Artificial Intelligence: Modeling the Intraorganizational Response to the AI Contingency" [26]: "Unlike the enabling technologies of the past technological revolutions, AI presents characteristics of the ultimate job replacer. For the first time in history, a technology holds relevant ontological qualities of both labor and capital. This dimorphic nature makes artificial intelligence a unique factor of production with significant replacement potential." According to the developers, the socioeconomic forecasts for the next ten years would not be too bad given the increased usage of AI-based hardware and software by organizations. This assumption is consistent with a recent Accenture report that presents a more optimistic picture of the near future than the statistical survey of AI specialists performed by scientists from Yale and Oxford. The report's authors state that "it is unlikely that intelligent agents would replace human workers" [27]. Conversely, Daugherty and Purdy anticipate a rise in the fusion of human

operators' abilities and skills with the accuracy and wisdom of virtual minds. Even if it's a little outdated, Deloitte 2020's report [28] gives a compelling report about where companies are headed. They underline the fact that "cutting costs by eliminating jobs is not the only path available for AI". In reality, their conclusion is that businesses must make a basic decision about whether to employ AI primarily for task automation that was previously done by humans or to also use it to support employees. The concept of a "super job," which combines the responsibilities and tasks of many traditional jobs by leveraging the complementing skills of AI and human operators, is presented in the research. Taking everything into account, the authors are hopeful that rather than replacing employment, artificial intelligence would eliminate duties from them. Actually, it seems that task automation rather than job automation accounts for the majority of automation. Even skeptic professionals find the concept of "full automation of labor" results deceptive. Although basic machine learning technologies are presently publicly accessible, the authors argue that their adoption is more likely to lead to employment reorganizations than job losses. Brynjolfsson et al [29], claim that researchers, managers, and entrepreneurs should concentrate on work redesign rather than automation alone. Automation improves worker productivity and quality by fusing human skills with those of machines and computers. This frees up time so that individuals may focus on things that need the greatest amount of attention. Most of the tasks that are currently being automated, are already inherently demeaning and are suitable for assigning to artificial agents. Automating authentication procedures is one recent example of job restructuring that could be very helpful in both public and private settings (e.g., hospitals, schools, and universities). Another perspective worth of notice is related to the changes made along the vertical axis of task design. AI could significantly improve jobs by allowing each human worker more autonomy and control over their work, even though positions are becoming more specialized. Moreover, linked to micro-organizational issues. encouraging psychological wellbeing in the workplace is another essential matter of discussion. The so-called "Technostress" is a serious problem when it comes to integrating AI into a business. The issues that modern workers face are numerous and include workplace dangers, instability, underperformance, and possible work overload. Digitalization can have a negative impact on workers' mental health. One tactic to mitigate the negative psychological effects of a decrease in job diversity, such as mental fatigue and monotony, is to increase employment enrichment opportunities. Furthermore,

companies must take the initiative to undertake upskilling programs so that staff members are comfortable interpreting and applying new clever technology.

In addition to this, several authors [30] state that Machine Learning technologies together with other organizational innovations, are leading the debate on centralized vs. decentralized rhetoric, towards the latter. IT is widely considered a facilitator for decreasing the degree of centralization. To exploit deeply the possibilities of AI and IT techs, one has to change primarily organizational culture and include in the realm of the viable possibilities completely decentralized structures, such as some agile form of organization, that has been developed during the pandemic, for instance. IoT and Blockchain will help get to the extreme form of organization, called by the author [31] "decentralized autonomous organizations".

The introduction of these disruptive innovations into the workplace has a noteworthy effect known as "delayering." Many hierarchical levels form an organization's chain of command, and it is rarely thought that having too many levels is advantageous: overly hierarchical structures are frequently linked to inflexibility, a lack of adaptability in responding to change, high structural costs, obstacles and higher costs related to communication, lower decision-making quality, problems with accountability, and lower employee motivation. IT has always been used to partially replace hierarchy, but modern AI algorithms do much more than just analyze data. Today's AI systems can already assign jobs and make decisions, and it's getting easier and easier for them to take on more "human" roles like motivating and leading employees. Thus, it makes sense to assume that AI will eventually take the place of some hierarchical roles and play a big role in the shift from tall to flat organizational structures.

Lastly, the tangible effects that are able to be seen inside an organization, are connected to coordination mechanisms. In particular, the authors of this study, cite the definition made by Schilling [32] on the difference between an organic and a mechanical organization: the first one is a combination between a low degree of formalization and a low degree of standardization, while the second ones have both high degrees of standardization and formalization. Historically, mechanistic designs have been favored for their ability to take advantage of economies of scale and for their greater productivity and efficiency. However, a primary issue with these kinds of structures is that they tend to confine the company, which makes it challenging to foster innovations and swiftly adjust the organization to external changes. The choice of adopting one of the two

systems is largely related to how stable (or unstable) the external environment is. A corporation is best suited for a mechanistic organizational structure in a stable environment. An organic structure functions best in environments characterized by a high degree of instability, dynamism, and unpredictability. Regarding the decision between mechanistic and organic structures with a sociological viewpoint on the status of contemporary society, makes it simple to understand how further global AI development may potentially affect corporate organizational structures. All kinds of businesses in all the three economic sectors will surely see an increase in more adaptable and changeoriented organic structures as a result of the external environment's increased risk and dynamism. Therefore, the hypothesis is that the main impact of AI on formalization and standardization is a decrease in their degree, which in turn causes the switch onto the adoption of organic organizational structures that are more "environmentally responsive". Incentives represent another interesting area of development for organizations in this changing environment: they can be applied in a variety of ways, ranging from monetary ones to opportunities for hierarchical progression and a greater sense of personal contribution to the total production of the company. One can assume that artificial intelligence will have a significant impact on the creation of a single incentive. This incentive primarily reflects the long-term trend of the average amount of working hours decreasing. The decrease in the average amount of working hours, in contrast to other incentives, is a nearly global trend that doesn't follow technical advancements and national norms rather than managerial choices. Given the high degree of sustainability between human workers and intelligent agents, the scope and form of such reduction (including increased temporal flexibility and autonomy) may become more dramatic than ever as organizations continue to deploy AI. A reduction in the weekly workload, if it is not coupled with a pay cut, may have a number of positive psychological effects that improve work-life balance, boost productivity, and increase employee motivation [33]

4 FOCUS ON AI AND HRM: EFFECTS ON LABOR FORCE

4.1 WHY AI IS BEING USED IN HR?

On the surface, artificial intelligence (AI) seems like a scary and confusing concept. It is acceptable that a robot may possess extraordinary physical strength that greatly exceeds that of a person, but can robots truly enter the symbolic domains of human endeavor? Can they use language and communicate with a knowledge base in ways that mimic or perhaps surpass the capacities of the human mind? The goal of AI advancement goes beyond creating "computer consciousness." Rather, it is increasingly being developed as an advanced type of engineering and design with measurable and functionally precise objectives.

Moreover, the issue is with the data given as inputs to produce the algorithmic analysis. Machine learning, once just a branch of research of Artificial Intelligence, proposes that computers may be used to solve problems by drawing well-informed conclusions from provided data sets. This can be used to measure strong, believable correlations and inferences against performance if it is incorporated into a feedback system. Unfortunately, the precision and the effectiveness of the analysis made by the AI is strictly correlated with the quality and the precision of the inputs. As stated in "AI: the HR revolution" by Gulliford and Dixon, "Algorithmic analysis of data does not run without bias. Data sets are pre-structured in line with historical precedents and patterns; algorithms are already "interested" because they are orientated to specific human interests and problems. These "biases" can reflect the culture of an organization and are hardwired into code." [34]

Meaning that the outputs produced are not meaningful and reliable if the information provided to the AI are biased by the actions, strategies and culture already embedded in the firm. Furthermore, provided that the information is unbiased, deep expertise is needed in order to design accurate data-collection methods, interpreting analytics results and to generate easy-to-understand takeaways. In fact, it is unreasonable to think that AI will abolish management biases because by nature (at least for now) it is not an autonomous authority: decision making is still a process reserved to humans and crucial decisions cannot be outsourced to machine learning systems with the expectation that they will provide accurate results. Integration between the two components is key. Nowadays, employees and management are required to have sets of skills quite divergent from the past: as repetitive and mundane tasks become less bearable by the workforce, AI's role could be the tool to free up time, that is one of the challenges of today's HR, in order to increase the frequency of human interaction and focus on what the authors call the "three C's", curiosity, creativity and critical thinking. The increased implementation of automation is reshaping the abilities demanded for work. More and more companies are prioritizing those skills that are transferable across jobs: a blend of particular cognitive and socio-behavioral talents that build the "adaptability" of the resource.

Out with tick boxes, in with constructive feedback in real words to generate far richer and accurate responses. Good people analytics technology can establish how key employee themes such as engagement drives key behaviors such as attrition, absence and productivity. And this means that for the first time, HR leaders can accurately predict the ROI of future workforce initiatives. Computers are not labor-saving, they are labourchanging.

Implementation of AI is being brought ahead very differently depending on the field considered. To better grasp the meaning of this effect, it could be useful to look at how marketing and marketing strategies changed in the last few years. Large corporations, thanks to their larger pool of customers, are the ones benefiting more: "Amazon is improving its capacity to make useful recommendations to online buyers by using more accurate data on their behavior. Google and Facebook have become the largest advertising platforms due to their capacity to personalize ads to specific consumers by using big data and AI." In this narrow club of companies, consumer goods firms, that launch several products every year, such as P&G, Unilever, Henkel or Nestlé would, by leveraging on AI and Machine Learning tools, "understand better why so many new product launches fail, and the factors that help successful product development in a wider variety of markets, segments and types of customers' profiles." Looking closer to one of the above-mentioned organizations, Unilever has shown an astonishing growth since 2009, when the new CEO Paul Polman took office. The core strategy of the company switched under his guidance by investing heavily and holistically integrating the Intelligence to their main processes, including marketing and Human Resources Management. From the year after the burst of the subprime crisis, taken by the management as an opportunity to rethink their internal structure, the company thrived: it became one of the leading firms in his industry by economic performance between 2009 and 2017. Today, Unilever produces and distributes more than 400 different products in different markets in 190 countries all around the world ranging from food and beverage to personal hygiene goods. For this kind of "scaled up" organization managing effectively internal and external processes has increasingly become a challenge but the key driver of success. Handling close to 170.000 employees is a challenge but running their layoffs and recruitment processes, even more. Estimation given by the management set the recruits to a number greater than the 30.000 a year leading them to analyze about 1.8 million curriculum vitae in the same period. In order to maintain a high level of the resources put under contract or retained, as highlighted by Bernard Marr in his article [35] Unilever set up a partnership with a firm specialized in AI recruitment called "Pymetrics" in order to create an online platform where candidates were assessed by their own homes.

The online selection process was divided into two stages: the first one included a series of games to test their attitude towards risk, their reasoning and logic. The data collected then, were crossed with the level of suitability of the role they were applying for. The second phases involved the candidate recording and sending a video interview in which he would answer questions given by the machine learning algorithm which analyzed natural and body language and selected the best fit for the role. In Unilever's chief of HR Leena Nair's words, feedback has the highest value: "Normally when people send an application to a large company it can go into a 'black hole' – thank you very much for your CV, we'll get back to you – and you never hear from them again. All of our applicants get a couple of pages of feedback, how they did in the game, how they did in the video interviews, what characteristics they have that fit, and if they don't fit, the reason why they didn't, and what we think they should do to be successful in a future application. It's an example of artificial intelligence allowing us to be more human." This way Unilever cut 70.000 hours of interviews, focusing "just" on the about 3500 possible recruits that would go through the old-school screening process.

Another partnership worth of being mentioned is between them and Microsoft that has led to the birth of "Unabot". Unabot's goal is to help better settle the new employee in the company, teaching him/her about the company culture, answering the most diverse questions: from IT systems, allowances, availability of parking spots. In addition, the bot, unlike other customer-oriented products (i.e., Amazon's Alexa) can discriminate and give different responses based on who's asking the questions (geographical location and seniority). Trialed in the Philippines, the successful program has been extended in 36 other countries with increasing results. In fact, "all its data comes from internal sources, such as company guidelines, schedules, policy documents and questions asked by the employees themselves. In the future, this could be expanded to include external data such as learning materials.", HR manager Leena Nair commented: "And although it's early days, the initial analysis seems to show that the initiative is popular with staff – with 36% of those in areas where it is deployed having used it at least once, and around 80% going on to use it again" [35].

By the words of Tom Stachura, Vice President of Talent Solutions & People Analytics at IBM: "AI is an accelerator, it allows us the ability to ingest a variety of data and provide context to a decision maker or employee or business leader. It allows us to deliver the right intelligence in the moment and achieve personalization at scale" [36].

IBM, one of the early adopters of AI, represents another clear example of how Artificial Intelligence helped build up a successful framework to extract value from a resourceful tool such as this one. As works almost flawlessly for Unilever's Unabot, the "Big Blue" has announced its own chatbot for attracting and hiring. The software at the foundation are doppelgangers: they both base their evaluation on NLP (natural language processing) and to skill matching algorithms. They state that: "The AI solution IBM developed to address this challenge is called Watson Candidate Assistant (WCA). WCA has changed the way job seekers engage with IBM. Previously, candidates and employers would meet for the first time at the job interview, after learning about the opportunity from an online jobs board or career website. By leveraging AI, candidates and employers can now have real-time interaction via a chatbot, resulting in a more personalized application process for job seekers. The richer information applicants receive in turn leads to a stronger fit of job applicants for roles." The "Watson Recruitment" feature of LM software assists recruiters in addressing potential bias, efficiently screening candidates, and scoring each one to forecast future performance (based on the cross-analysis between their talents and those necessary for the vacant positions). Other areas of development, highlighted by IBM and that are worth addressing are the "Retain" and "Develop" process. Retaining better is done by considering plenty of data points before calculating the optimal salary rather than being just a function of tenure and performance. Moreover, the algorithm helps in finding the best balance between fixed and variable parts of the allowance, practice relatively important when dealing with companies listed in the stock exchange or

internal factors that make agency issues plausible that could lead to failures. In addition to that, IBM "emphasizes transparency" by showing "employees [...] where they sit relative to the market, because the low and high range of compensation for workers with their skills is provided, in addition to their personal salary". The firm has been experimenting with personalized learning for years now. By enabling AI to "tag" specific images or documents and merging them with the information retrieved by the program, machine learning is utilized in this instance to enhance and filter the content that appears in front of the employee on the company's learning platform. On "Your learning", employees can find tailored recommendations depending on the job role, skill set, business unit organized in channels based on interests and aligned with the needs and the business initiatives. They also stopped using manual assessments for employees' skills and are now implementing real time skills inference: not only management saves time in assessing all the self-evaluation made by workers and the notes made by their supervisors but now they can verify, on aggregate level, what skills are sufficiently developed and represent a competitive advantage and what are missing and need to be upgraded. In a span of three years, from 2015 to 2018, they claim they brought the effectiveness of the process to an 85-95% rate of accuracy. The company is also cultivating growth by starting to open the opportunity to access career coaching courses or mentoring in any form to every employee. By nature, in fact, career development is a highly laborintensive task and a particularly expensive one, especially for a large enterprise. So, until some time ago, it was destined either to inexperienced or underperforming workers, or to high potential resources: the objective being to capture value and to increase the overall percentage of retention. Motivating and engaging all the employees using an AI assistant prevents also losing possible resources due to bias of different sorts, related to asymmetric information or intrinsic in the selection processes.

Having gone through two main players in the industry, switching the focus to the industry seems easier. If we look at it, keeping in mind what a resource-based view is, few elements more are worth of consideration, some of which were stated briefly before.



Figure 14 IBM Human resource process

Most of the companies that already experienced different degrees of AI implementation, based their processes piggybacking on existing AI software instead of creating from scratch one. Resources and time play a large role in the decision and the companies that can afford it and/or were early adopters of the technology, such as IBM and Unilever, come up with an incredible competitive advantage.

In 2022, ChatGPT makes its debut and it's freely available for everyone to use. After going through testing and updating it is now widely used and its possible applications are even wider. Budhwar et al. list some of them: "[...]the language learning application Duolingo is utilizing a GPT-4 model to improve personalized learning, Be My Eyes, provider of assistive technology is using it to create a solution for individuals with visual impairments to make them aware of their surroundings. Microsoft Bing, 2023 is using GPT-4 to improve search engine user experience, and Stripe, a financial platform, is employing it to safeguard chat rooms from spams and fraudsters. Morgan Stanley is using GPT-4 for streamlining internal technical support processes, and Salesforce has implemented it to provide personalized recommendations to help users with their queries. Most notably, the government of Iceland has partnered with OpenAI to use GPT-4 to create an entire PowerPoint presentation with a single text prompt or summarize long documents in Word." [37]

Taking in consideration the scope of the employment of generative AI, starting to address it as a disruptive technology it's not far-fetched at all. The examples above clearly state the cross-business impact, particularly OpenAI's creation.

Human capital and the resource-based view (RBV), which hold that under the correct conditions, people may be a source of long-term competitive advantage, are the foundations of modern strategic human resource management (SHRM).

Predictions have been made about how generative AI, machine learning, natural language processing applications will really impact business' internal processes, and employees' well-being.

In order to analyze how the employment of those resource(s) add up to a medium-long term competitive advantage, Jay Barney, as theorized in "Firm Resources and sustained competitive advantage", its famous VRIO model, results are useful. The question of value, rarity, imitability and organization of a resource (or capability) is of fundamental importance to maintain a sustained competitive advantage. Budhwar et al. highlighted two different perspectives (a positive and a negative one) that helps comprehend which future, different authors, predict for ChatGPT and if represents, for the firms, a strategic resource.

The negative perspective mostly revolves around the concept of value and substitution, partially following the VRIO framework. In fact, as per the concept of value, "ChatGPT is freely available for everyone, so there is no or limited possibility to generate and reap the rents as proprietary rights are lacking. The rents and the benefits are there for everybody, who knows how to handle and apply the software". In addition to that, scarcity is not there anymore. From the beginning, OpenAI' software has had several different competitors, the market has already started to stabilize but most importantly, the latest increasing custom for software developers is to make their creation open source. In order to correctly analyze the "Inimitability" part, a paper from 1994 by Jeffrey Pfeffer called "Competitive advantage through people: Unleashing the power of the workforce" helps understand what relates to human resources and "imitating" successful processes by implementing AI solutions. The author's idea on "achieving a competitive advantage through people" goes through concepts such as "causal ambiguity", "path dependency" and "social complexity". In order to get the sense on how strategically important imitability is in a RBV, we should digress on what those three concepts actually mean.

4.2 ISOLATING MECHANISMS

A company can maintain its competitive advantage for a longer period of time if it can stop a rival from copying the resource or capability that provides it an edge. We refer to this tactic as isolating mechanisms. For example, a patent is a legitimate means of preventing copying. Occasionally, a rival can "re-engineer" the patented idea by making minor adjustments, getting around the patent to copy the concept without violating it. A company can use additional means of isolation to reduce the possibility of a rival copying its strategies. Path Dependence, Causal Ambiguity, and Social Complexity are these additional "isolating mechanisms".

By causal ambiguity, we refer to the circumstance in which it is difficult or impossible to connect a phenomenon's outcomes or effects to its starting conditions or origins.

It is the ambiguity resulting from the trait of being amenable to several explanations for the connection between two phenomena, such as the one between a company's competitive edge and its available resources. Imitability is constrained by causal ambiguity. It is ingrained in the connection between a company's business inputs and outputs, aids in preventing copying of whatever competitive edge the company may possess, and so aids in preserving better firm performance.

Lippman and Rumelt (1982) recognized causal ambiguity as an imitation-limiting condition that contributed to the explanation of firm-level performance variations. They defined it as the "fundamental uncertainty about the character of the causal relationships between acts and outcomes [among production factors]". Their model acknowledges how rivalry reduces profits in addition to the existence of economic rents that draw imitation and new players into the market. They mentioned ambiguity within and between firms in their arguments, but they did not cite their sources.

Path dependency, instead, describes how a product or technique is still used because it was previously preferred or used. Even when there are newer, more effective alternatives, a firm may continue to use a product or procedure. Path dependency arises from the fact that following an established path is frequently simpler or more economical than starting from scratch.

Few takeaways on path dependency:

• History is important in path dependency; past events stick around because people are resistant to change.

- Change may be resisted because of the financial costs or because decision-makers are acting cautiously or ignorantly.
- When original ideas or standards are accepted and upheld even when there is a better option, industries exhibit path dependency.

The ultimate reason on why we see such a lack of change is that policymakers, managers and so on, usually make assumptions, then cautions decisions but, in the end, they fail to learn from experience. Secondly, the problem stems from the inability or a reluctance to invest in change because of several implications, the related costs being the main issue.

At last, social complexity occurs when a rapidly changing environment is the subject of several interactions. For example, several stakeholders are typically involved in corporate operations, each with unique and occasionally conflicting requirements. We frequently find it challenging to meet all these demands [38].

To conclude the analysis on the negative perspective, it is clear how today's specific HR tasks are almost fully replaceable and replicable by AI. From a negative standpoint, ChatGPT might signal the end of HRM as a viable means of gaining a long-term competitive advantage. Nevertheless, it has been demonstrated time and time again that technology advancements have led to new triumphs. For this reason, we would also like to emphasize, from a different angle, the potential benefits of ChatGPT improvements.

Even though for many reasons, Machine Learning and AI software, could represent a disruptive technology, particularly for low-formalized and low skilled jobs, the disruption would create huge advancements. As a matter of fact, there's a movement toward open-source software becoming widely accessible. This has advantages and financial savings for both employers and employees, particularly in sectors like gig economy and self-employment. This change suggests that employee knowledge will no longer be restricted by non-disclosure or non-competitive agreements and will be freely available. By streamlining procedures like creating job descriptions and policy documents, ChatGPT and other similar applications help improve HR operations. But there are problems associated with this shift, such as biased information and privacy issues. Despite these obstacles, organizations, people, and society may all gain from embracing an open resource-based perspective, which is made possible by tools like ChatGPT. This method highlights the need for strategic focus in HR and enables experts to use AI for mundane work while addressing intricate organizational issues. Even if open resources are readily available, the value of an HR professional's unique perspective cannot be overstated, as

they are able to customize AI-generated insights to suit the context of their firm. As stated before, intertwining those new practices with human knowledge and control, will probably lead to competitive advantage.

"Outsourcing" tasks to ChatGPT comes with risks, mostly related to these issues:

Information that is inaccurate or misleading: human judgment is essential as ChatGPT may provide inaccurate, out-of-date, or misleading information.

- ChatGPT and context: Ignoring or ignoring the context might result in a lack of contextual knowledge about the business, which can have disastrous effects on finding the correct answers and making wise decisions.
- Outdated data: ChatGPT was developed and trained using data that already exists. This suggests that neither past nor future developments have been considered. How much ChatGPT, and artificial intelligence in general, can produce new knowledge and ideas on its own is unknown
- Bias and discrimination: big businesses' experiences with ChatGPT, an artificial intelligence tool they use for recruiting, alert them to the possibility of racial bias and a bias against female candidates.
- GDPR 2, privacy, and data security: Information provided with the chatbot may be misused or disclosed to unauthorized parties, leading to privacy violations or data breaches.
- Ethical and legal issues: What moral and legal ramifications come with using chatbots with artificial intelligence? IP for created content is owned by whom? Will the usage of ChatGPT be hampered or prohibited by federal legislation or industry regulations?

These risks represent "critical conditions" that would enable a productive collaboration and could allow employees, organizations and, approaching it with a holistic perspective, the society at large.

Adopting ChatGPT and an open resource-based viewpoint can help businesses and individuals, including HR professionals, share and circulate knowledge about HRM. Taking into account various levels and sectors, cooperation, co-creation, and information sharing between various firms may offer an alternate path to attaining competitive advantage. Since cooperation and knowledge sharing can address corporate and societal difficulties that are beyond the scope of businesses, open resources can encourage

collaborative innovation and even co-opetition. Our alternative approach seeks long-term benefits for individuals, organizations, and society, as opposed to the conventional resource-based paradigm that concentrates on individual competitive advantage. Furthermore, by enabling HR professionals to strategically concentrate on organizationspecific topics while utilizing ChatGPT for everyday tasks, leveraging an open resourcebased theoretical perspective can still contribute to organizational competitive advantage. The major impacts highlighted by Andrew J. Knoblich and Steven Rogelberg [39] are on employment relations, well-being, and engagement.

For what concern employee relations, a central value stressed by the authors is trust: "employment relations are likely to be moderated through the use of ChatGPT interfaces insomuch as employees view the technology as an appropriately leveraged, capable, and trusted resource".



As an AI language model, I am designed to provide information and answer questions to the best of my ability based on the data I have been trained on. However, there are some important considerations to keep in mind when using AI like me:

- Knowledge limitations: My knowledge is based on the data I was trained on, which goes up until September 2021. I may not have the most up-to-date information, and my knowledge of specific subjects might be limited.
- Misinterpretation: I might sometimes misunderstand your questions or provide answers that don't fully address your concerns. This can be due to the complexity of language and the limitations of Al understanding.
- Bias: Although efforts have been made to minimize bias in my training data, I might still inadvertently display some biases present in the text I have been trained on.
- Not a substitute for professionals: While I can provide general information and advice on various topics, I am not a substitute for consulting with professionals, such as doctors, lawyers, or financial advisors.

You can trust me to provide general information and answer questions to the best of my ability, but it's always a good idea to verify information, especially when it comes to critical decisions or matters that require expert guidance.

Figure 15 ChatGPT response to prompt regarding trust

Effects on workers' well-being can be measured by looking at an AI-enabled chatbot called "Woebot", "a commercially available conversational agent that uses cognitive-behavioral therapy to provide mental health support to its users. During a randomized control trial, participants in the treatment group (which used Woebot as a therapeutic intervention for 2 weeks) reported a significant reduction in depressive symptoms. While Woebot is not a ChatGPT-enabled application, its function is illustrative of the potential impact ChatGPT can have on employee wellbeing, as it relates to mental health."

They also point out that workers who are concerned about job insecurity may experience some unfavorable effects.

In accordance with well-being, employee engagement can have both positive and negative effects. It is true that they can improve human upskilling by giving opportunities for "empowerment, creative exploration" using AI outcomes, but those same opportunities that produce dynamic and effective job markets also present new challenges for everyone. Employees that find it difficult to adjust to these new procedures may experience time wastage, mistrust, and dissatisfaction as a result.

5 THE FUTURE OF MANAGEMENT

5.1 REDEFING PURPOSE AND STRATEGY

A common error made by executives is to think of artificial intelligence (AI) as a plugand-play technology that yields instant benefits. They start investing millions in data infrastructure, AI software tools, data expertise, and model development after deciding to launch a few projects. In certain areas of the organizations, a few of the pilots are able to make marginal progress. But then the major gains that CEOs were hoping for don't materialize for months or even years. Businesses find it difficult to transition from company-wide initiatives to pilots, and from concentrating on small-scale business issues like better customer segmentation to larger-scale issues like streamlining the entire customer journey. Also, leaders frequently have an overly limited perspective on AI needs. While talent and state-of-the-art technology are undoubtedly necessary, it's just as critical to match an organization's structure, culture, and working methods to facilitate widespread AI adoption. However, most non-digital organizations have old mindsets and working methods that are incompatible with AI.

Fountain et al. [40] make three suggestions to scale up AI in a long-term sustainable way:

• *"From siloed work to interdisciplinary collaboration"*: When AI is created by cross-functional teams with a variety of backgrounds and viewpoints, it has the greatest potential impact. Collaborating with analytics professionals alongside business and operational personnel will guarantee that projects tackle wider organizational priorities rather than only discrete business problems. Diverse teams are also better able to consider the operational adjustments that new applications might call for. For example, they are more likely to see that, when an algorithm for predicting maintenance needs is introduced, maintenance procedures should be completely redesigned. Additionally, there is a significant rise in the likelihood of adoption when development teams incorporate end users into the design of their apps.

• "From experience-based, leader-driven decision making to data-driven decision making at the front line": with the algorithm's recommendations, employees up and down the organization, when AI technologies are embedded in

the organizational processes, will increase their intuition to arrive at better answers that machines and humans could not arrive at if they worked on their own. However, for this strategy to be effective, people at all levels must feel empowered to make decisions and accept the recommendations made by the algorithms, which necessitates a break from the conventional top-down strategy. Employee usage of AI will be hampered if they must seek approval from a superior before acting. Decision making, before the implementation of such Machine Learning systems, relied on the experience and gut instinct of senior managers. The new method ranked the best plans for each participant by quickly analyzing the wide range of scheduling permutations. It did this by first utilizing one algorithm to reduce hundreds of millions of alternatives to millions of scenarios, and then another algorithm to reduce those millions to just hundreds. After that, knowledgeable human planners used their experience to make decisions that were ultimately backed by the data without consulting their supervisors. Since they had assisted in defining the tool's criteria and restrictions and were aware that they would ultimately make the final decision, the planners quickly embraced the tool and had faith in its results.

• *"From rigid and risk-averse to agile, experimental, and adaptable":* as also stated in the previous chapters, in order to accommodate AI processes and develop an efficient strategy, organizations have to update their internal structure. In addition to this, Artificial Intelligence applications rarely have the desirable results straight away, needing time before being deployed successfully. A test-and-learn mindset will help people see errors as opportunities for learning, which will lessen their fear of failing. By gathering early consumer feedback and applying it to the next iteration, companies may address small issues before they become major ones. The pace of development will quicken, allowing small AI teams to produce minimal viable products in weeks as opposed to months.

In order to get employees on board, adapting the culture to accommodate better innovations is pivotal. Barriers could arise from the workers' fear of becoming obsolete or from distinctive organizational characteristics. For instance, relationship managers who take pride in understanding client demands may reject the idea that a computer could know more about what customers want and disregard product recommendations from an

AI tool. Additionally, managers in large firms may object to the decentralized decision making or reduction in reports that AI may enable if they feel that their position is determined by the number of employees under their supervision. For what concerns a company's structure potential issues, "Organizations that assign budgets by function or business unit may struggle to assemble interdisciplinary agile teams". In some cases, creating a new class of experts can be a solution: the "analytic translator". Identifying roadblocks, these individuals serve as a link between the technical fields of data science and engineering and the domains of risk management, manufacturing, supply chain, marketing, and so forth. Translators contribute to the easy implementation of AI technologies by ensuring that they meet business needs. In order to identify and address issues early in the implementation process, they might poll end users, watch their behaviors, and examine processes. Another way organizations can try to minimize the downturns, suggest the authors, is "Budgeting as much for integration and adoption as for technology (if not more). In one of our surveys nearly 90% of the companies that had engaged in successful scaling practices had spent more than half of their analytics budgets on activities that drove adoption, such as workflow redesign, communication, and training. Only 23% of the remaining companies had committed similar resources." Companies that have already enabled AI practices to have divided roles between a "hub" and several "spokes".

Hubs serve to develop AI talent, which should also establish communities for AI specialists to exchange best practices and establish organizational-wide procedures for AI development. Organizations that have successfully integrated AI are 2.5 times more likely to have a defined approach for developing models, deriving insights, and implementing new AI capabilities, and they are three times more likely to have a hub than their peers. Hubs must be in charge of AI-related standards and systems as well. These should be produced gradually rather than all at once, before business cases have been established, and should be motivated by the demands of the firm's initiatives.

Since the spokes will be interacting with the people who will be using the AI systems the most, they should nearly always bear a little additional set of duties. Adoption-related responsibilities include impact tracking, performance management, incentive programs, workflow improvement, and end-user training. One manufacturer's sales and service department established a "SWAT team" to assist customers in utilizing the product and devised a pricing strategy to increase adoption in order to encourage consumers to take

use of the AI-enabled services that come with its smart, connected equipment. It is obvious that such a task belongs in the purview of a spoke and cannot be assigned to an analytics hub.

The remainder of the job is in the gray region, and where it should be done depends on the unique qualities of each firm.



Figure 16 Key Roles to Organizing AI

A significant portion of the labor involved in effective AI reforms lies in the gray area of accountability. Key tasks can be owned by either the hub or the spoke, shared by both, or shared with IT. These tasks include directing AI projects, assessing the problems they will solve, developing algorithms, designing tools, testing them with end users, managing change, and building the supporting IT infrastructure. Although assigning blame inside an organization is not a precise science, there are three things that should be taken into consideration:

• "The maturity of AI capabilities"

Analytics executives, data scientists, data engineers, user interface designers, visualization specialists (who visually interpret analytics findings), and the like, are frequently best suited to sit within a hub and be distributed as needed to the spokes when a company is just starting out with AI. Together, these participants may create the

organization's fundamental AI resources and competencies, including shared analytics software, data processing procedures, and delivery strategies. However, these specialists can work just as well, if not more, inside the spokes as time goes on and procedures become standardized.

• "Business model complexity"

The need to create guilds of AI professionals (of, say, data scientists or designers) increases with the number of business operations, business lines, or geographic areas that AI tools will support. Businesses with intricate operations frequently combine these guilds into a hub and then distribute them to company divisions, departments, or regions as required.

• "The pace and level of technical innovation required"

Some businesses concentrate more on gray-area strategy and capability building in the hub when they need to innovate quickly. This allows them to better monitor changes in the industry and technology and swiftly deploy AI resources to meet competitive challenges.

This paragraph started stating that it is the responsibility of management to correctly facilitate the adoption of AI and that organizations, if they want to ensure an effective implementation, they need to educate everyone with a top-down approach. In order to achieve this, companies are starting their own internal AI academies, which usually consist of workshops, in-person or virtual classroom instruction, on-the-job training, and even site visits from seasoned colleagues in the sector. In addition to hiring outside instructors to create their curricula and provide training, the majority of academies also set up procedures to develop their own internal resources [41].

5.2 PERFORMANCE ANALYSIS: HR VS AI

HR practitioners should be encouraged to be more proactive and help identify facets of performance where the bot could help managers (who are typically the ones doing the ratings) do a better job [42]. Recently, a company called Confirm has experimented with using ChatGPT in their performance management process, specifically for performance reviews. Their experience has been promising: the bot was very successful in writing

performance reviews by asking pointed questions of colleagues of the ratee. However, as Josh Merrill, the CEO of Confirm [43], cautioned, "ChatGPT is not ready to give feedback to individual employees, yet. We would hasten to add that the bot should probably not be giving feedback anytime soon, as performance management is a human process and should stay as such, meaning that the bot should assist individual managers in doing their jobs as supervisors, not replace them. Prioritizing their retention requires us to be able to identify, objectively, who inside a company are the true performers and future leaders".

Many managers are too busy with daily tasks to take the time to give constructive criticism, which frequently leaves brilliant workers feeling undervalued and dissatisfied. This has a negative effect on employees' performance and causes them to become disengaged [44]. Disengagement has several detrimental and disruptive repercussions on the organization. According to the writers, disengagement means that time is running out before they can find the empowerment, recognition, and investment they want at a different company, which can be expensive. People's engagement levels rise and remain higher when they feel understood and heard. If they don't, they end up being a flight risk or a cultural cancer within a business, which is never good. AI-driven tools could have the ability to mitigate those unwanted repercussions by identifying and remedying on cultural and philosophical confusion between management and workers avoiding costly circumstances such as losing talents because of the absence of meaningful dialogues regarding breaks in the chain of command or a low recognition (by the c-suite) of achievements accomplished. Jose Benitez Cong, former executive at Apple, Nest and Google revealed [45] that "even the best companies struggle to recognize and retain their star employees" and that "career growth is incredibly difficult to quantify and measure with a universal performance measurement tool. Career development is complex and difficult and performance reviews don't work. Everyone has different goals and aspirations and each company is driven by a unique team with uniquely gifted individuals. Yet we still haven't found a way to facilitate a natural conversation around career development, performance and recognition that employees (and managers) can use." Moreover, he noticed that, if productivity has enormously increased thanks to the latest trends regarding the continuous connection and communication implemented with tools like Skype, Microsoft Teams and others, performance has remained a topic relegated to the traditional annual or bi-annual reviews.

In this field, in the recent years, several startups' projects have been brought forward focusing on finding the aspects that employees value the most, helping managers and leaders to stir in that direction. Humu, cofounded by Laszlo Bock, another former Google executive, has as its objective to utilize Behavioral Change Technology to make workers happier. Firm's mission is to "Making work better everywhere through machine learning, science, and a little bit of love" [46]. They created their in-house software called the "Nudge Engine", that delivers tiny, direct and scientific adjustments based on the observation of internal dynamics. The company was acquired by Perceptyx, a company based in California that specializes in people analytics combining it with business data, in 2023.

In recent years, it has become increasingly crucial to recognize the potential of utilizing people analytics. A few notable examples of organizations that have used these systems are Electronic Arts, Tesla, and Airbnb. In addition to that, as stated in the precedent chapters, "the main goal is not to relieve managers from their work but to enable better decision making by freeing their hands of administrative tasks and focusing on real time interactions with employees and strategic actions".

Aside from the apparent benefits for management, there has been a lot of discussion in the workplace about the use of AI for feedback. Actually, in order to gather advanced data analytics, organizations would (and do) need to closely observe employees' behavior at work, accurately assess their productivity, and offer customized recommendations for improving work, all in a precise and consistent manner. Some methods resulted "invasive" and could represent a dangerous risk and nullify the efforts done to engage and retain more workers. A blatant example of this scenario is how companies tried to track employees during Covid-19 pandemic. The use of surveillance software, which allowed companies to monitor what their employees are doing and how long they are doing it, apparently surged in line with the crisis when millions of people stopped going into offices. Companies obliged their subordinates to install on their devices all kinds of tools: Hubstaff is a software that logs users' mouse clicks, keyboard input, and web pages visited; Time Doctor records user screen footage, going one step further. Every ten minutes, it may also use a webcam to snap a photo to make sure staff members are using their computers. Isaak, another tool, developed by Status Today in the UK, tracks employee interactions to see who collaborates most. It then combines this data with information discovered from employee files to identify persons who are considered

"change-makers." [47] It goes without saying that detractors have said that those programs harm employees' morale and erode the trust that is based on the agent-principal relationship. According to Cori Crider, a lawyer and the founder of Foxglove, a nonprofit organization that opposes governmental and corporate misuse of technology, the results of these initiatives may create an even more dangerous power imbalance, making it harder for workers to hold management responsible for potential wrongdoings and detrimental practices. Moreover, Crider insists that "What you're seeing is an effort to turn a human into a machine before the machine replaces them". In her opinion, managers have to create an environment in which people feel trusted, and not surveilled. In those cases, if performance and productivity assessment is the final aim of adopting these technologies, an opposite effect can be triggered. To put it in the words of authors Siliang Tong, Nan Jia, Xueming Luo and Zheng Fang [48], in their paper called "The Janus face of artificial intelligence feedback: Deployment versus disclosure effects" and to the negative ones as "disclosure effects".

The first ones are there because artificial intelligence feedback enhances the accuracy of employee performance evaluations by accurately and reliably assessing a larger volume of data than human managers can. Since AI can attain a higher degree of customization, feedback from AI is also more pertinent to certain employees. Both criteria lead to higher quality feedback, which increases employee productivity. Conversely, employees who don't trust or rely on feedback generated by ML and GL are more likely to worry about losing their jobs. In their study, they found a net positive effect of using ML rather than human managers assessment: "employees who received AI feedback obtained 12.9% higher job performance"; and that "AI identifies more mistakes and makes more recommendations to correct each mistake to improve employees' job skills", increasing learning and job performance. In order to mitigate the adverse disclosure effect (that they calculated to affect the workers by 5,9% when they were receiving the same feedback by AI instead of manager), it's been suggested that their findings lead them to believe in a close relationship with worker's tenure in the company. From their point of view, ongerserving employees typically have larger networks and more relational capital inside the company, which allows them to provide resources and assistance during unfavorable shocks. As a result, long-serving workers often experience fewer negative consequences from AI feedback disclosures than do employees with shorter tenure. Considering this, one tactic that companies might use is to give veteran and recently hired staff members

separate sets of feedback; the former would receive AI-driven feedback, while the latter would only receive evaluations from human managers. A second possibility, parallel and contiguous with the first strategy, could be brought forward by disclosing AI assessments together with measures and suggestions that reduce their resentment towards ML generated feedback. The coexistence of the two effects reveals the reason why AI is considered by the authors as having a Janus face and why a higher degree of transparency is needed, advocated in the first place by policymakers, thus enabling every actor involved to extract the most value and benefits out of it.

To build upon the concept of complementarity (between AI-driven recommendations and human judgment), widely discussed in the previous chapters, the need for an holistic and more humane approach is increasingly needed. AI, at least for now, cannot substitute those functions where managers are called to make decisions based on less-structured, less-codifiable and more implicit information, or when they need to have "unstructured" conversations in regard to promotion and suggestions on performance enhancing opportunities, or when it is needed to coordinate with team members, build connections and motivate employees. The heterogeneity of effects should also be carefully examined: generally speaking, the younger the resource, the more exposure, so knowledge, they have had to formal education as well as usage in other contexts, which reduces employee aversion and unfamiliarity with ML and generative tools. Furthermore, studies show that workers who are currently performing well and have more opportunities for career advancement find it easier to adapt to these technologies, which reduces the size of the disclosure effect that was previously examined.

6 CONCLUSIONS

The rise of Artificial Intelligence in recent years has attracted numerous controversial remarks. For example, CEO of IBM, Ginni Rometty, argues that AI technologies are "technologies to augment human intelligence...By and large we see a world where this is a partnership between man and machine and this is in fact going to make us better and allow us to do what the human condition is best able to do". Stephen Hawking, on the other hand, remarked that "the development of full artificial intelligence could spell the end of the human race" [49], and Bill Gates has also said that "humans should be worried about the threat posed by Artificial Intelligence". The application of artificial intelligence (AI) in enterprises signifies a fundamental change in how companies function, make decisions, and interact with their staff and clients. Leaders must carefully guide their organizations through the fundamental and occasionally challenging changes in processes, responsibilities, and culture brought about by new applications. Businesses which are adept at integrating AI across the whole company will have a significant edge in a future when collaborative machines and humans perform better than either one alone. Artificial Intelligence will be one of the greatest tools at human's disposal. It goes beyond simple technology advancement. As this thesis has shown, integrating AI significantly alters organizational culture and structure in a few ways, resulting in higher levels of innovation, better employee engagement, and operational efficiency. Moreover, flatter organizational structures are becoming more and more common since they speed up decision-making and encourage teamwork. This change encourages a sense of accountability and ownership by enabling staff members at all levels to use AI technologies. Additionally, the focus on data-driven decision-making calls for the creation of new positions and skill sets, underscoring the significance of ongoing education and flexibility in the workplace. Businesses may enhance consumer experiences, spur innovation, and better respond to the ever-evolving demands of the market by embracing AI as a catalyst for change. It will be these companies that successfully leverage AI to foster an agile and morally responsible culture that will shape the nature of work in the future.

7 **REFERENCES**

- [1] Sokolowski, Robert. "Natural and Artificial Intelligence." Daedalus 117, no. 1 (1988): 45–64. http://www.jstor.org/stable/20025138.
- [2] Stuart Russell; Peter Norvig Artificial Intelligence, A Modern Approach (3rd edn, Pearson Education 2016)
- [3] OECD (2022). Definition of an AI System: Update. Organization for Economic Co-operation and Development (OECD).
- [4] National Institute of Standards and Technology (NIST). (2023). Artificial Intelligence. U.S. Department of Commerce.
- [5] Kowalski, K. (2017, May 11). Deep Blue vs. Garry Kasparov: The chess match that changed history. Live Science.
- [6] Warwick, K. (2012). Artificial intelligence: The basics. Routledge p.65
- [7] Tom M. Mitchell. Machine learning. 2006
- [8] Alpaydin, E. (2020). Introduction to machine learning (4th ed.). MIT Press.
- [9] Munakata, T. (2008). Fundamentals of the new artificial intelligence (2nd ed.). Springer.
- [10] Richard Szeliski, Computer Vision: Algorithms and Applications (Griets David, Schneider Fred Springer eds 2011)3,5

[11] Schumpeter (January 30, 2020). *"Clayton Christensen's insights will outlive him"*. The Economist. Archived from the original on May 7, 2021

- [12] <u>https://tepperspectives.cmu.edu/all-articles/ais-disruptive-potential-in-business/</u>
- [13] <u>https://www.nfx.com/post/ai-leapfrogging</u>
- [14] Han, P., & Wang, Z. (2024). *Technology adoption and leapfrogging: Racing for mobile payments*. Federal Reserve Bank of Richmond Working Paper
- [15] <u>https://kpmg.com/it/it/home/insights/2023/10/kpmg-ceo-outlook-</u> 2023.html#disruptivetechnology
- [16] D. Zhong et al., *Overview of predictive maintenance based on digital twin technology*, School of Computer Science, Northwestern Polytechnical University, Xi'an, 710129, China
- [17] <u>https://www.ibm.com/topics/predictive-maintenance</u>
- [18] Cardoso, D., & Ferreira, L. (2021). *Application of predictive maintenance concepts using artificial intelligence tools*. Applied Sciences, 11(1), 18.
- [19] <u>https://www.cognitiveautomation.com/resources/what-is-a-digital-twin-with-ge</u>
- [20] "BlackRock: The \$4.3 trillion force". Fortune. 7 July 2014
- [21] <u>https://www.ibm.com/it-it/topics/random-forest</u>
- [22] <u>https://ecp.nl/wp-content/uploads/2018/11/Artificial-Intelligence-Impact-Assesment.pdf</u>
- [23] European Union. (2024). Regulation (EU) 2024/1689 of the European Parliament and of the Council of 11 July 2024 on the European Union Agency for Cybersecurity (ENISA)
- [24] Boultwood, B.; "How Artificial Intelligence Will Change Qualitative Risk Assessment," Global Association of Risk Professionals, 18 December 2020
- [25] Citigroup, Inc., "Citi Global Trade Uses AI to Digitize Compliance in Next Generational Project," 29 April 2019
- [26] Bellini, F., Bashirpour Bonab, A., & Rudko, I. (2021). *Organizational structure and artificial intelligence: Modeling the intra organizational response to the AI contingency*. Journal of Theoretical and Applied Electronic Commerce Research, *16*(6), 2341-2364
- [27] Accenture. (2017). Artificial intelligence has potential to increase corporate profitability in 16 industries by an average of 38 percent by 2035 [Press release]. Accenture Newsroom.
- [28] Volini, E.; Schwartz, J.; Denny, B.; Mallon, D.; von Durme, Y.; Hauptmann, M.; Yan, R.; Poynton, S. 2020 Deloitte Global Human Capital Trends; Deloitte Report; Deloitte: Shanghai, China, 2020
- [29] Brynjolfsson, E.; Mitchell, T.; Rock, D. What Can Machines Learn, and What Does It Mean for Occupations and the Economy? AEA Pap. Proc. 2018, 108, 43–47.
- [30] Čudanov, M.; Jaško, O.; Jevtić, M. Influence of Information and Communication Technologies on Decentralization of Organizational Structure. Comput. Sci. Inf. Syst. 2009, 6, 93–109.
- [31] Malone, T.W. Is "Empowerment" Just a Fad? Control, Decision-Making, and Information *Technology*. BT Technol. J. 1999, 17, 141–144.
- [32] Schilling, *M.A. Strategic Management of Technological Innovation*, 6th ed.; McGraw-Hill Education: New York, NY, USA, 2016

- [33] Wisskirchen, G.; Biacabe, B.T.; Bormann, U.; Muntz, A.; Niehaus, G.; Soler, G.J.; von Brauchitsch, *B. Artificial Intelligence and Robotics and Their Impact on the Workplace*; IBA Global Employment Institute: London, UK, 2017.
- [34] Gulliford, F. and Parker Dixon, A. (2019), *"AI: the HR revolution"*, Strategic HR Review, Vol. 18 No. 2, pp. 52-55
- [35] Bernard Marr (2021) The amazing ways how Unilever uses artificial intelligence to recruit & train thousands of employees, Bernard Marr. Available at: https://bernardmarr.com/the-amazing-ways-how-unilever-uses-artificial-intelligence-to-recruit-train-thousands-of-employees/
- [36] The business case for AI in hr, IBM, October 2021
- [37] Budhwar, et. al. (2022). Artificial intelligence challenges and opportunities for international
- *HRM: a review and research agenda.* The International Journal of Human Resource Management. 33.
 [38] Hitt, M. A., Ireland, R. D., & Hoskisson, R. E. (2024). *Intellectual property isolating*
- mechanisms. In Strategic management (4th ed.). Virginia Tech Press.
- [39] A.Knoblich S.Rogelberg, ChatGPT impact on employment relations, employee wellbeing and engagement, https://doi.org/10.1111/1748-8583.12524
- [40] T.Fountaine, B. McCarthy, T.Saleh, Building the AI-Powered Organization, Harvard business review, July-August 2019
- [41] J.Canals, F.Heukamp; The future of Management in AI world, Palgrave Macmillan 2020
- [42] Cooke, F. L., Schuler, R., Varma, A., & Arora, A. *Human resource management research and practice in the era of artificial intelligence. Human Resource Management Journal,* (2023).
- [43] Metz, C. (2023, August 29). Confirm raises \$6.2 million to bring generative AI and network analysis to performance reviews. VentureBeat. <u>https://venturebeat.com/enterprise-analytics/confirm-raises-6-2-million-to-bring-generative-ai-and-network-analysis-to-performance-reviews/</u>
- [44] Bryan Buck and John Morrow, "AI, performance management and engagement: keeping your best their best", Strategic HR Review, 2018
- [45] Jose Benitez Cong, "People aren't performance reviews", August 2016
- [46] <u>https://www.humu.com/</u>
- [47] Hawkins, A. J. (2020, June 4). *Startup AI scores productivity of workers, raising concerns about bias.* Technology Review.
- [48] Chatain, O., & Murtha, T. P. (2023). Building an AI capability: Labor, learning, and the strategic choices firms make. Strategic Management Journal
- [49] Cave J., (2014, December 5). *The 'superintelligence' and the future of AI*. BBC News.