A Work Project presented as part of the requirements for the Award of a Master Degree in Management from the NOVA – School of Business and Economics

Adoption State of Artificial Intelligence: A SaaS Perspective:

Overview of the state of adoption of Artificial Intelligence with particular attention in the SaaS industry

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Date: 16.12.2021

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Abstract

The following thesis will focus on the general topic of Artificial Intelligence (AI). The main purpose of this work is to investigate how generally AI is being implemented and developed in modern times. Artificial Intelligence is critical in the SaaS industry. The study aims to get an overview of the state of adoption of Artificial Intelligence with particular attention to how it is in the SaaS industry and what it may indicate for the future. The author compares secondary data analysis with interviews of SaaS experts to better understand of how the SaaS industry differentiates from the general market.

Keywords: Artificial Intelligence, Technology Adoption, Classification Algorithm, Travel and Tourism, Banking, Construction, Software as a Service, Conversational AI, State of Adoption

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

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1. Introduction

1.1 Background

The Covid-19 pandemic crisis has supercharged the adoption of Artificial Intelligence (AI). According to a PWC study, 52% of companies accelerated their AI adoption plan due to the pandemic. Of this 52%, 86% have claimed that AI will become a "mainstream technology" in their company in 2021 (PWC 2020). The trend does not seem to be just a trend of the pandemic but a trend that will continue through the 2020s. A survey by The AI Journal has demonstrated that leaders are confident that AI will play a significant role in the future. 74% predict that AI will bring more efficiency to business processes, create new business models (55%), and help create new products and services (The AI Journal 2020). The increasing adoption of AI means it is being used in very distinct ways by the different industries to perform various tasks and achieve very distinct goals. As such, to continue to move toward its crucial to continue to revolutionize and update its processes. An excellent way to do so is by gaining insight into different industries that have personalized and created processes to maximize AI and learn from it. Usually, these techniques imply gains in productivity in production processes and daily-routine tasks since these can be automated by machines or fully digitalized. However, it is vital to provide a definition and an understanding of what AI is, what it might achieve and the main risks and benefits it brings across several industries and sectors clear to the general population. Usually, when people think about AI, a significant portion still thinks that it is a tool to eradicate jobs, increase revenues and collect data to breach privacy. According to a study performed by the Oxford Commission on AI & Good Governance, 47% of North Americans and 43% of Europeans think that including AI in our lives will mostly be harmful. If we explore the answers by profession groups, construction and manufacturing workers are the most worried – 42% think it will be mostly harmful –, while agricultural workers are the least worried ones – 28% think it will be harmful, while 38% believe it will mostly help (Oxforf Internet Institute 2020).

1.2 Motivation and Purpose

The main goal of this of how the different industries could learn from each other and what patterns are visible throughout the diverse industries.

The rest of the paper is organized as follows: In chapter two, the authors analyse the concept of Artificial Intelligence, its history, and its acceptance. The third chapter comprises an overview of the different fields of artificial intelligence. In the next chapter, the authors examine the different benefits and risks of AI, both in a general overview and a sector-specific analysis. The fifth chapter is an assessment of investments in AI in an overall and sector-specific evaluation. The sixth chapter will cover a more in-depth dive into specific sectors. Finally, conclusions and comparisons are in the seventh chapter.

2. Literature Review

2.1 The concept of Artificial Intelligence

The definition of AI has been a topic subject to great discussion due to the lack of consensus in defining it. So much so that no singular definition of the field is universally accepted. While numerous definitions of AI have emerged over the last few decades, John McCarthy provided the following in 2004, “It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence. Still, AI does not have to confine itself to methods that are biologically observable” (McCarthy 2007). However, a distinct and more comprehensive definition was proposed by Nils Nilsson in 2010, “Artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment” (Standford 2016). The main limitation in defining AI as merely making machines intelligent is that it does not clarify what AI is and what exactly is an intelligent machine. Thus, Britannica brought forth another definition along

these lines, “The ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience” (Britannica 2021). Simply put, AI is the intelligence that is manifested by machines. These are programmed to mimic human actions in order to, later on, be able to execute activities that are commonly correlated with human minds, including problem-solving, learning, and performing physical tasks (Advani 2021).

Strong artificial intelligence (AI), also referred to as general AI or artificial general intelligence (AGI), is a theoretical kind of AI that describes a particular approach to AI development. Strong AI aspires to mimic human functions including reasoning, planning, and problem-solving. Simply said, Strong AI strives to develop intelligent machines that are indistinguishable from human mind (IBM 2020). Weak AI, also known as narrow AI, focuses on a single activity, such as answering questions or playing chess depending on user input. It can only perform one sort of activity at a time, while Strong AI can handle a wide range of tasks. To ensure accuracy, Narrow AI relies on human intervention to specify the parameters of its learning algorithms and to provide appropriate training data and eventually educate itself to tackle new problems. On the other hand, while it accelerates it is the growth phase, strong AI does not require human input, eventually, it will teach itself how to solve new issues (IBM 2020).

2.2 The history of AI – Main marks in history

The idea of a “Machine that thinks” goes way back, being first mentioned in ancient Greece, but gained particular importance after the birth of computing. Specifically, when Alan Turing published *Computing Machinery and Intelligence* and posed the question “Can machines think?”. Six years later, John McCarthy coined the term “Artificial Intelligence” for the first time. Since then, AI has come a long way, from different programs like Deep Blue, Watson and

AlphaGo defeating champions in Chess, Jeopardy and more recently GO, a Chinese game, with great complexity. Neural networks have also significantly evolved, starting in 1967 with Frank Rosenblatt and its Mark 1 Perceptron, the first computer-based neural network learned through trial and error. More recently, Baidu's Minwa supercomputer identifies and categorizes images with much higher efficiency than humans. AI has also come far in terms of practicality; in the past, it was pure fiction. Nowadays, it is embedded in daily life, with most people carrying an artificial assistant in their pocket. Likewise, AI is present in most, if not every, industry, being used as a tool to reach multiple goals in a wide variety of scenarios, including control management, personalization, customer interaction, decision making, and much more.

2.3 AI Acceptance

The importance of AI is rising in all parts of society. It is regarded as a source of competition and innovation as it proposes targeted solutions in different areas. However, despite many people using AI every day, it is evident that not everyone accepts or agrees with it (Arnold 2021).

On the one hand, recent studies show that the support towards AI is more significant among the wealthy, educated, and those who have more experience dealing with technology. On the other hand, an analysis by the OECD reveals that subgroups are more vulnerable and less enthusiastic towards AI and workplace automation. These include people from developed countries with lower levels of education, low incomes, and individuals whose jobs could easily become automated. Hence, people who struggle to pay their bills regularly are more hostile towards AI and robots than those who never experienced difficulties. Moreover, other analyses further mention that men are, in general terms, more accepting of AI than women, which could be due to the fact that women have shown greater distrust in technology than men (Zhang and Dafoe 2019).

On a different note, Pegasystems, a leader in customer engagement software, carried a global study to assess consumer views on AI. The data unveiled that consumers have mixed feelings towards AI. While most are eager to welcome AI and recognize a promising future ahead, others fear AI and still favour human communication over a machine when given the option. Another aspect that is open to discussion is that consumers believe AI falls short of fulfilling their expectations, mainly due to the lack of understanding of the concept. Thus, there is room for companies to take advantage of this uncertainty and align their approach with their consumers' preferences (Pega 2019).

The acceptance of artificial intelligence also differs from country to country. In Asia, the perception of AI is usually favourable, around two-thirds or more in most Asian countries. For example, Singapore (72 percent), South Korea (69 percent), India (67 percent), Taiwan (66 percent), and Japan (65 percent) believe AI has benefited society (World Economic Forum 2020). However, most of the other continents and regions polled do not agree that AI has benefited society. Countries such as France, the UK, and the US are predominantly negative towards AI's impact on society. On the other hand, Sweden and Spain are two of the few countries outside of Asia-Pacific where a majority of people (60 percent) think AI is a good thing (World Economic Forum 2020).

Consumers and corporate leaders have different concerns about AI. In the next five years, AI will significantly impact the way companies do business, according to 85% of CEOs. However, there are differing viewpoints on how much AI may be trusted. Over three-quarters of CEOs believe AI is "positive for society," but even more say that AI-based choices must be explainable to be trusted (84 percent) (World Economic Forum 2019). A survey from the Economist assessed whether executives thought AI could live up to its hype or not. A fifth of the respondents claimed that AI was" just hype and no substance", whereas 36% stated they thought it helpful but that there is hype in this technology. On the other hand, 36% thought AI

would live up to its promises (The Economist 2020). The pandemic changed a little bit this perception. Since the pandemic, 50% of respondents stated they have a more favourable view of AI. Of these respondents, the most confident industries that AI would help them during the pandemic were mining, manufacturing, and technology. The least confident ones were travel and tourism, consumer, and retail (The Economist 2020). The adoption rate is also a good way of measuring how accepting AI is in varied industries. A study from O'Reilly shows that Computers, electronics, and technology, unsurprisingly, topped the list with 17% of respondents. Financial services (15%), healthcare (9%), and education (8%) are the industries that are using AI the most. In the pharmaceutical and chemical industries, we find minimal AI utilization (2%). Similarly, only 2% of responders are from the automotive industry, even though AI is critical to emerging goods such as autonomous vehicles. Finally, the energy industry accounted for 3% of the respondents, while public utilities accounted for 1% (O'Reilly 2021).

3. The main fields of Artificial Intelligence

The objective of this section is to present and explain the main fields that exist related to AI. These are the main tools used to deliver tasks once performed by human intelligence such as learning, reasoning, solving problems, identifying, and understanding languages and perceive specific situations or environments (Future Today Institute 2021). The fields found are based on the interest put on by several studies and books, such as (Nilsson, The Quest for Artificial Intelligence 2009), (Minsky 1960), and (Russell e Norvig 1995), and include Machine Learning (ML), Robotics, Natural Language Processing (NLP), Computer Vision and Expert Systems.

3.1 Machine Learning (ML)

ML is a field of AI where algorithms learn from huge amounts of data without human intervention to improve the accuracy in making predictions and pattern detection (Nilsson

1998). According to (Russell e Norvig 1995), inside these ML algorithms we can still make the distinction between three: supervised, unsupervised and reinforcement learning. Supervised learning is a subset of ML that uses labelled datasets (e.g. if we are trying to predict the age of someone, age is our label), meaning that the label is the variable we want to predict – if both inputs and outputs can be seen, that is supervised learning. The most common models are Regressions (to predict outputs that are continuous variables, such as the height of someone) and Classification (the outputs are discrete variables, and sometimes "yes" or "no", like when we're trying to prevent the churn rate of a website). Unsupervised learning uses unlabelled datasets, meaning that we have no output variable to predict. The most common algorithms are Clustering (group data based on similarity) and Dimensionality Reduction (simplify data by reducing the number of features). Finally, reinforcement learning algorithms deal with no data and must solve problems. Instead of dealing with data, it deals with an environment, where correct decisions give rewards and wrong decisions give punishments. One known use case is chess – the algorithm will try random moves and receive rewards or punishments for them and then will learn how to reach the terminal state: *check!* (Russell e Norvig 1995).

Robotics develop artificial agents that are designed to perform human tasks and interact in the physical world environment (Russell e Norvig 1995). It literally studies robots (designs, production, and operation), machines that can be used to perform human tasks alone or supervised by someone. They can be used in manufacturing automation, exploration of the sea, hazardous waste inspection, surgeries, environment monitoring (e.g., drones), home robotics (e.g., autonomous vacuum cleaners), among others. According to Medium, regarding the main fields inside this subject, the focus is on Operator Interfaces, Mobility or Locomotion, Manipulators and Effectors, Programming, and Sensing and Perception. As for the first one, an operator interface is a vehicle through which the user of the robot and the robot itself communicate, meaning that it is the platform through which a human gives instruction to a

robot. Robots need to move from a place to another to complete their job, and that's why mobility and locomotion are a field of great interest (for instance, drones use propellers and other systems to move, and those need to be developed). These machines also need to grab, transform, and move objects like they had a human hand (one of the most common applications is in the auto-industry), and that's why researchers are putting effort in manipulators and effectors. Programming is important since it is the language used by the user to communicate with the robot (and this is where ML might help, since robots can learn to avoid mistakes). Finally, sensors are fundamental to collect data to inform the robot about the environment around it (Medium 2020).

3.2 Natural Language Processing (NLP)

NLP gives computers the ability to extract data from written and spoken words, allowing for tasks such as translation and speech recognition (Nilsson 2009). Combined, computational linguistics, statistics and deep learning models can perform NLP tasks. It translates pieces of text from a language to another, allows machines to answer to voice commands (e.g., *Hey Siri*), serves as the motor to chatbots as they identify the text written, process and understand it and powers GPS systems to talk, for example. Concluding, the main fields of interest are text processing, speech recognition and speech synthesis – and most of them rely on ML algorithms to perform (IBM 2020).

Computer Vision deals with allowing machines to collect information through vision, analysing images or videos to make predictions and pattern recognition (Nilsson 2009). We need to distinguish this concept from image processing – the last one aims to create an image from an existing one, while computer vision aims at understanding what is happening (Machine Learning Mastery 2019). When there is a surveillance system, it is not uncommon to have two cameras capturing some common zones – that is actually a good way to interpret distances between objects and help in making decisions. The main tasks and fields computer vision is

exploring are optimal character recognition (e.g., when someone gets a speed ticket, the camera automatically reads the plate number), machine inspection (e.g., scan the status of the outside of a plane to check if it is ready to fly again), retail (recognition of products for an automatic checkout, like the one used in the Amazon Go shops), warehouse logistics (development of package deliveries in an autonomous way), medical imaging, self-driving vehicles (by analysing the environment, the car adapts the speed and the turns), 3D model building (from information collected by drones and planes), motion capture, surveillance (analysing the traffic, drones in the sea, etc) and fingerprint recognition and biometrics (Szeliski 2021).

Expert Systems are computer systems simulating complex human decision-making by explaining the reasoning behind it. These are being integrated with databases to do recognition and decision-making like humans, with the final objective of creating knowledge discovery with the help of data-mining processes and end up with an intelligent database. It brings visible advantages, such as an increased availability (since these systems are not specific to a single computer), reduced costs per user (as a fixed cost, if the number of users increases, the average cost decreases), consistency (if a human is tired will treat some problems with greater difficulty, while an expert system is always ready), multiple expertise converted into one machine, explanation of the reasoning behind the decisions done, quick responses and emotion-free opinions (Jackson 1998).

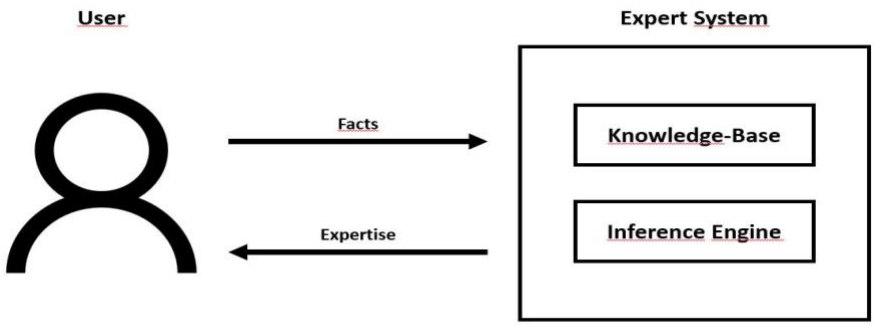

Figure 1: : An Expert System, based on (Jackson 1998)

Most of the times these fields are not exclusive and require connections to achieve better results. For example, Deep Learning (DL), a subset from ML that trains techniques such as Artificial Neural Networks (ANN), techniques are used in NLP algorithms, since these are built to tackle and understand the temporal nature of language (Jurafsky e Martin 2000). ANN are a set of networks composed by non-linear elements (Nilsson 1998) and are compared to real neural networks since they adjust the weights of connections with new inputs just like the human brain connections between neurons change with more information, and both learn to make more accurate decisions (Russell e Norvig 1995). These DL algorithms are used in Computer Vision (Goodfellow, Bengio e Courville 2016) like the recognition of sound waves from the vibrations they reproduce in objects seen in video (Davis et al. 2014) Also, DL algorithms are used for Robotics. (Punjani e Abbeel 2016) used a DL algorithm to try to represent the dynamics from a helicopter through a network model, and the model outperformed the baselines by large.

From the relations stated above and the studies observed, we can check that specially DL is used to complement several other fields of AI. One of the best-known cases of how these Neural Networks are present in our lives is to look at how easy it is to communicate with an iPhone just by saying "Hey Siri" – a practical application of DL in speech recognition and NLP. The holder of the iPhone says "Hey Siri", there is a Deep Neural Network (DNN) that converts the acoustic pattern of the voice into a probability distribution, and then temporal integration to calculate a confidence score to check whether "Hey Sri" was said or not (Apple Machine Learning Research 2017). If instead of talking to Siri, the holder just wants to unlock its iPhone through face detection, another DNN – and here we have DL helping Computer Vision.

4. The benefits and risks of AI

4.1 General / Ethics of AI

The use of AI involves several benefits and is accompanied by numerous risks at the same time. Davenport and Ronanki (2018) are approaching AI through the business lenses and describe it as a cognitive technology which benefits three major business needs: automating business processes, gaining insights through data analysis, and engaging with customers and employees.

The most common type is the automation of digital and physical processes, which are generally easy and cost-effective to implement and usually bring a quick and high return on investment. It is especially useful for automating back-office work like transferring data and updating customer records or extracting information from multiple document types using natural language processing. These kinds of business-processes are often outsourced offshore and can be automated, which results in reduced costs without a loss of employees (Davenport and Ronanki 2018). Routine operational activities, such as maintenance systems, accounting and information inquiry tasks are performed much better and faster by AI systems than by humans (Lee and Yoon 2021).

The second most frequent use of AI is in the field of data analytics with the help of algorithms for pattern detection and interpretation in order to gain business relevant insights. With the help of data analytics, companies can predict what a customer is likely to buy, identify credit fraud in real time or automate personalized targeting of digital ads. Such tasks are often beyond human ability and therefore do not pose a significant threat to human jobs (Davenport and Ronanki 2018).

Cognitive engagement represents another main benefit of AI, which is used less frequently by companies compared to automating business processes and gaining insight through data analysis. This category includes the deployment of intelligent agents that offer customer service

at any time. It is also used within companies on internal sites for answering employee's questions regarding HR or IT related topics. In addition, it comes to use in health treatment recommendation systems that help to customize care plans under consideration of individual patients' health status and previous treatments (Davenport and Ronanki 2018).

Also, companies can stay ahead of the competition by transforming products and services. In R&D heavy sectors, AI can accelerate the product innovation and discovery process through accessing new value-adding areas (Møller et al. 2018). A widespread concern in society is that AI will replace a majority of jobs performed by humans. A health app called Noom provides customized support to their clients in order to help them attain their health goals. From 2017 to 2019 the number of Noom's employees rose from 77 to 1100. That significant increase shows that AI can not only help to improve products and services, but also that AI can facilitate the creation of many new jobs (Lee and Yoon 2021).

The numerous benefits of AI are accompanied by a lot of risks and proves this technology to be a double-edged sword. Used responsible, it can improve our lives in many ways. Yet even AI generates business value and consumer benefit, it is also giving rise to umpteen risks and unwanted consequences which negatively affect individuals, organizations and society (Cheatham et al. 2019).

On an individual level, AI can be harmful in economical, psychological as well as physical ways. The underlying black box character is the root cause for unexplained actions the algorithm might perform, like unreasonably banning a client's credit card or unjustifiably accusing a person of a crime (Diakopoulos 2016; Dourish 2016). Further, physical threats arise through autonomous-vehicle malfunction, overreliance on inadequate equipment predictive-maintenance or the misdiagnose of medical conditions by machine learning models (Cheatham et al. 2019).

Another risk of AI is the unequal distribution of power. On the one side, governments and organizations have access to useful tools and resources like client data and highly developed technology. On the other side is the majority of society which does not have access to these powerful tools (Someh et al. 2016). 2016, Facebooks' CEO Mark Zuckerberg was accused of abusing his power when algorithms of the social media platform censored the photograph of the "napalm girl", a historic picture of a naked girl which is iconic for the Vietnam war. Another example is the use of automated bots on Twitter, Facebook, and Reddit during the 2016 U.S. presidential election and UK European Union Referendum, which interacted with users and promoted certain content and viewpoints (Mittelstadt 2016).

A further risk of AI are possible discriminatory effects. The below figure shows the results of a study about the COMPAS machine learning algorithm by *ProPublica* which is one of the most prominent cases about discrimination through AI. The algorithm is used by judicial systems in the U.S and supports judges in their decision making through assessing the risks of former prisoners to become delinquent again when released from prison. Figure 2 shows the error rates of the COMPAS algorithm and its discriminatory bearing. African Americans are almost twice as likely as white people to be labelled a higher risk but actually did not re-offend, whereas white people are labelled a lower risk yet did re-offend way more often than African Americans (Yapo und Weiss 2018).

	White	African American
Labeled Higher Risk, But Didn't Re-Offend	23.5%	44.9%
Labeled Lower Risk, Yet Did Re-Offend	47.7%	28.0%

Figure 2 - Disproportionate error rates, from Ethical Implications Of Bias In Machine Learning (Yapo und Weiß 2018)

The case of the COMPAS algorithm is just one of many examples of discriminatory effects induced by AI. The origin of the problem is the underlying bias due to bad data and lack of inclusivity. If a ML model is trained solely on data of a specific group, it is obvious that the result is less divers and might neglect certain groups with fewer occurrences in the training data (Yapo und Weiß 2018).

Further, the close relationship of big data and AI implies concerns about privacy and data protection. The processing of personal data by algorithms proves to threaten individuals' privacy, especially when it comes to analysing and predicting socio-economic aspects of individuals. A survey revealed that two thirds of Europeans expressed concerns regarding data security (Payne et al., 2015) and also the majority of Americans are worried about the use of their personal data by companies and governmental institutions (Auxier et al., 2019).

In the following, we will see that the benefits and risks discussed so far do not apply for a particular sector only but can be found in most common industries in which AI comes into use.

4.2. Benefits and risks per sector

4.2.1. Banking and Finance

Financial institutions are trying to change the way they interact with their clients or customers. One of the main benefits AI brought to these sectors is the way they interact with their clients through insights and advice, giving them a personalized experience to their needs and objectives (Tink 2021). This contributes to a better customer or user experience, increasing the probability of having a client staying for a longer time and recommending the services to its peers – more than 50% of bank clients think personalized experiences are drivers to trust the institutions. These technological mechanisms can speed up decision making when it comes to allow or not for a loan – risk assessment mechanisms and underwriting processes get faster with machine

learning algorithms since these can manage multiple data sources at the same time. This means a faster loan generation, and clients get happier in a shorter time (Deloitte US 2021). Also, regulatory reporting becomes easier, clearer, and more accurate with the help of AI. There is no need for a lot of manual interventions like mappings and reviews, regulatory changes will be easier to address due to the speed machines take in adapting and the quality of the reports increases (PwC 2020). Finally, fraud detection and anti-money laundering mechanisms are developed through machine learning techniques as well, preventing financial institutions to process illegal transactions and detect potential crimes. These are used to detect fraud patterns and do real-time analysis of movements to perform risk-monitoring (McKinsey 2020).

Regarding the risks, the amount of data collected by these institutions to create tailor-made products can make them breach privacy laws – if they hold the data for longer and for more purposes than the ones held in the contracts with the customers (Atkins e Luck 2021). Also, because of the huge amount of data collected, banks and other financial institutions get more prone to be victims of cyberattacks and information leaks. These algorithms are designed to help in decision making, and if they are not well done, final outcomes might be biased or not accurate. Financial institutions need to be careful when dealing with these outcomes and make sure that they are transparent, accurate and aligned with the culture and objectives of the firm (Deloitte 2018). If we say that personalized banking experiences might be a driver for increasing customer loyalty, the fact that there are fewer human interactions can be a reason to decrease that same metric, and therefore institutions need to look carefully at this – a few years ago, changing from one banking institution to another would be a high-cost process, while today, with the developments seen in AI, this is way easier and with increasing customer demand for good services these financial institutions will need to step up their game and provide reasons for their customers to stay around longer (Forbes 2019).

4.2.2 Healthcare

"An ounce of prevention is worth a pound of cure.", said Benjamin Franklin, one of the Founding Fathers of the United States of America, back in 1735.

One of the main benefits AI and robotics are giving to this sector is early detection of diseases such as cancer. The American Cancer Society says 12.1 million mammograms are done per year in that country, and the usage of AI is making review and translation 30 times faster and with an accuracy of 99% (Wired 2016). Diagnosis is also easier with the help of these algorithms. 80% of health data comes unstructured, making it hard to read, meaning that only 20% of the data is easy to read by computers (such as numerical data or records pre-organized by humans) (Healthcare Data Institute 2015). IBM developed Watson for Health, and this tool processes and stores far more data than any human, allowing for a quicker and more accurate diagnosis. Also, predictive analytics tools can inform and support clinical decisions and help doctors to prioritise tasks on the treatment (PwC 2017). AI may also benefit the treatment process for patients and help doctors manage the treatment plans – example of AiCure, a platform that helps people with long-term conditions to comply with their medications by visually recognizing the face of the patient, the medications it is taking and to confirm the success of the ingestion. It also offers virtual assistance to the patients and assesses the progression of conditions over time (Vasishtha 2018). Finally, it accelerates the process of putting medical solutions in the market. The California Biomedical Research Association estimates that it takes 12 years for a drug to go from discovery to the patients. With the help of AI, these processes last less, and drugs are becoming available in a shorter period (PwC 2017). Just look how fast the Covid-19 vaccine took from discovery to the market – the pandemic started in the end of 2019 in China, reached the rest of the World by the beginning of 2020 and by the 8th of December 2020 the first person in the UK received the first shot of the Pfizer

vaccine (BBC 2020). This is one of the great examples showing how can technology help the healthcare industry.

Regarding the risks, one that arises is data bias. Training AI models needs a huge scale of input health data, and if the data used for training does not fit to the population to which the solutions are being applied to. Insufficient or bad quality data can also lead to this bias (Sunarti et al. 2020). According to the same authors, there are privacy issues regarding the hold of sensitive health data – the privacy of the individual is an ethical obligation. Finally, we need look carefully for how these algorithms are built and how accuracy might not be a good indicator of performance. Imagine a program that aims at identifying if a tumour is malign or benign that has an accuracy of 99% – this means that for every 100 predictions, it gets 99 right. What if the one left is a malign tumour that is predicted as benign? The objective of this algorithm is to identify the bad cases, and not the good ones. Therefore, imbalanced classes must be looked after when dealing with these algorithms, and sometimes the technology will not be enough to make decisions.

4.2.3 Agriculture

Similar to the healthcare industry, AI can be used beneficially for the classification and prediction of crop diseases. Based on input parameters about the physical constitution of the plant, diseases can be forecasted and appropriate measures for prevention and recovery taken on an early stage (Tilva et al. 2013). Image processing coupled with an artificial neural network for example helps to classify seedling diseases (Huang 2007) or to detect the percentage of infection in leaves (Sannakki et al. 2011)

Further, rule-based crop management systems provide an interface for general management of all sorts of crops and give advice regarding crop selection, fertilizer application and pest related issues (Bannerjee et al. 2018).

Next to the monitoring of diseases and pests, the handling of harvested crops is also a crucial aspect of agriculture. Bannerjee et al. (2018) refer to various AI powered food monitoring and quality control mechanisms for the storing, drying and grading of harvested crops.

AI is also employed for soil and irrigation management. Rule based expert systems evaluate the design and performance of micro irrigation systems (Brats et al. 1993) or recommend crops depending on land suitability (Sicat et al. 2005). Further, AI is used for estimating soil moisture (Arif et al. 2013) and predicting rainfall using atmospheric inputs (Manek and Singh 2016).

Moreover, AI models are applied to predict crop yield, which is beneficial for estimating crop costs and developing marketing strategies (Bannerjee et al. 2018). Overall, such AI applications provide tremendous support in the decision making for farmers and create value in terms of enhanced crop yield, efficiency and environmental sustainability.

In terms of social sustainability, however, risks due to the dehumanizing character of AI arise. One thinks of driverless machines and other robots that increase the risk replacing traditional farmer jobs. In order to prevent social inequality, the ethics of AI need to be considered similar to other sectors and concerns over data privacy, transparency and unintended consequences of the technology require significant attention (Lakshmi and Corbett 2020).

4.2.4 Retail

Artificial intelligence has reinvented the retail landscape and is expected to continue that trend. AI is expected to boost wholesale and retail gross value by $2.2 Trillion by 2035 (Statista 2021).

The most notable area in which AI has brought great benefits to retail is the customer experience. AI-assisted conversational assistants help customers navigate questions, FAQs, and troubleshooting and redirect them to a human expert when necessary, improving the customer experience by providing on-demand, always-available support while streamlining staffing (Deb Marotta 2020). Chatbots, for example, can respond to many questions at the same time.

This is a lifesaver for companies with overburdened call centres and long wait times. It allows customer service departments to perform more, resulting in a better client experience (Salesforce 2021). Another significant benefit that helped retailers like Amazon become the behemoths today is AI's personalisation to retailing. Personalisation in advertising refers to the use of data or consumer insights to improve an ad's relevance to its intended audience. This can include information like demographics, interests, purchasing intentions, and behaviour patterns. Increasing the relevancy and personalisation of adverts is becoming a primary priority since it significantly improves the user experience and customer retention (IBM 2021). Customers can benefit from artificial intelligence in retail by making product discovery more straightforward as well. Customers may now take a picture of a product they like in the real world and use it to find an online store that sells it (Forbes 2020). Another central area in which AI can create significant benefits for retailers is in making operations more effective. AI can be utilised in forecasting, demand planning, assortment, allocation optimisation, and return optimisation in the supply chain. "When you are shipping billions of packages every year and working with tens of millions of products, you can't do it in that manual process," said Steve Gurney, head of worldwide general merchandise at Amazon Web Services (National Retail Federation 2021). Another area where AI has succeeded is in streamlining warehouse and in-store store operations. From the amazon robots that help Amazon employees in the packaging process in warehouses to in-store where using AI, shops can easily optimise their space and inventory. Existing consumer preferences, product location, season and weather conditions, expiration dates, and other factors are considered by algorithms to put shelves and products where visitors anticipate to find them intuitively (CHI Software Developmet 2021).

Nevertheless, AI does bring some disadvantages to the retail industry. For once, privacy violation and data abuse can destroy an organization’s reputation and customer trust. More than half of executives express "serious" or "severe" concern about AI's ethical and reputational

hazards in their firm. That means that developing an AI ethical risk program that everyone buys into is required before AI can be deployed at all. For companies that use AI, this must be a priority (Harvard Business Review 2021). Another risk is the replacement of the workforce. According to economists at MIT and Boston University, robots could replace as many as 2 million more employees in manufacturing alone by 2025. “This pandemic has created a very strong incentive to automate the work of human beings,” state Daniel Susskind, a fellow in economics (Time 2020).

4.2.5 Construction

The adoption of AI in the construction industry is quite low compared with other industries, even though it encompasses many possibilities and potential use cases. AI can be beneficial for optimizing project schedules and for enhancing project planning. I addition, image recognition and classification on work sites can identify and assess unsafe work behaviour. Moreover, analysed sensor-data can be used to understand signals and patterns in order to provide real-time solutions, prioritize preventive maintenance, reduce costs and prevent unplanned downtime (Bianco et al. 2018).

Automation can replace traditional manual observation, which usually tends to be time-consuming and prone to errors. In terms on safety, AI helps to detect and predict potential risks, not only on the construction site, but also when it comes to project management, streamline operations and budget planning. In addition, robots can deal with unsafe operations and replace humans in dangerous work environments (Bolpagni et al. 2021). AI can also amplify the efficiency of the construction execution process through new approaches like process mining. Repetitive routine tasks can be taken over by robots which work continuously without taking a break at almost the same quality and productivity (Pan and Zhang 2021).

Important to mention is the role of Building Information Modelling (BIM), which serves as a "[…] digital backbone to work with AI." (Pan and Zhang 2021, p.7). Through the collection of large amounts of data about all aspects of the project, real-time analysis can support to streamline the complex workflow, make processes more efficient and cut costs. In combination with AI techniques, computer vision promotes the understanding of data in images or videos and is used for the inspection and monitoring of complex construction tasks and structural conditions. It provides actional information about construction safety and can perform automated damage detection which leads to a safer work environment (Pan and Zhang 2021).

On the other side, the advantageous of digitalization are accompanied by the exposure to cybercrime and privacy intrusion with potentially huge economic and financial consequences. Examples of cyber threats in the construction industry include malware, social engineering and phishing. In addition, construction work is often conducted in unsecure environments. Small mistakes by AI can comprise the safety of construction workers and lead to life-threating accidents. Furthermore, the location of construction sites is often secluded and lack power and internet connectivity. However, AI mostly relies on good internet connectivity and power supply, which poses another threat to the usage of this technology (Abioye et al. 2021).

4.2.6. Hospitality

The hospitality industry is expected to reach USD 44.38 billion by 2026, and there is an urgent need to revolutionize it. The most promising approach is to invest more in AI technologies in the industry and therefore improve its customer service and experience, which they rely upon heavily. The hospitality industry has adopted digital technology long ago due to the significant amount of data generated. For hospitality specifically, AI's primary purpose is to explore and analyse guest data, aid in decision-making, and manage guests' complaints. Nevertheless, the industry could take more advantage of the use of AI and incorporate it into different areas within hospitality (Roy 2021).

The main benefit for the hospitality industry in adopting AI is that, by doing so, it can offer services that are somewhat more accurate, timely and efficient, when in comparison to relying solely on people's capabilities. Along with this is AI's ability to provide customers with better experiences aligned with their interests. This is feasible as AI streamlines processes, analyses them, and collects valuable data from different sources, therefore improving its recommendations. Another substantial benefit AI brings for hospitality is its ability to enhance customer profiles based on previous guests' history, preferences, and satisfaction, consequently generating a more loyal customer base (Qualetics 2020). Nonetheless, AI is also beneficial in the sense that it aids those working in the industry. Germany-based Model One has been testing a robot nicknamed Sepp to answer simple questions and deliver basic information to customers. IBM Watson was the mastermind behind Sepp's creation, and the robot is capable of understanding people's requests as well as learning new information. It can, for instance, provide weather information and let guests know at what time breakfast is served. Likewise, in Virginia, USA, Hilton has an AI member of staff. Like Sepp, robot Connie can provide helpful information to their guests and learn from its interactions. However, Connie's most impressive capability is its ability to make gestures, just as people do. IBM's Watson vice president and chief technology states, "When it is asked 'where's the elevator?', it says it's down the hall to the left while pointing down the hall to the left" (Fomby 2019).

Nonetheless, AI-driven robots are not the single domain in which AI is positively affecting the hospitality industry. In 2018, Avvio, a tech company, launched Allora, the world's first booking platform entirely run by machine learning. Traditional booking platforms are unsuccessful in delivering a personalized experience to their guests. Therefore, Allora consolidates multiple insights from different users and optimizes their experience by finding the best hotel and experience. The platform considers thousands of users' preferences based on geography, booking history, and other circumstances that impact the hotel selection (Allora 2021). A survey

done by the online platform Booking unveiled that 75% of guests prefer self-service options thus, making chatbots another great benefit of AI in the hospitality industry. Chatbots are capable of assisting with current reservations and answering common questions concerning hotel policies as well as transportation, changes in dates, check-in and check-out times and payments. Booking's chatbot is fitted to manage 50% of customers' "post-booking accommodation-related requests". If the chatbot is incapable of answering, the person will be redirected to a customer service member (Fomby 2019).

Despite all the great benefits that AI has delivered, there are still some risks concerning the implementation of AI in the hospitality industry. AI is still a very vast field, and although there has been significant development in recent times, the field is still very fresh, and AI is still developing. The previous vice president and AI leader of Google, Andrew Moore, even stated, "AI is currently very, very stupid". In fact, the term AI Stupidity is used to illustrate AI's inability to make sound decisions by only relying on the data that is available. As AI is based on human input, people are likely to provide inaccurate or biased data, thus leading to inaccurate or biased decisions. Additionally, businesses are further concerned about data privacy issues. Despite it being mandatory to follow data privacy laws and their ethical use, data collected during user interactions could be gathered for devious reasons. Hence, there is a significant risk of violating data privacy. However, if businesses were to obey every law and regulation, AI could become a significant source of competitive advantage (Fomby 2019). Likewise, data privacy issues are also a concern for customers. Many are reluctant to rely on information delivered by AI-based technologies completely, as the provided data depends on the program's quality and algorithms that make the technology work. Therefore, many customers will continue to seek human help, even when the required information is available (Roy 2021).

Another liability for implementing AI in the hospitality industry is that this type of technology is expensive to implement and costly to maintain. While technology is more easily attainable

and there are several options available, most hospitality businesses may not have the budget to invest in AI-driven technologies, thus causing them to lose their competitive advantage (Koo, C. et al. 2021). Finally, the most pressing risk of implementing AI in the hospitality industry is unemployment. Most people believe AI will replace humans due to new developments in technology. Workers in the hospitality industry are fearful for their jobs and anticipate AI will take over the more obsolete tasks, thus leaving many unemployed. A study developed by McKinsey Global Institute reveals that intelligent robots will replace 30% of the world's working population by 2030. Given the many different tasks that require minimal effort in hospitality, it is likely that most people will no longer be required and will, in fact, be replaced by some AI technology (Bughin et al. 2018).

4.2.7 Industrial Products

According to a Deloitte poll on AI adoption in manufacturing, 93 percent of businesses believe AI will be a key driver of growth and innovation in the industry (Deloitte 2019).

Artificial intelligence has, in many ways, revolutionised the industrial product industry. For instance, with the introduction of autonomous industrial robots, production improved significantly. Production can now be operational 24/7, while human beings need rest and regular maintenance. Robots do not get tired or hungry, and they can operate on the assembly line 24 hours a day, seven days a week. This enables the growth of manufacturing capacity, which is becoming increasingly essential to fulfil the expectations of global consumers (Rowse 2019). Additionally, robots are more efficient overall. Artificial intelligence technology ensures that products satisfy the necessary quality and regulatory requirements. Manufacturers can accomplish this by incorporating AI technologies such as machine learning and big data into their equipment, such as tracking sensors (Global Trade 2020). Safety is another topic that AI significantly improves in this sector. Humans are prone to making mistakes and are fallible. Errors and mishaps happen on the factory floor and in any building or processing setting; this

is a problem that AI and robotic aid can almost completely eliminate. Furthermore, remote access control necessitates a reduction of personnel, mainly when the activity is hazardous (Rowse 2019). AI also enables factories and industrial complexes to minimise operational costs.

According to Deloitte, manufacturing is predicted to generate 1,812 petabytes (PB) of data per year, outnumbering communications, banking, retail, and several other businesses (Deloitte 2019). Consequently, it can use and develop predictive that programs aid the sector in multiple stages of the business. For example, Data is collected in real-time to monitor the state of equipment in predictive maintenance scenarios. The idea is to uncover patterns that can assist forecast and ultimately prevent failures; AI systems are increasingly being employed to achieve this goal using learning algorithms. Plants can be more strategic when analysing equipment state and anticipating when maintenance should be conducted when predictive maintenance is automated (Stefanini Group 2020). Additionally, producers might synchronise production schedules to increase output. According to a report by McKinsey, an AI predictive maintenance model can boost productivity by 20% (McKinsey 2017). It can also save up to ten percent on maintenance costs. Aside from production, AI plays a vital role in other sectors of manufacturing. Distribution and supply networks, monitoring, customer behaviour, and changing patterns are all examples. As a result, AI in manufacturing ensures that businesses can anticipate market shifts. They can then strategize for better manufacturing and other cost management processes with this information. Manufacturers can also utilise AI algorithms to forecast market demand (Global Trade 2020).

Nonetheless, it also does have its disadvantages and challenges. First, the costs of implementing and maintaining artificial intelligence are substantial. For small businesses and start-ups, the budget is often prohibitively expensive. Even while artificial intelligence reduces labour costs, installation, and maintenance costs (Global Trade 2020). Another disadvantage of artificial intelligence is that it is vulnerable to cyber-attacks. According to a recent World Economic

Forum research, cyber-attacks are among the top five global stability threats (World Economic Forum 2019). For any manufacturer who uses AI software, this kind of information might be frightening. Finally, the scarcity of talent and expertise. Because these technologies necessitate complex programming frequently, it is critical to factor in expert availability. Furthermore, because such hands are in high demand, the cost of hiring them will be expensive. “Demand for workers with AI talent has more than doubled over the past three years, with the number of AI-related job postings as a share of all job postings up about 119%.” (Indeed 2018).

5. Investment in Artificial Intelligence

5.1 Investment in Artificial Intelligence

Artificial Intelligence changed and reshaped the behaviour of most companies, among it also on their investment approach and strategy. It is important to mention that the aspect of investments into AI must be divided into two segments: one the one side investments are conducted internally, therefore focusing on establishing and implementing own concepts through recruitment of personnel and purchase of assets. On the other hand, investment of AI is conducted through funding, Mergers & Acquisitions, or strategic funding’s in external companies, that serve as an asset, to amplify the product portfolio or as a value addition to existing technologies and processes. The following part will analyse different aspects of investment activities within AI industry, focusing on the internal investments that companies have conducted and on differences between external investment throughout the last decade.

5.2 Overall Information of AI Investments

IDC research in 2021 have estimated a global investment value of almost 342 billion USD only in 2021, forecasting further growth in the upcoming years by breaking the 500 billion USD mark until 2024. Mayor part (88%) relate to spending’s on AI based Software, followed by expenditures in AI based hardware (Needham 2021). Within the industry, investments for “AI

services" show the fastest development as it is forecasted at a CAGR (Compound Annual Growth Rate) of 21% and a total market volume of 50 billion USD by 2025 (Kenyon 2021).

Throughout the last 10 years, companies' investment in the own AI structures, processes and human resources have increased drastically as strong raising revenues of AI Enterprises indicate (Columbus, Forbes 2018). Whereas majority of companies had to make large budget cuts for operations during the Coronavirus Pandemic, investment in technology and mainly in AI were maintained or even increased over time (Kark, Gill and Smith 2021)· Gartner Research data of 2020 indicate that 66% of organizations decided to actively fund new and existing AI related approaches to enhance "[…] customer experience […], retention, and revenue growth – along with cost optimization […]" (Stamford 2020) i. Moreover, 50% of companies of the Life Sciences, Energy, Retail Consumer Products, Telecommunications, Government and Automotive industry stated that they are "[…] progressing their AI efforts as planned or even quickened the pace of deployments" during the economic shutdown caused by COVID-19, indicating the overweighting benefits generated by AI based approaches (Liu 2020).

Based on OECD research of "Venture Capital Investments in Artificial Intelligence", the AI industry is one of the most prosperous industries throughout the last years by growing an average of 34% Year to Year and being responsible for almost 75 billion USD in VC (Venture Capital) investments into AI companies alone in 2020 (Tricot, OECD 2021). Investments in US and China based companies are responsible for almost 80% of the monetary value of the investments creating an enormous gap towards the EU27 countries that represent an aggregated 9% of total investment volume. Not only has the amount of investment grown over the years (from 500 in 2021 to almost 3900 in 2019) (Tricot, OECD 2021), but also the average ticket size per each investment as it almost doubled in most of the regions. Moreover, changes can be identified in the average ticket size between 2012 and 2020. The amount of tickets with a size of 10 to 100 million USD per investment has almost been doubled, whereas as strong decrease

(-17%) in investment tickets bellow 1 million USD con be recognized (Tricot, OECD 2021). Reason for such development is connected to changes in the approach towards start-ups, as the aspect of long-term growth and maturation through large amounts of cash to finance their operations is accepted.

Furthermore, Crunchbase studies indicated that since 2000, investments in AI related companies have increased up to six times, making it one of the fastest growing industries (Columbus, Forrbes 2018). Further information from the OECD reports indicates that in 2020 over 20% of the overall investments conducted by Venture Capital are related to an AI focused company (Tricot, OECD 2021). Enlarged investments are mainly related to potential high return of investments due to the growing demand on customer side and constantly developing technological market standards.

5.3 Leading Investment Companies & Major Investments

Most of the leading successful Venture Capital companies are based in the US and evolve companies such as Sequoia Capital, Y Combinator and Andreessen Horowitz. GlobalData announced Sequoia Capital as the most successful VC investor in the AI space in 2020 by having participated in 52 deals and investing over 400 million USD in 2020 alone (GlobalData 2021). The market is heavily disputed as market giants such as Meta Platforms, Amazon or Alphabet Group have also increased their efforts by acquiring and strategically investing in emerging companies with high technological standards. Google, nowadays Alphabet Group, are the largest investors among the leading technology elite by having acquired over 30 AI start-ups and having spent over 4 billion USD (Hurst 2020) on M&A activities since 2009. Among their top investments, the acquisitions of DeepMind in 2014 for over 500 million USD (Shu 2014) and the acquisition of Onward. Objective of the investments was to elevate the quality of the offered services by automating their processes and improving the customer experience on the respective platforms. Facebook, nowadays Meta Platforms, have acquired AI based

companies such as AI.Reviere (Wiggers 2021), Bloosbury AI (for 23-23 million USD) (Ha 2018) and Scape Technologies (for 40 million USD) (O'Hear 2020) to improve their existing NLP, Machine Learning and Virtual Recognition services (Shu 2014). Such investments by large entities have proofed that certain know-how and human resources can only be obtained by acquiring smaller markets players, driving companies values to higher dimensions.

The traditional bootstrapping, therefore, the financing of future operations with own capital (Kenton 2020), is not a common practice among most AI start-ups, due to enormous costs connected to human resources, hardware, and license fees for software. This creates the opportunity for other type of investors such as Business Angels and Early-Stage investors, which gained on popularity throughout the last years within the AI industry. Among the successful Early-Stage investors Venture Capital companies such as Y Combinator or M12 can be found, which focusses on funding tickets bellow 50 million USD (GlobalData 2021).

It is important to differentiate by the final purpose of the investment. The activities of larger companies mostly tend to improve the already existing technology behind the own products, whereas the investment activates of smaller and medium sized companies also aims to expand the product portfolio.

On the one hand, this can be seen in large deals such as the acquisition of Nuance by Microsoft in 2021 (Baker, Porter and Dina 2021). The company was acquired for almost 20 billion USD to improve Microsoft conversational AI focused platform with its cutting-edge NLU (speech and text recognition) and NLP technology. Not only the Tech Giants have shown interest in the emerging industry, as for example players such as Panasonic acquired the supply chain-based company Blue Yonder in 2020 for 7 billion USD (Blue Yonder 2021). The electronics provider aims to "[…] aim to optimize the overall supply chain not only within single companies but also across companies." (Panasonic 2021) An additional deal enhancing the strategy of

acquiring external companies to improve the own product performance can be identified in the Zoox acquisition by Amazon in 2020. The E-Commerce giant acquired the autonomous driving system for 1.2 billion USD to accelerate own developments for autonomous delivery vehicles with the objective of solving the last-mile issue and cutting mayor cost of delivery (About Amazon 2020).

On the other hand, the diversification of the portfolio can be seen in a company such as Zebra Technologies. The Illinois based designs, manufactures, and sells automatic identification and data capture products and amplified its product portfolio by acquiring Antuit.ai in 2021 (SupplyChainBrain 2021).

With Antuit omni-channel approach, Zebras Technology will be able to offer the services through new channels, increasing the value for its customers and their end-customers. Moreover, Ipsos also present a similar approach based on the most recent acquisitions of the companies Infotools (IPSOS 2021), Synthesio (IPSOS 2018) and Intrasonics (IPSOS 2021) for over 60 million USD through the last three years. In results in an expansion of services by acquiring players that focus on social media and audio, therefore implementing new sources of data to complement the conventional approach of the French market research company. An additional example consists in the MarTech (Marketing Technologies) leader Hootsuite. The Canadian company offers a unified solution of Social Media and Marketing Management, unifying different services of the industry. With the recent acquisition of HeyDay!, a conversational AI provider, for 60 million USD, Hootsuite plans to expand its operation into also helping its client automize its communication towards end client by using state of the art Natural Language Processing and Natural Language Understanding systems (Hootsuite 2021).

5.4 Investment per Industries

Based on the high penetration of the adaption of the digitalization by the beginning of the 20th century, it can be assumed that majority of the nowadays known industries are able to implement AI approaches. The industries differentiate by the degree of implementation of AI approaches, therefore also defining the scope and value of the companies with AI based solutions. It is important to state that the AI industry it's an industry itself, yet the usability of it is always connected with other industries.

Based on OECD research of "Venture Capital Investments in Artificial Intelligence", industries indicate strong differences in terms of ticket size and popularity during the timeframe of 2012 and 2020. In quantitively numbers, the industries of IT infrastructure and hosting (2012-2020: 4063 deals = 19.8% of all deals), Media/Social Platforms/Marketing (2012-2020: 3351 deals = 16.3% of all deals), Business processes and support services (2012-2020: 2944 deals = 14.3% of all deals) and Healthcare, drugs, and biotechnology (2012-2020: 2545 deals = 12.4% of all deals) are the largest industries up to today (Tricot, OECD 2021). When comparing with the aggregated total value of all investments between the timeframe of 2012 and 2020, changes can be identified. The industry with the highest investment is the "Mobility and Autonomous Vehicles" industry, accounting for over 29% of the monetary value of the investments since 2012, yet slightly decreasing during the last years. Surprisingly none of the before mentioned industries are equalling the relative amounts of deals with the relative monetary value of the investments: IT infrastructure and hosting = 10% and steady performance of the years, Media/Social Platforms/Marketing = 11%, decreasing performance over the years and even reaching 6% in 2020, Business processes and support = 11% and steady performance of the years and Healthcare, drugs, and biotechnology = 10% and increasing performance of the years (Tricot, OECD 2021).

High investment in the Mobility and Autonomous Vehicles are connected to the factor of high cash burn and low margins. The large AI-based transportation services such as Uber, Bold, Lyft and Didi received additional mayor cash injections to compensate the extensive cash burn during the initial phase for their operations, technology assets and marketing spending's (Lehtonen 2021). In addition, Googles' autonomous car manufacture Waymo had an impact by raising almost 2.5 billion US in a second external investment round in 2021 (Alamalhodaei 2021).

5.5 Investment by Geography

When analysing the source of the investment related activities a very homogenous distribution among different regions can be identified. Mayor origin of deals is connected to the US and China, as they account for almost 72% of all closed deals between 2012 and 2020, accounting for almost 80% of the monetary value of the investments (Tricot, OECD 2021).

When comparing the US to China, US takes the clear role as the more active investor as they account for 174 billion USD in investments during the period of 2012 and 2020, accounting for more than 50% of all VC investments over this period. Throughout the years, China, and other countries such as UK, EU27, Japan and Israel started to increase the amount of investment, yet the American VCs still account 43% of all total investments in 2020 (Tricot, OECD 2021). EU27, mainly due to the investments from German and French VCs, performance throughout the years had a positive performance, as all countries increased the aggregated amount of invested money to a total of 7 billion USD and a total participation in 800 deals in 2020 (Tricto 2021).

It is important to differentiate between the factor of origin of the investing VC and the origin of the to be invested company. When comparing the activities on national terrain, China represents 70% of the investments in local firms, whereas the US only accounts for 60%. Mayor

differences can be identified when it comes to investment outside the own country, as the US based VCs account for almost 20% - 24% of the globally conducted investments, excluding themselves and China. In comparison to this, China, accounts for only 5% of the globally conducted investments, excluding them itself and the US. This big difference indicates that the efforts from China are mainly focused on investing locally. Moreover, the investment landscape in China changed due to foundation of government-led incubators and the raise of strong Chinese technology firms such as Alibaba, JD or Baidu (Tricot, OECD 2021).

5.6 Investment Trends in the AI Industry

The heavily increasing investments throughout the whole world strongly indicate a prosperous future for the industry. Yet, as presented in 1.3 and 1.4, certain industries have experienced a decrease in demand, influenced by the geolocation or the change in customer requirements.

Assessing future trends in the AI industry can be approached from different perspectives, as it can be analysed from an industry point of view or on a more technological point of view.

When performing an analyse of the industry point of view, industries such as the Mobility and Autonomous Vehicles will continue growing due to the raising demands for cars working based on renewable energies and the constantly increasing fuel prices caused by limited natural resources.

When performing an analyse of the technological point of view, three mayor trends will be the main challenge according to the Yang Lu from Antai College of Economics and Management, Shanghai Jiao Tong University: development of platforms, algorithms, and interfaces (Lu 2019). According to Professor Lu, future developments should focus on creating platforms that can perform at a higher level, therefore processing larger amount of data in a shorter time. Such requirement is closely connected with Hardware AI providers such as NVIDIA, Intel or Google that are already working on next generation (GPU = Graphics Processing Unit instead of CPU

= Central Processing Unit) devices to fulfil those demands. In addition to this, platforms shall develop own approaches to combat increasing to prevent malicious processes and threads, making them event more secure against Cybersecurity related issues (Doshi-Velez and Kim 2017). Yang Lu indicates that the future development of the algorithms should aim changing from an “artificial intelligence” towards an “humanoid intelligence”, therefore preparing algorithms to adapt to changing circumstances in the social world and combine it with the material world (Lu 2019). Last but not least, the development in regards of the interface should combine the factor to a very elaborated and professional back end with an user friendly front-end to prevent any kind of usage problems on the platform and therefore also decrease unnecessary expenses on Customer Support.

6. Adoption State of Artificial Intelligence: A SaaS Perspective:

6.1 Introduction

The adoption of AI has been growing significantly in the past decade, and the pandemic boosted this process considerably. According to IBM's Global AI Adoption Index, nearly a third of IT professionals polled claim AI is being used in their company. Furthermore, due to the COVID-19 epidemic, 43% of firms said they had expedited their AI rollout (IBM 2021). At the same time, the software as a service (SaaS) market is growing noticeably and is becoming an ever more popular way of companies adopting new technologies, including artificial intelligence. This section aims better to understand the current state of adoption of this technology, how it is in the broader market, how it is in the SaaS industry, how they differ and what this may indicate for the future**.**

6.2 Background

Software as a service, or SaaS, is one of the three main categories of cloud computing and the most common with consumer-level products together with infrastructure as a service (IaaS),

platform as a service (PaaS) and artificial intelligence as a service (AIaaS). The "as a service" translates to over the Internet, so SaaS is a third-party application available over the Internet with no physical connection to any one device. Salesforce defines SaaS as "a way of delivering applications over the Internet—as a service. Instead of installing and maintaining software, you simply access it via the Internet, freeing yourself from complex software and hardware management" (Salesforce 2021). SaaS extends the Application Service Provider (ASP) model idea. The basic concept of an ASP is similar to that of SaaS in that it provides computer-based services across a network. However, unlike SaaS, which is self-service, the ASP model required the vendor to create each login and environment manually. SaaS first appeared at the beginning of the century when Salesforce, in 1999, first launched its customer relationship management (CMR) (Big Commerce s.d.). SaaS covers a wide variety of industries. There are SaaS for a wide range of corporate functions and fields. For instance, there are services for financial management, customer relationship management, marketing management, human resources, and much more. However, SaaS also has a significant presence in customer-oriented services. Most of the apps that most use daily are SaaS, such as email providers, video conferencing apps, zoom and teams, and productivity apps like Microsoft's Office 365 apps. SaaS also embraces entertainment services like Spotify, Netflix, Disney Plus and many others. SaaS leading players are also prominent companies globally, like Netflix, Microsoft, Salesforce, Google, SAP and many more.

The SaaS market has grown substantially and is expected to continue the same trajectory for the future to come. Since 2015 end-user spending in SaaS has grown 447%, from $31.4 Billion to $171.9 Billion (Statista 2021). Furthermore, according to MarketWatch, "The SaaS market is anticipated to grow at a compound annual growth rate (CAGR) of 21.20% during the forecast period 2018-2023" (MarketWatch 2021). In the beginning, SaaS was thought to be solely for start-ups and small businesses, as it was slow and unreliable. However, that is not the case

nowadays. With time the services became of excellent quality and reliability with all types and sizes of firms using SaaS. BMC software expects that by the end of 2021, 99% of organisations will be using at least one SaaS solution, and nearly 78% have already invested in SaaS options (BMC 2021). In addition, a Statista study shows that 38% of organisations claim that SaaS is extremely important in helping organisations realise their business goals. In comparison, 35% say that SaaS is quite important in assisting organisations in accomplishing their business goals (Statista s.d.). Additionally, the symbioses of AI and SaaS have also been growing with the popularity of AIaaS. As a result, off-the-shelf AI solutions are being adopted by a wide range of industries. According to industry analysts, global AI software revenue — the majority of which is online artificial intelligence as a service software (AIaaS) — is expected to rise at a staggering 34.9 % per year through 2025, with the market exceeding $100 billion (OMDIA 2020).

7. The State of Adoption of Artificial Intelligence

7.1 The state of Adoption of Artificial Intelligence

To get a complete overview of the current state of adoption of AI, both from a general and from a SaaS perspective, two different methods were used. Firstly, secondary data analysis was conducted to outline the general state of adoption. Secondly, a series of interviews were conducted to get a better view of the experience of specialists in this industry. Comparing the secondary data with the interviews allowed for a better and fuller indication of how these two perspectives might differ and what it may imply for the future regarding the SaaS role.

Those interviewed were current employees of companies that offer software as a service or specialists in the area, such as analysts from technology research and consulting companies. The companies targeted were companies that provide software as a service and use directly or indirectly artificial intelligence in the respective services. The firms ranged from small start-

ups still in the development stage to big established corporations that are already market leaders and valued well above the billion-dollar mark. They also varied in type, from marketing and consumer targeting companies, financial fraud to software development companies. The interviews tried to get an international outline. Even though most experts interviewed worked for Portuguese firms, most are international companies that have clients and offices all around the world. This variety of companies allowed a broader and more ample understanding of the state of adoption from the perspective of the SaaS industry. Interviewees include employees from companies like Outsystems, Feedzai, Gartner, Unbabel and others. The interview targeted different topics such as the forces or reasons that drove companies to adopt and those that made companies either sceptical or worried about adopting and some misconceptions that may exist in the process. It also tackled the difference between firms of different sizes and types about their openness to adopting AI.

7.2 The State of Adoption

The first aspect of the state of adoption that will be analysed is an overall overview of the state of adoption in the general market. The topics analysed will be the current rate of adoption, where businesses are on their AI journey, which subsets of AI have the most demand and which sectors are investing the most, giving an idea of each sectors openness. Afterwards, there will be an examination of the different forces or reasons driving or preventing the adoption of AI.

7.3 Overview of the state of adoption in the general market

According to IBM's Global AI Adoption Index 2021 report, as a result of the COVID-19 outbreak, 43% of companies have increased their AI rollout (IBM 2021). The same report states that 74% of companies are exploring or deploying AI, 43% are exploring AI solutions, and 31% have already deployed AI-based solutions (IBM 2021). In the same report, IT professionals, when asked about their company's current position in their respecting AI journey, claim that

they have taken the following steps to investigate or use AI in their business operations: 34 % say their organisation is analysing data in order to build and scale AI, but no AI projects have been implemented. The organisation is now adopting pre-built AI applications such as chatbots is at a rate of 31 %. Twenty-seven percent stated that their company is developing proofs of concept for specific AI-based or AI-assisted projects. Twenty-four percent are looking into AI solutions, but we have not acquired any tools or apps yet. Finally, at a rate of 21%, claim that the company is using AI across the board (IBM 2021). The AI investments allocated by firms in the past 12 months have been earmarked in areas such as Data security (31%), Automation of processes (25%), Customer care (25%), virtual assistants/ Chatbots (25%), Business process optimisation (19%), Fraud detection (16%), and many others (IBM 2021). According to Corinium's What is driving AI adoption, the most in-demand or requested subset of AI is with a significant majority machine learning, with 90% of the respondents showing their interest in this technology. Another highly requested subset, with 75%, is automation technologies. After these two subsets, popularity decreases substantially, with subsequent popular subsets in demand being deep learning (32 %), computer vision (28%), neural networks (24%) and at last, chatbots (22%) (Corinium 2021).

7.3.1 Maturity

According to an O'Reilly survey, when speaking of the industry that uses AI the most, computers, electronics, and technology, predictably, topped the list with 17 % of respondents. In addition, the industries that use AI the most include financial services (15%), healthcare (9%), and education (8%). Conversely, very little use of AI was found in the pharmaceutical and chemical industries (2 %). Similarly, only 2% of respondents work in the automotive business, even though AI is vital to upcoming goods like self-driving cars. Finally, public utilities accounted for 1% of respondents, while the energy business accounted for 3% (O'Reilly 2021).

Maturity varies from industry to industry, while geography does not significantly influence AI maturity. When it comes to AI maturity by industry, the difference is more apparent (O'Reilly 2021). Financial services (38 %), telecommunications (37 %), and retail (40 %) had the highest percentage of responders indicating mature processes among the top eight industries. Computers, electronics, and technology came in fourth place, with 35% of respondents reporting mature processes, although having the most responses. The laggards were education (10 %) and government (16 %). Manufacturing (25 %), defence (26 %), and media (29 %) were all in the centre, as well as Healthcare and life sciences at 28 % each. On the other hand, when it comes to industries considering AI, education is at the top of the list (48 %). Respondents in government and manufacturing appear to be further ahead, with 49 % and 47 % in evaluating AI, respectively, indicating that they are working on pilot or proof-of-concept projects (O'Reilly 2021).

7.3.2 Size

Openness to adopt AI is an aspect that appears to be correlated to size. Larger organisations are about 70% more likely than smaller companies to actively implement AI in their business operations (IBM 2021). SMEs lag behind major companies in implementing data analytics. In 2018, big data analytics usage in firms accounted for 34.1 percent, 18.8 percent, and 10.6 percent of large, medium-sized, and small businesses in OECD nations, respectively. National researches and data also point to an SME gap in AI implementation. Studies from countries like Korea, Denmark and Canada have shown that more prominent firms are ahead in adopting and implementing AI and data analytics (OECD 2020).

However, this correlation between size and openness seems to be reversed in the SaaS industry. According to the specialists interviewed, smaller firms may have the edge regarding openness to adopt AI, even though size may not even be the main factor. Firstly, smaller firms have significantly more agility and less inertia when adopting new technologies, including AI.

Bigger firms have additional barriers in adopting new technologies due to the long and complex processes present within the firms. Because of the magnitude of their operations, more prominent corporations tend to have long and perplexing processes for alterations in their structure or processes. As a result, adopting technologies, like AI, that have the objective of optimising processes and structure but do require a significant change to the same usually have a substantial amount of inertia. Smaller firms, on the other hand, do not have these complex processes making the eventual adoption more direct and more uncomplicated. Another feature that makes smaller firms more open is their appetite to try new things and willingness to take risks that big firms do not and sometimes cannot afford. Nevertheless, more prominent firms do have a significant advantage in adopting new technologies, the resources. Larger companies not only have the financial capabilities but also have the people necessary to develop such projects.

The characteristic that most experts claim is the fundamental factor when it comes to a company's openness to adopt AI is culture. Culture is the aspect that truly defines how open a firm will be to adopt AI, more specifically, the young and modern culture of innovation. This culture is usually associated with smaller companies, primarily because smaller companies are usually newer firms that were already born in this digital era, an era when AI was already something normal. These newer companies are more willing to take risks and usually have a culture that is more inclined to innovate. Nevertheless, this culture is not exclusive to smaller companies, but as a rule, it is a characteristic that is related to newer and smaller companies.

7.3.3 Adoption Drivers

Another crucial aspect is the factors driving companies to want to invest, adopt and eventually implement AI. According to 50 percent of respondents in 2020, providing a better customer experience is one of the significant reasons for AI adoption in enterprises. Furthermore, the potential for increased staff productivity was the second most important business consideration

for AI adoption among businesses, according to 47 percent of respondents. This is followed by accelerate innovation (45 percent), speed of new product development (45 percent), higher competitiveness/ market share gains (44 percent), improve risk management/amelioration (42 percent), drive top-line revenue growth (38 percent), and higher margins (37 percent) (Statista 2021).

According to the interviews, similar reasons and forces are experienced in the SaaS industry. According to the experts, there are principally three reasons driving AI adoption: The use of AI as a differentiator and as a way of improvement of products or services, the improvement of internal processes, and, unfortunately, just for PR (Public Relations). The latter is the main wrong reason that drives companies to adopt AI. It is also the one that leads to a failed adoption and integration of the technology due to the lack of vision, strategy and know-how. Using AI as a way of improving the product or services is the most common reason specialists in the SaaS industry see driving firms to adopt AI. This is true for both SaaS companies and their respective clients. The truth is that AI allows for a more efficient and versatile way of analysing a lot of the components of a business. This is quite clear in SaaS companies that work in sectors like financial fraud detection and customer targeting. Prior to the use of AI, the detection of fraud and the target of customers was based on rules, for instance, any transaction above a particular value in a store that the customer never shopped in was not cleared, and the payment was cancelled. This leads to a substantial amount of false positives. AI allows for more efficient detection of frauds by learning from the historical data. This allows for fewer false positives, which translates into a better user experience and subsequently into a better service or product.

The other common reason that leads companies to adopt AI is the improvement of internal processes. The use of AI can have significant benefits on both top-line and bottom-line tasks like marketing and sales, as well as operational functions such as supply chain management and manufacturing. A good example is how AI has been used in FP&A (Financial Planning &

Analysis). FP&A is an area in the financial department that performs important corporate decision-making budgeting, forecasting, and analysis. AI significantly enhances FP&A forecasts and projections. FP&A teams work with massive datasets drawn from across the company daily, and more data leads to better forecasts, but only AI has the speed, accuracy, and granularity to handle today's data volumes. Furthermore, AI also allows teams to have more time to think strategically and examine new prospects since it takes on and speeds up the tiresome process of searching for faults and discovering exciting trends. Which also boosts the confidence of FP&A teams in their work and results.

7.3.4 Adoption Barriers

In the same way that there are reasons driving AI adoption, there are also barriers preventing the adoption of the same. AI adoption can be a challenging and expensive process, which leads companies to put off its adoption and implementation to its operations. According to a paper by the Harvard Business Review, there are mainly three reasons making adopting AI difficult and expensive, the small datasets, the cost of customisation and the gap between proof of concept and production (Harvard Business Review 2021). Engineers at a consumer internet company with millions of customers have millions of data points from which their AI may learn. However, dataset sizes are substantially smaller in other industries. Methods used for big datasets with dozens of millions of data points do not work with small datasets. Complementary AI talent is a commodity that has increased in demand considerably in the past few years. "Demand for workers with AI talent has more than doubled over the past three years, with the number of AI-related job postings as a share of all job postings up about 119%." (Indeed 2018). This increase in demand led to a lack of AI talent available that, as a consequence, made capable AI talent expensive. Thirty-five percent of corporations state that one of their main challenges with cognitive technology is that they cannot get enough people with expertise in this technology. Other 40% claim that technologies and expertise are too expensive (Deloitte 2017).

The last obstacle was the gap between proof of concept and production. AI can take significant time between working in the lab and being fully operational in production. Occasionally it is expected that a few months, sometimes years, is needed between proof of concept and being deployed.

The SaaS experience is aligned with the barriers just mentioned. The most commonly mentioned reason is the lack of talent and expertise mentioned previously. The increasing popularity of AI and ML has led to a boosted demand for AI talent, which has become a rare and expensive commodity. The high demand not only means that it is hard and expensive to find and hire talented and capable people in the AI/ML field, but it is equally hard to keep the existent talent. Another factor driving firms away from AI is the complex implementation of adopting this technology. It is not a simple process and can lead to significant changes to the company's structure and processes. Change like having to rebuild teams to incorporate data analytics, to implement a new data culture that will affect a wide variety of processes, and also changing old processes that have been embedded in the firm, like transitioning from paper to digital. These changes can result in extensive change, demanding adaption and high financial commitment. Justifying the financial investment is also a challenge, according to the experts. Because it is a complicated process and requires a specialised skill set, the cost of adoption can be high and, in some cases, may prevent corporations from adopting AI. Another key barrier is the lack of data. As mentioned before, in order to build a proper AI program, a fair amount of good data is required, so as to have this data, it is necessary to have a data culture within the firm previously. When there is a scarcity of data culture, and consequently, a lack of data, this barrier can be especially problematic to develop AI programs properly.

Another major problem associated with AI is that a lack of education and knowledge on the subject can lead to misconceptions regarding what AI is or what it can do. There are four main misconceptions that the specialists interviewed most frequently encounter. The first one is the

idea that all messy data can be figured out by AI algorithms. Because "garbage in, garbage out" applies to AI, teams working with complex data cannot rely on a black-box AI algorithm to solve their problems. Companies must realise the importance of data, the investment of good practices regarding data and data collection. Firms have to invest in data strategies at the top and throughout the firm. Secondly, the investment in AI has to start on small things, and it is a strategic long term investment, do not expect to get immediate results in the first quarter after the implementation of AI. Another misconception is that companies should just throw AI at the problems, that AI will solve any problems. Companies have to realise that AI is a tool that can solve a problem in a more holistic solution. AI is not a solution is a tool. Finally, companies should not apply AI wherever. In order to adequately adopt AI, firms need experts in their firms. AI is an area that needs specific practices, technologies and expertise. Other honourable mentions include the fear of letting machines decide for people, the scepticism that comes from the hype around this technology and the lack of a strategic view and applicability of use cases.

8. Conclusions

The state of adoption gives a good summary of how, where, and why AI is being used or not. From this overview, a few indications of what the future of AI may bring and what role SaaS may have in that future. These will be the topics addressed in this section, what the current state may mean for the future and what role SaaS will take.

8.1 Indications from the Current State

With the popularity and adoption rate of AI increasing considerably, an aspect that is bound to change is its use as a differentiator. Nowadays, it is common for companies to adopt and use AI to differentiate themselves from the rest. However, this will not be the case for the future, at least for more ordinary AI. With the adoption of AI exponentially increasing every year, AI in most industries will become the norm. As a result, the standard of services and products will

pass by incorporating AI. This will mean that AI will be mandatory to not become a laggard within specific industries. Of course, AI will still be used as a differentiator in specific cases of highly advanced subsets or technologies of the field, but generally is most likely to become the standard rather than a differentiator.

Another aspect that will most likely change with time is the barriers. With time and the development of AI, and the increase of the pool of talent, most current barriers of AI will disappear and be substituted with others. For example, with due time and further developments in the AI field, AI will become cheaper and more accessible, knocking down today's financial barrier. Another barrier that will be surpassed is the absence of talent; with AI's growing popularity and success, the AI pool of talent will undoubtedly increase significantly, making AI talent affordable. Nevertheless, this does not imply that there will be no barriers, new challenges are bound to surge, maybe more on the legal side of AI, with increased politics on data protection, and AI audits.

8.2 The Role of SaaS in the Adoption Of AI

In many ways, SaaS can resolve most barriers that companies face in the journey of adopting AI. The first barrier it takes down is the lack of ability to adopt the technology; this is more present in SMEs. SaaS makes adopting AI or analytics easier, cheaper, more scalable, and quicker. Adopting through a third-party provider is less costly in two different ways. For once, there is not a considerable economic burden, especially in the beginning, because of the significant financial investment that is required to develop AI in-house properly. SaaS flexibility means that a company's subscription of services is decided by the business's demands and is updated in response to variations in needs over time. And later, as the company expands, it can try out new services and gradually enrol new employees. SaaS enables companies to add additional services as it requires them.

Secondly, the lack of talent and expertise and the high costs get solved by opting for third party providers. Most times, implementing AI by using a SaaS requires only incorporating an API. The expertise typically required to develop, maintain and update the program disappear since the provider takes care of these responsibilities. Another aspect connected with the expertise necessary is understanding the use cases of the technology. Companies have seen that buying these technologies through an external provider gives them the security of achieving a higher degree of specialisation in that area. Those companies selling the service are usually experts in that area. They are product experts who understand how the technology can be exploited to its best use.

Moreover, in some cases, the absence of data or data culture gets to be overlooked. Certain services do not require the possession of data; services include already trained programs that use the SaaS data. That is the case, for instance, for AI-powered financial fraud programs that have already been trained with previous data. Additionally, SaaS delivers secure data storage since these services are usually based on cloud infrastructures such as Amazon Web Services (AWS) or Microsoft Azure, which already have data security measures. This insurance allows companies to ensure that their data is safely stored and secure.

However, SaaS also have some downsides regarding data ownership and portability, and the fact that SaaS could also expose firms to lock-in effects. Because user data is frequently housed online for training AI systems, questions about data ownership and management can arise in the case of SaaS. There is also the issue of data portability, which occurs when data generated by one SaaS provider is not transportable and reusable by another. Small businesses may be subjected to lock-in effects as a result of SaaS solutions, making it difficult for them to re-evaluate their subscription plans and switch to other (hopefully more competitive or appropriate) solutions and providers. Finally, Reliance on SaaS subjects SMEs to external risks

because their business activities rely on the software's availability. They may lose access to their data and software if their SaaS providers stop providing services.

Another aspect that may be changing with the emergence of SaaS and AIaas is the share of adoption in smaller firms. As mentioned previously, statistically speaking, the adoption of AI is more common in larger companies than in small ones. Nevertheless, that is not the experience from experts in the SaaS industry, which stated the norm is that younger and smaller firms tend to have a more modern culture of innovation that is willing to try new things and take risks. This disposition to try new things combined with the more negligible inertia could signify an ascending trend regarding the adoption of AI within smaller firms.

8.3 Future of AI

Artificial intelligence has already infiltrated our daily lives. In addition, as AI becomes a more powerful force in society, the focus is changing from creating intelligent systems to building intelligent systems that are human-aware and trustworthy.

8.3.1 AI Trends

Several things have spurred the AI revolution. The maturation of machine learning, aided in part by cloud computing resources and widespread, web-based data collection, is the most important. "Deep learning," a type of adaptive artificial neural network built using a mechanism called backpropagation, has moved machine learning forward tremendously. Significant advancements have complemented this improvement in information processing algorithms in hardware technology for basic tasks like sensing, perception, and object recognition. New data-driven product platforms and markets and financial incentives to develop new products and markets have led to the advent of AI-driven technology.

Nevertheless, it is not clear what will shape the next steps of artificial intelligence. Many of the approaches used in the past 25 years began about the same time, in the 1950s, and have risen

and waned in favour as the difficulties and triumphs of each decade have changed. According to Pedro Domingos, a computer science and engineering professor at the University of Washington, the 2020s should be no different, implying that the era of deep learning may end soon. However, as is typical of the research community, there are divergent views on what will happen next—whether an earlier technique will regain the favour of the discipline will develop an altogether new paradigm (MIT Technology Review 2019).

It is not clear what technologies will fuel the subsequent phases of AI. Nevertheless, there are a few technologies that are considered to be "hot" areas of research; only a few will be mentioned since AI expands to vast fields. A popular field at the moment is large-scale machine learning. Scaling existing algorithms to deal with massive data sets is a crucial focus of current efforts. Another area that has gained attention in the last few years is deep learning. The capacity to train convolutional neural networks successfully has benefited the field of computer vision, with applications such as object recognition, video labelling, activity recognition, and various variations thereof. Reinforcement learning, which simulates the process of training animals through punishments and incentives, has witnessed a dramatic increase in mentions in paper abstracts in recent years (MIT Technology Review 2019). The concept is not new, but it has not worked for decades. Finally, an increasing amount of research is committed to the idea of Internet of Things (IoT), that a diverse set of devices might be linked to collect and share sensory data. Appliances, vehicles, buildings, cameras, and other items are examples of such devices. While connecting the apparatus is a question of technology and wireless networking, AI can interpret and utilise the massive volumes of data generated for intelligent and productive purposes.

8.3.2 "As a Service" Role in the Future of AI

Increasingly, the cloud and the SaaS world are becoming a trend. One of the reasons is the ability to adopt faster, focusing on the core and not worrying about the development,

maintenance, and upgrading of AI programs. In a way, having AI almost in a plug and play approach. In many ways, there is a particular inclination, especially in specific sectors, that the usage of AI as a service will be the meta. For sectors with a significant end-user presence, AI as a service or through SaaS will probably become a trend very quickly. Focusing on the customer is of greater importance more than ever. Furthermore, SaaS allows companies to reduce the software deployment time, give consumers a diversified selection of resources to fulfil various needs and relieve firms of specific maintenance responsibilities. SaaS vendors may deliver product improvements, bug fixes, and security updates on the fly. AI as a service is not a global market trend, but it will be in specific verticals.

9. Conclusions

With the intent of getting a better understanding of how the different sectors mentioned beforehand differ concerning the adoption and use of artificial intelligence, three questions were answered concerning each sector to establish a common ground of comparison. The questions were: 1. How is the state of adoption of AI in the different industries? 2. Will the adoption of AI keep developing drastically in the different industries? 3. What are the main use-cases in the different industries? These three questions will allow for an interpretation of how AI is, how it is used and how it will be in each sector.

1. How is the state of adoption of AI in the different industries?

AI is well adopted in the banking industry but still at an early stage as banks are still struggling to unlock actionable insights from purchasing records. However, this adoption is still in an early stage since these institutions did not start yet to extract the full potential from the data they collect. Today, the data extracted is mainly used to automate back-office procedures or to better manage risk, while the developments for front-office activities are still at an early stage. However, there is an upward trend in AI that is driven by the pandemic since, during this period, incumbents had to adapt to closing their branches and start selling and promoting their

products and services online, and that can be confirmed by the tech trends observed in the last year. In fact, 60% of the banking institutions closed their branches or operated in shorter periods while implementing digital processes – 34% invested in remote account openings and 23% in digital authentication methods (Deloitte Insights 2020).

Artificial intelligence in the industry of social listening and marketing is being implemented rapidly and increasing in efficiency. At the company I work at, Sentione, our most unique proposition is our technology. Our algorithms are currently able to monitor and analyse speech in 81 languages, which covers 71% of the world's population. Currently, due to the opening of Sentione branch in Dubai, we are working on algorithms for Arabic language. We have invested over PLN 20 million in the development of natural language understanding engines, and our experience in monitoring the Internet has allowed us to create very extensive and accurate databases on how people express themselves. Every day we collect 42 million public utterances from the Internet - social media posts, comments, contributions to forums and articles, which serve as training material. As a result, our bots understand the intent of the interlocutors with an efficiency of 96% - better than many real humans.

More than ever, AI has a crucial role in the software industry; in the SaaS industry, that role is even more apparent. AI represents a new generation of SaaS solutions and the opportunity to embrace new methods of gaining a competitive advantage. According to Mckinsey, the high-tech industry, the broader industry where SaaS is in, is the most likely, alongside telecom, to report AI adoption (Mckinsey 2020).

Compared to other industries, the adoption of AI in the construction sector is relatively low (Blanco et al., 2018). A research study based on literature review, quantitative and qualitative data analysis of primary data revealed that the application of AI in the most digitally advanced construction practices is still limited. The survey included the opinion of 105 professionals in

C-level positions, data scientists, innovation managers, software developers and BIM consultants from the most digitally advanced construction sector practices. 30% of the participants stated that AI is not used at all in their organisations, and 6% were not even aware of the topic (Bolpagni et al., 2021). The construction industry remains one of the least digitalised industries worldwide and struggles to adopt AI due to various challenges such as high initial costs of deploying AI, security and trust concerns, internet connectivity, talent shortages, internet connectivity and computing power (Abioye et al., 2021).

The research on this thesis revealed that AI is quite well implemented in the travel and tourism industry and to a more extensive level than people might think. Despite many AI and AI-driven technologies being primarily used in the hospitality sector, the employment of AI goes beyond that. People may not be aware of it, but while travelling and visiting an attraction or checking in at a hotel, the likelihood of using AI and AI-driven technologies is enormous. Many platforms, including Booking, Airbnb, TripAdvisor, and Skyscanner, use AI to improve their results and recommendations. Airports and tourist attractions also use AI and AI-driven technologies to run their businesses. Therefore, one could say that AI is everywhere in the travel and tourism industry.

2. Will the adoption of AI keep developing drastically in the different industries?

When considering the banking industry, we conclude that there is currently a lot still to explore in the AI field, thus there are several opportunities to incorporate techniques and algorithms in business to scale them. AI revenues across the globe grew 12,3% from 2019 to 2020, while the global FinTech market is expected to reach a value of $22.6 billion by the end of 2025, growing at a CAGR of 23% between 2000 and 2025. Focusing on FinTech alone, a CAGR of 25% is expected by 2022, making the total market value reach $309 billion (Forbes 2020). These statistics are enough to stay that this market is not yet saturated and will continue

to grow at impressive rates, showing that AI adoption is a must to thrive in the market and thus will increase drastically in the years that will follow.

The use of AI in customer service is also growing in popularity. After the introduction of lockdown, the load on bank hotlines increased by up to 80%, overloaded consultants were not able to handle all cases, and customers were annoyed by the long wait for a call. An effective voice bot can answer even 1000 calls per second, which means that within 8 hours, it could serve all adult Poles. For future development, it would be important to implement effective voice bots. For example, calling a bank helpline to activate or de-activate a card automatically – at any time of day or nice, signing up for a vaccination or doctor's appointment without waiting in line for an agent, and other examples that would improve the customer's experience.

SaaS is catching on to the AI and machine learning trend, and investment in this field steadily increases. With a substantial portion of the industry's companies incorporating AI into their various services and participating in the development of AI. All big players like Amazon, Google, and Microsoft are announcing offerings that integrate AI. These are strong evidence that AI and machine learning might be the next step in distinguishing a SaaS and assisting it to carve out a market niche. With the continuing development of AI in terms of capabilities and accessibility, AI adoption is bound to increase within the SaaS industry.

By the end of 2018, the global market size of AI in construction was $408.1 Million and is estimated to reach 2,642.4 Million by 2026, increasing with a CAGR of 26.3% (Research Dive, 2020). Additionally, a clear upward trend of publications about AI applications in the construction industry from 1960 onwards is observable (Abioye et al., 2021). Heavy investments and enhanced research indicate a drastic increase of AI in construction. The prospected strong rise is even more emphasised by the advanced technologies inspired by AI,

which are not completely employed yet but are at the edge of development (Pan et Zhang, 2020).

AI is one of the fastest-growing technologies and could be the leading source of revenue in the global economy. Thus, businesses in the travel and tourism industry will most likely start investing even more in AI and AI-driven technologies. Due to Covid-19, the implementation of AI in the travel and tourism industry escalated significantly. Because of that, people are now used to certain perks that were not available before. To maintain their competitiveness in the industry, businesses will be forced to become more tech-forward and invest in AI. Consequently, one could say that the adoption of AI will undoubtedly keep developing in the travel and tourism industry.

3. What are the main use-cases in the different industries?

In the banking sector, the main fields of AI that are being explored are ML, Computer Vision and NLP. In the first one, we have been seeing software automating routine human tasks that bring a drop in costs for banks. We are talking about anti-money laundering (AML) and fraud detection algorithms, tools that ease the risk management teams tasks and avoid human mistakes. Besides that, authentication mechanisms such as digital signatures, fingerprint and facial ID are features of general adoption today and are convenient to the end-user, and these are based on ML algorithms. Computer Vision is helping on Know-Your-Customer (KYC) procedures and helping scan documents. As said before, remote account openings are a trend in financial services, and thus there is the need to submit and process documents such as photos and ID cards online. Finally, NLP is helping to understand and to read these documents that users upload during their KYC procedures, but also empowering virtual assistance tools such as chatbots – as users require help and assistance on demand and in real time, a bot is sometimes the quickest way to fix a situation. In the future, we will watch a drastic rise in predictive

analytics as banks will try to identify better which customers are their target and which are the best ways to cross-sell products, increase retention and thus profits.

At Sentione and within the social listening and marketing industry, natural language understanding engines combined with simple interfaces allows the building of CAIP chatbots without the involvement of an IT team. Using the AI-powered solution, it allows us to help automate customer management processes easier than ever before. We help automate customer service using AI, collect real-time consumer insights, control businesses online reputation, and help improve online customer care.

Due to the nature of the SaaS industry, artificial intelligence comes in all shapes and forms. Because SaaS companies provide a plethora of different services for various industries, use cases can diverge significantly, and the subsets of AI used can also vary substantially. SaaS solutions in which machine learning plays a strategic role are personalisation, automation, predictive analytics, enhanced security, release management (Faster shipment of code), and many others. The service nature of SaaS means that it touches most industries and most departments within firms. This nature means that AI use-cases in the SaaS industry diverge noticeably.

The subfields of AI used in construction include ML, Computer Vision, NLP, Knowledge-based systems, Robotics and Optimisation. The most frequent areas in which these techniques are applied are Health and Safety, Scheduling, Cost estimation, material management, site monitoring and performance evaluation, plant and equipment management, project planning, and knowledge and risk management (Abioye et al., 2021).

AI is already implemented in many businesses in the travel and tourism industry. Facial recognition is one of the newest trends in AI and is mainly being used in airports. This technology is helping in mitigating the amount of time people spend in immigration and

customs verifying their travel documents. Virtual Reality (VR) is also achieving popularity. Hotels and tourist attractions are employing VR to promote their businesses and provide more information about their facilities or environment. However, the most common AI-driven technology found in the industry is Chatbots. These are used in many travel and tourism platforms to answer simple questions and perform simple tasks. Lastly, one of the most common tools people use is Google Translate. Its camera tool allows people to take pictures of a text and translate it to any language, making it easier to break language barriers.

From this brief overview of AI in the different sectors, some inferences can be made. In terms of the adoption of AI, it is no surprise that industries within the general high-tech industry are ahead in the adoption of AI. The social listening and marketing industry and SaaS industry demonstrate a high adoption rate for artificial intelligence. Because these industries are heavily dependent on technology, innovating and being on top of the new technologies is a must. This boosts companies in such industries to enter early in developing and adopting technologies, like AI, especially when those technologies are at the core differentiators of their businesses, like Sentione and many SaaS companies. Sectors with heavy end-user presence are also keeping up with the adoption of AI. The dynamism required in such industries requires companies to be on top of their game regarding technologies that can improve service considerably. One industry that goes under the radar when it comes to the adoption of AI is the tourism and travel industry. Even though AI is spread throughout the industry, it is used in cases where it can go unnoticed, as is the case with check-ins, booking and recommendations. Banking is also well in regard to the adoption of AI, but it is still in the early stages. It is still in the process of maximising the value of the data available. On the other hand, industries with complex machinery and specific safety standards are still lagging. Construction is one of those industries. Due to the complex incorporation required and the lack of talent, the financial burden is still high. The required

conditions are still missing, and there are still significant concerns regarding security and trust in the technology.

One not surprising trend is that the investment in AI is on the uprising and it will become a more standard technology in most industries. The heavy and investments and the normalisation of AI will indicate that in most industries, the presence of AI will be mandatory for companies to prosper, translating to a growth in the need to adopt the technology. In banking, there is still substantial room for development and practices that will catapult practices in the field. Technology companies will continuously innovate in technologies that will set them apart from the rest, making the role of disruptive technologies like AI ever more crucial. The growing need for dynamic customer services also means that consumer-focused industries, like tourism, will have to unceasingly have to innovate and integrate more and newer technologies within their services. At last, laggards in the adoption of AI that are now heavily investing, like construction, will start in the future to have such technologies as the norm in various processes.

When it comes to use-cases and subsets used, there seems to be a set of use cases and adjacent subsets of AI popular within most industries, but at the same time, some specific cases that are mostly just used in certain industries. Machine Learning, computer vision and Natural language processing are the most popular types of AI used. NLP is commonly used in chatbots in industries like banking, tourism, and social listening and marketing, delivering automated customer service and improved customer experience. In banking, NLP is also used to understand documents that customers upload. In social listening and marketing, where NLP is the main subset of AI used, NLP also lets companies better manage customers. Machine learning is also a popular subset used in various industries since it permits companies to automate specific routine processes. In banking and other industries, computer vision improves Know-Your-Customer (KYC) procedures, allowing banks and other corporations to get better insights into their clients. Another use case that is on the rise, especially in the banking industry,

is the usage of AI-based predictive analytics that allow for better predictions and forecasts that give companies great information to make the best decisions. Some specific use cases used in the tourism industry to improve customer experience are AI-powered virtual reality and facial recognition. One sector with particular use cases is construction due to its industrial nature. Construction also uses many popular subsets of AI used in the other industries, like ML, Computer Vision and NLP, and other specific subsets like Knowledge-based systems and Robotics. Even though it uses similar types of AI, it uses them for different use cases. Construction uses AI mainly for Health and Safety, Scheduling, Cost estimation, material management, site monitoring and performance evaluation, plant and equipment management, project planning, and knowledge and risk management. SaaS is a peculiar industry because it uses all these subsets and use-cases and more. Because it provides software for a wide variety of uses and various industries, it uses most subsets of AI for various use cases.

There is a trend regarding certain types of AI and how they are utilised. For instance, NLP in chatbots is present in industries that deal heavily with customers since it helps improve standard processes in such industries, like customer service. At the same time, it is also becoming more popular a specific personalisation of AI and how it is used. Therefore, industries are using AI for particular use cases developed specifically for that industry. Like the usage of face recognition and VR in tourism or robotics in construction. This emergence of industry-specific usages of AI indicates that industries see the potential of AI in their specific industries and are investing in creating and developing specific types and cases to improve processes within the industry.

In sum, at the moment, the industries leading adoption are the tech-heavy ones, like SaaS and Social listening and marketing, mainly because, in some cases, it is at the core of businesses in these industries. Industries with an excellent customer presence like tourism and banking are not far back. At last, industries where safety concerns and heavy machinery, like construction,

are still lagging. However, the adoption of AI is going in an upward direction in all industries. Heavy investment and the emergence of AI subsets tailored for specific industries signal that executives through the varied industries recognise the potential that AI can have in their industries are committing to heavy financial commitments.

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