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SCHOOL OF ECONOMICS AND BUSINESS

WRITTEN WORK

AN ANALYSIS OF THE ROLE OF ARTIFICIAL INTELLIGENCE IN THE INSURANCE INDUSTRY

Ljubljana, march 2025. HANADI BOROVAC

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LIST OF ABBREVIATIONS

AAE - Actuarial Association of Europe

AI - Artificial Intelligence

AGI - Artificial General Intelligence

AMICE - Association of Mutual Insurers and Insurance Cooperatives in Europe

ANI - Artificial Narrow Intelligence

ASI5 - Super Intelligent AI

BCI - Brain-computer interfaces

BPO - Business Process Outsourcing

CEE - Central and Eastern Europe

DL - Deep Learning

EFMA - European Financial Management Association

EIOPA - European Insurance and Occupational Pensions Authority

EU - European Union

FBiH - Federation of Bosnia and Herzegovina

GDP - Gross Domestic Product

GDPR - General Data Protection Regulation

HLAG - High-Level Advisory Group

IoT - Internet of Things

ITO - Information Technology Outsourcing

LTG - Long-term guarantees

ML - Machine learning

NLP - Natural language processing

NSA - National Supervisory Authorities

OCR - Optical character recognition

OECD - Organisation for Economic Co-operation and Development

POC - Proof-of-concept

R&D - Research & Development

RPA - Robotic Process Automation

RS - Republic Srpska

SII - SII

SSC - Shared service centers

1 INTRODUCTION

Technology, having impacted every aspect of our lives, is slowly starting to be used in all of the insurance procedures. The digital transformation of the insurance industry has progressed significantly, extending well beyond the shift from analogue to digital data management (Stoeckli et al, 2018). The use of artificial intelligence (AI) in different insurance processes, such as consumer profiling, marketing, underwriting, claim processing, and fraud detection, has made this possible. (Lakhangaonkar, 2021). Balasubramanian et al. (2021) research highlights the significant impact of artificial intelligence and advanced technology on insurance business, including distribution, underwriting, pricing, and claims, with insurance transactions being conducted instantly. Yong (2023) highlights the significant role of data and algorithms in the insurance sector, including risk assessment, policy pricing, loss quantification, claim settlement, and fraud detection. The impact of discriminatory and generative AI is both short- and long-term.

Patel (2023) recognizes that AI in life insurance could increase earnings, increase efficiency, and reduce risks. AI can decrease mortality, increase decision-making and improve the development of sustainable and revenue-generating customer partnerships.

Eling et al. (2022) state that the primary advantages of automation in the insurance sector revolve around the opportunity for expense reduction. Additionally, the elimination of human errors in administrative repetitive tasks ensures a higher level of accuracy, allowing skilled employees more time to focus on tasks that truly contribute value. The implementation of automation in claims reporting and settlement processes accelerates business operations, resulting in enhanced customer satisfaction. Artificial intelligence applications, capable of processing and analyzing extensive data from telemetric devices, social networks, and various online sources (such as customer feedback, images, and videos), can streamline processes like underwriting. This, in turn, reduces the number of questions posed to the insured, leading to increased satisfaction and positively impacting customer retention.

Yong (2023) highlights the opportunity for AI in the insurance sector, particularly in extracting innovative insights from complex actuarial and claims datasets. However, he warns that incorrect data inferences may negatively impact insurance policies when combined with behavioral and ecological data.

Although AI is capable to boost productivity, improve customer experience, and improve risk management, it also raises significant ethical, societal, and practical issues. Patel (2023) recognizes there are hazards and unforeseen effects that must be balanced and monitored by policymakers.

Businesses are taking notice of AI, which has the ability to alter every element of insurance production and business models, resulting in greater well-being for people and

society. While the advantages are numerous, there are hazards and unforeseen effects that must be balanced and monitored by policymakers. Regulators should handle privacy and ethical problems, and insurance supervisors should evaluate data protection rules. Technology has the ability to worsen current market arrangements, and authorities should keep an eye on access to big data and artificial intelligence to avoid an oligopolistic market structure. Risk classification might result in exclusion or affordability difficulties, and authorities must put boundaries around which sorts of big data can be utilized. AI guidelines from the OECD and HLAG can help insurance regulators better monitor AI advancements and require governance frameworks that control AI in insurance businesses. There is a shortage of AI capabilities at both the regulatory/supervisory side and industry, and increasing international cooperation is required for cross-border activities and data transfers (Hachaïchi, 2023).

Yong (2023), implies that the risk connected to the use of AI in insurance may be roughly divided into two categories: technological and usage. He continues to add that the main technological risk is data confidentiality due to AI development, which enables the gathering, storage, and managing of information without consent. Privacy leakage is also a major concern, and generative AI, which manipulates data to create new content, adds another risk to corporate data confidentiality.AI algorithms optimize training data for insights, but leakage can lead to economic and intellectual property loss. Illegal modification can deteriorate performance and lead to undesirable consequences. The black-box nature of AI systems makes decision-making difficult, especially in the insurance sector, where transparency, explainability, and auditability are crucial. AI performance heavily depends on data, and abuse can lead to adverse effects. Over-reliance on AI can result in incorrect recommendations and weak skill development, as users struggle to determine appropriate trust levels due to lack of awareness of AI capabilities.

By addressing these facets of the issue, the thesis seeks to give a comprehensive analysis of AI's involvement in insurance industry and to contribute to a greater understanding of both the potential advantages and dangers it poses.

Zarifis et al. (2019) have conducted research that assessed the adoption of AI-driven automation in insurance sector. They found following uses of AI in insurance to be dominant:

- automating routine, low-complexity tasks,
- handling large-scale data processing,
- enhancing and refining data sets,
- managing structured, semi-structured, and unstructured data,
- streamlining claims processing and adapting to emerging risks,
- generating new insights on existing clients,
- AI-driven virtual assistants for analysts,

- detecting fraudulent activities,
- accelerating risk identification for automated systems,
- enhancing risk assessment and prediction,
- discovering and interpreting new data sources.

When it comes to the impact of the AI, it is concluded that the AI can facilitate portfolio development, ehance sales, ehance client experience, streamline and enhance the claims handling, ehance the underwriting procedure, optimize risk pricing and fight insurance frauds (Kumar et al, 2019).

Maier et al. (2020) have discussed the transformative potential of leveraging large historical datasets and advancements in machine learning to improve precision and clarity of risk assessment in the insurance industry. The authors introduce a mortality model and life score that reliably assesses candidates. The implementation of such an approach is shown to have significant implications for both profitability and customer experience. The wide implementation of a standardized mortality risk assessment is seen as opening exciting possibilities in the industry, including increased insurance access, life insurance-linked securities for portfolio expansion.

Concerns arise regarding AI liability and insurability due to several factors. The limited understanding of potential damages caused by AI entities stems from the novelty and infrequent use of this technology. Over time, this issue may be alleviated as more information is gathered about the uses and potential harms of AI. The "black-box" problem further complicates matters, as it prevents the evaluation of the decision-making process of AI entities during and after a decision. This opacity leads to unpredictability in the actions and behavior of AI entities, posing challenges for actuarial science in accurately calculating premiums for associated activities.In simpler terms, AI, encompassing machines, robots, or algorithms, autonomously reaches conclusions and makes decisions without human intervention. Machine learning uses initial code and databases to self-teach the "correct" or "best" decisions within a virtual black-box, hidden from human creators or users. Consequently, AI decisions remain opaque, unpredictable, and inexplicable. The lack of foreseeability, varying degrees of autonomy in AI entities, and the absence of complete human control contribute to difficulties in establishing legal causation between the victim and the tortfeasor. The challenge extends to reasoning about causation in fact concerning the damage inflicted and the liable party due to these inherent characteristics of AI decision-making (Lior, 2022).

When it comes to the current state of using AI in insurance, it is not used to a sufficient extent in Bosnia and Herzegovina. However, this is a technology that is in its infancy, which means that the application of AI is expected to grow gradually in the future. Croatia Insurance has introduced a new advancement in European insurance, significantly improving the system of assessing damages on motor vehicles using artificial intelligence. This sophisticated digital system connects a 360° rotational mechanical platform, video

equipment, and a calculation system for damage detection and repair estimation, aiming to speed up the process and increase assessment accuracy. With this solution, drivers do not need to leave their vehicles, and damages are assessed in less than three minutes, which is five times faster than the previous conventional method. The automated assessment system is technologically linked to the already implemented damage report via QR code, allowing Croatia Insurance clients to quickly and independently report damages in just a few minutes without the need for physical paperwork. The average duration of reporting and assessment with the new technology is five times faster, reducing the process from 30-45 minutes to 6-8 minutes, with the assessment alone taking up to three minutes (Profitiraj.ba, 2023).

The research of the proposed master's thesis aims to contribute with a thorough exploration of the integration of AI within the insurance industry. By delving deeply into this subject matter, the thesis aims to address critical questions regarding the influence, advantages, challenges, opportunities, and future trends associated with AI adoption in insurance. Firstly, the thesis aims to clarify how artificial intelligence reshapes core processes within the insurance sector, including underwriting, risk assessment, and claims processing. This examination will provide insights into the fundamental alterations brought about by AI and its implications for the future of these vital functions. Secondly, the thesis endeavors to identify and clarify the tangible benefits that AI has for insurance companies, such as improvements in operational efficiency, financial performance, and customer service. By highlighting these advantages, the thesis contributes to understanding the transformative potential of AI adoption within the insurance landscape. Aside from that, the thesis acknowledges and addresses the challenges and risks associated with integration of AI in the insurance sector, including ethical considerations, privacy concerns, compliance issues, and workforce adaptation. By examining these challenges, the thesis aims to provide valuable insights into mitigating risks and navigating ethical dilemmas associated with AI implementation.

The aim of the thesis, titled "Analyzing the Role of Artificial Intelligence in Insurance," is to “dive deeply” into artificial intelligence and its applications within the domain of insurance. The thesis seeks to offer a thorough assessment how AI is harnessed in transforming and streamlining various facets of the insurance sector.

Given the ongoing acceptance of AI across a spectrum of industries, it is imperative to unravel its distinct impact on the insurance business. This sector, in particular, stands to undergo substantial changes as AI technologies continue to evolve. In this context, the thesis is dedicated to addressing the following questions:

- How does artificial intelligence influence critical processes within the insurance industry, including underwriting, risk assessment, and claims processing?

The first inquiry delves into the fundamental alterations brought about by AI in core operations of insurance. It scrutinizes how AI redefines underwriting, risk evaluation, and claims processing, shaping the future of these vital functions.

– What advantages does AI bestow upon insurance companies concerning their operational efficiency, financial performance, and customer service?

The second question seeks to identify the tangible benefits of AI adoption within insurance. It sheds light on the improvements AI offers in terms of operational efficiency, financial viability, and the enhancement of customer service, ultimately leading to a more competitive industry landscape.

– What challenges does the AI integration pose in the insurance industry?

The third question acknowledges the transformative potential of AI but is also attuned to the obstacles it presents. It examines the hurdles, risks, and ethical considerations connected to the seamless assimilation of AI into the fabric of insurance.

– What opportunities and future trends does AI introduce to the insurance domain?

The final query is dedicated to exploring the vast potential and emerging trends that AI unfurls within the insurance sector. It provides insights into the evolving landscape, unearthing the possibilities and innovations that AI promises, shaping the future of insurance.

By examining these central inquiries, this thesis aspires to offer a comprehensive and insightful perspective on the profound implications of AI within the insurance industry. Through thorough analysis and exploration, it seeks to offer a well-rounded identification of AI's role and the transformative changes it introduces to this vital sector.

This master's thesis seeks to exmamine the application of AI in the insurance sector, its impact on various sectors, its effectiveness in optimizing operational performance, minimizing expenditures, and enhancing risk assessment and claims processing accuracy. The main goals are:

- to explore the scope and application of AI as it is now being used in the insurance industry
- to find out how AI will affect risk assessment, policy pricing, loss quantification, claim settlement and fraund detection of the insurance sector
- to present the benefits of using AI
- to describe and analyze the privacy, compliance and workforce adaptation issues facing the insurance industry in implementing AI.
- to provide insurance companies with advice or insights on how to best use AI to their advantage

- to explore the ethical issues and legal consequences of applying AI in insurance, particularly with respect to client information and decision-making processes.
- to explore increasing trends in artificial intelligence and technologies
- to contribute to academic knowledge by offering a thorough examination of the involvement of AI in insurance and perhaps filling in any gaps in previous studies.

The primary goal of the study is to carry out an in-depth assessment of the impact and significance of Artificial Intelligence within the insurance market, employing qualitative research approach.

A case study approach is adopted to delve into existing AI applications within the global insurance landscape. By examining various international examples, research seeks to offer a thorough insight into the applications of AI technologies across different facets of the insurance industry worldwide. Through case selection and in-depth analysis, this methodology seeks to highlight the diverse applications, benefits, challenges, and potential implications of integrating AI in insurance operations. This approach enables an exploration of AI's potential role in enhancing efficiency, risk management, customer service, and innovation within the insurance sector, offering valuable insights for stakeholders in BiH aiming to leverage AI for competitive advantage and sustainable growth.

To supplement the case study approach and gain deeper insights into the practical implementation and challenges of adopting AI within the insurance sector, semi-structured interviews will be conducted with two professionals from leading insurance companies. These interviews will play a key role in the research approach, providing firsthand perspectives and experiences realated to the use of AI technologies in various insurance functions. By engaging with industry experts, this study aims to capture insights, practical considerations, and potential barriers to AI adoption within the insurance domain. The qualitative data obtained from these interviews will be analyzed alongside the findings from the case studies, enriching the research with real-world perspectives and enhancing the validity and depth of the study's conclusions.

2 THE ROLE OF AI IN INSURANCE

2.1 Overview of the insurance industry

The services sector has witnessed significant growth and prominence within the global economy, largely propelled by globalization and advancements in information technology. The services sector, particularly the insurance industry, is essential in economic development. Insurance services are intricately linked to overall economic growth, with a sophisticated insurance sector fostering investment and trade by mitigating risk for companies. In emerging economies, where capital scarcity often hampers

investment decisions, insurance companies play a crucial role in reducing investment costs and facilitating capital raising for businesses (Khan et al, 2018).

Aside from that, insurance companies contribute significantly to infrastructure development by providing essential risk coverage for large-scale projects such as airports, railways, and power plants. Without insurance, such projects would struggle to withstand unforeseen events due to funding constraints. Within the financial system, insurance companies serve as key players, acting as risk buffers and providing stability. They facilitate risk transfer from insured individuals to insurers, thereby enhancing the overall business environment and enabling companies to invest in new ventures without bearing excessive risk. Additionally, insurance companies contribute to the stability of stock markets through their substantial investments, particularly in securities traded on stock exchanges (Baur et al., 2001).

The insurance industry comprises firms offering risk mitigation through insurance agreements. Essentially, insurance includes the insurer, ensuring compensation for potential future events, on the other side, the insured, pays a fee for this coverage. While the perception of insurance as a slow-growing and secure investment has diminished since the 1970s and 1980s, it remains valid when compared to other financial industries. The insurance sector operates on the premise of managing risks through policies customized for individual circumstances. Actuarial analysis is essential in determining the likelihood of certain events and adjusting premiums accordingly. Additionally, insurance companies often collaborate with banks through "bancasurance" a practice more prevalent in Europe but gaining traction in the United States. A distinguishing feature of insurance companies is their ability to utilize customer premiums as investments, commonly referred to as "the float." This enables them to generate returns on investments while providing financial security to policyholders. Despite primarily offering insurance plans, insurance companies have expanded into corporate pension plans and annuities, placing them in direct competition with other financial service providers. Many insurance companies now have their own broker-dealers, either independently or in partnership, further diversifying their offerings (Beers, 2023).

The insurance industry is essential in both established societies and transitioning economies for several reasons. Firstly, it promotes better risk management within a country, providing a safety net for individuals and businesses in times of adversity. Secondly, by offering protection, insurance instills confidence among individuals and businesses, encouraging their participation in economic activities, which, in turn, contributes to overall development. Additionally, insurance contributes to economic development by facilitating sustainable investments. However, to drive economic development, insurance laws must strike a balance—sufficiently robust to protect policyholders while avoiding excessive constraints that obstructs insurance sector. Moreover, maintaining a healthy insurance industry is paramount for sustained economic growth, necessitating effective and appropriate regulations (Stojaković & Jeremić, 2016).

The insurance sector's impact on economic growth is multifaceted, encompassing various channels that mobilize savings, enhance risk management, and facilitate capital accumulation. Through risk transfer and loss mitigation, insurers contribute to economic efficiency and stability, thereby fostering growth. Particularly in the context of capital accumulation, insurance premiums paid in advance create room for investment, with differences observed between life and non-life insurance due to regulatory influences and investment strategies. Furthermore, insurers are important in monitoring risk, encouraging efficient resource allocation and incentivizing loss mitigation efforts, which can complement government security programs. The economic benefits derived from insurance are contingent upon the cultural context of each economy, with societal attitudes towards risk shaping the efficacy of insurance mechanisms. Societies indifferent to risk may underutilize insurance, limiting its potential to spur economic growth. Indicators such as the number of insurance companies, employees, and insurance funds, along with premium income relative to GDP, serve as crucial metrics for evaluating the insurance sector's activity and its significance in cross-country comparisons of economic development (Richterkova & Korab, 2013).

Economic growth is commonly gauged by metrics such as the rate of growth in GDP, national income, and per capita changes in GDP and national income. Economic development encompasses a broader spectrum of indicators, including macroeconomic aggregates, alongside various other factors. Thus, economic development is viewed as multifaceted method, requiring the alignment of predefined objectives aimed at enhancing living standards and fostering productive potential. Strong insurance regulations are vital to safeguard policyholders while also allowing insurance companies to contribute to economic activity through their products and investments. However, regulations should strike a balance, avoiding excessive prescription that could stifle the industry's ability to support economic growth effectively. A healthy insurance sector is essential for overall economic growth, underscoring the importance of effective and appropriate regulatory frameworks (Stojaković & Jeremić, 2016).

There is a positive relationship between financial markets and economic growth, focusing on banks and stock markets. The study conducted by Haiss & Sumegi (2008) extends the analysis to the insurance sector in Europe from 1992 to 2005, differentiating EU-15+ economies from Central and Eastern European (CEE) economies, as well as between life and liability insurance. It finds that in mature economies, insurance investment fosters growth, while in growing markets, liability insurance has a larger impact. The significance of the link between insurance and growth has increased as the insurance sector's share of the financial sector grows globally. In 2005, insurance companies managed USD 17 trillion in total assets, with institutional investors overseeing a substantial portion of household holdings. The swift increase in total insurance premiums and assets compared to GDP. underscores insurers' role as key institutional investors. This

emphasizes the potential importance of insurance companies in driving economic growth through their investment activities.

The insurance sector in Europe has been adapting to the new Solvency II (SII) regime since its implementation in January 2016. This directive introduced significant changes and requirements concerning reporting formats, technical reserves estimation, capital adequacy, and presentation standards. In the initial year of SII implementation, reporting to National Supervisory Authorities (NSAs) was limited, with the impact of long-term guarantees (LTG) on financial position metrics first reported in 2017. Although the 2016 stress test provided some insight into LTG measures' impact, their full effect will be better understood throughout 2017. Under the Solvency II Directive, EIOPA is mandated to annually report to the European Parliament, the Council, and the Commission on the impact of LTG measures until 2020. EIOPA's first Annual Report on LTG measures, published in December 2016, examined their utilization and impact on insurers' financial positions, including solvency capital requirement ratios and technical reserves. The report covered 69% of the technical provisions in the EEA insurance and reinsurance market, involving 901 insurance undertakings from 24 countries.

The Financial Stability Report presents EIOPA’s evaluation and analysis of the European insurance sector, highlighting the effects of the Solvency II framework introduced in January 2016. Despite substantial changes in balance sheet structure and solvency capital requirements, the transition has been smooth, leading to stable profitability and solvency positions. The report highlights the diverse corporate structures and sizes within the European insurance landscape, with opinions varying on the effects of Solvency II on consolidation in the sector. Feedback suggests that while rising capital requirements may increase consolidation probability, it could also lead to pressure on prices and the loss of specialist insurers and product variety. The social impact of Solvency II depends on changes in insurance prices, potentially affecting demand and societal well-being. Additionally, there is the importance of insurers as significant investors in the real economy and their role in fostering sustainable growth in Europe. The introduction of Solvency II incurred significant costs. However, this doesn't necessarily translate to premium adjustments; instead, insurers may adapt products to current market conditions (Stroe, 2018).

EIOPA was asked by the European Comission in 2018 to provide an opinion on integrating sustainability, particularly regarding climate change mitigation, into Solvency II. They defined "climate risks" to encompass all risks arising from climate change, such as extreme weather events and general climate trends like rising temperatures or sea levels. Initial steps included collecting data from non-life (re)insurance companies and assessing the effects of climate change-related risks on morbidity and mortality. However, integrating sustainability risks faces challenges due to its focus on short-term capital requirements, while sustainability risks are long-term. Traditional non-life insurance policies typically cover only a 12-month period, limiting the consideration of

longer-term risks. Additionally, market participants may delay adapting their investment strategies to climate change risks due to perceived long lead times, creating what's termed the "tragedy of the horizon." This behavior underscores the need for incentivizing firms to address climate risks in their asset portfolios sooner rather than later (Pfeifer & Langen, 2021).

Economists have highlighted insurance's role in economic growth through various channels, including reducing firms' capital needs, fostering investment and innovation, and promoting stable consumption. The growth in premiums paid by the insured is closely linked to GDP growth, prompting this research to analyze the relationship between gross domestic product per capita and insurance market development in the EU, distinguishing between old and new member states. Study conducted by Kramaric & Galetic (2013) builds on previous research by examining this relationship across all EU member states, focusing on both total and segmented life and non-life insurance markets from 2000 to 2009. Dynamic panel analysis is employed to understand how overall economic development influences insurance sector growth, with data sourced from Insurance Europe and Eurostat for indicators like insurance density rates and GDP per capita. The empirical analysis revealed a strong positive correlation between the growth of insurance market and gross GDP per capita in the EU27, particularly in the total insurance market and the life insurance segment. However, this correlation was even stronger in the sample of EU12 countries. Conversely, the correlation coefficient for the EU15 sample did not show a strong and positive relationship between these indicators. Panel analysis further investigated how GDP per capita influences gross written premium per capita in both old and new EU member states, separately examining total, life, and non-life premiums. The results indicated that economic development, as measured by GDP per capita, significantly influences insurance demand, especially in new EU member states. This could be attributed to the historical context of former socialist countries in the EU12, where state-owned insurance companies dominated the market, leading to underdeveloped insurance industries and a lack of insurance culture compared to the EU15.

Table below shows the indicators of the European insurance market’s growth from 2012 to 2016.

Table 1: Indicators of the European insurance market's growth from 2012 to 2016

Indicator	2012	2013	2014	2015	2016	Tendencies 2014/2012	Tendencies 2016/2014
Life insurance premium volume, billion of EUR	897,71	849,69	912,33	793,52	781,33	Growth	Decline
Non-life insurance premium volume, billion of EUR	600,31	624,63	630,20	543,27	556,37	Growth	Decline
Total premium volume, billion of EUR	1402,02	1474,32	1542,53	1336,79	1337,70	Growth	Decline
Insurance density: premiums per capita in EUR	1569,20	1668,49	1730,82	1486,94	1474,20	Growth	Decline
Insurance penetration %	6,73	6,82	6,83	6,89	6,73	Growth	Decline
Total premium volume as a share in the world GDP, %	2,17	2,19	2,19	2,00	1,95	Growth	Decline

Source: Adapted from Stroe (2018)

In Europe, the insurance sector stands as the foremost institutional investor, playing a crucial role in supplying the necessary investments for fostering economic growth. With insurance and reinsurance operating on a global scale, European (re)insurance companies have achieved noteworthy international acclaim. Presently, approximately one-third of all globally operating insurance conglomerates are based in the EU. Additionally, the European insurance industry serves as a substantial source of employment, contributing significantly to both direct and indirect job opportunities. Insurance plays a significant role in driving economic growth and development (Insurance Europe, 2024):

- it enables economic transactions by offering risk transfer and compensation
- it fosters risk management and the adoption of safety measures

- it supports financial stability through long-term investments in the economy
- it promotes steady and sustainable savings and pension planning.

Table 2 shows the share of insurance premiums in GDP in countries in region for the period 2010-2014.

Table 2: The share of insurance premiums in gross domestic product in individual countries compared to the EU for the period 2010-2014

	2010	2011	2012	2013	2014
Serbia	1.80%	1.70%	1.90%	1.80%	1.90%
Slovenia	5.66%	5.57%	5.70%	5.47%	5.20%
Croatia	2.74%	2.73%	2.75%	2.78%	2.65%
Montenegro	2.05%	1.97%	2.01%	2.18%	2.11%
Macedonia	1.52%	1.50%	1.52%	1.44%	1.45%
Hungary	3.13%	2.82%	2.69%	2.71%	2.66%
Romania	1.56%	1.38%	1.41%	1.27%	1.21%
EU 27	8.40%	7.90%	6.70%	6.80%	6.95%

Source: Stojaković & Jeremić (2016)

Between 2010 and 2014, countries in the region had earned insurance premiums well below the EU average. In terms of insurance structure, while the EU countries typically had a ratio of life to non-life insurance of 2:1, these countries had the opposite ratio. Debt securities held the largest portion of the portfolio, representing a third of total investments for European insurance companies. Bonds saw a significant increase in their share by 35% compared to 2000, reaching a peak of 35% of the investment portfolio by 2010. Stocks also contributed to the portfolio, increasing their share and adding to the overall riskiness. While participation shares saw a 30% increase in their share of the portfolio from 2000 to 2010, this was accompanied by a gradual decline in the value of debt securities, which decreased by 33.8%. Loans have been declining from 17% in 2002 to 15.4% in 2010. Table also reveals that Hungary and Croatia closely followed Slovenia and other EU countries in terms of insurance premium participation in GDP from 2010 to 2014, an important metric (Stojaković & Jeremić, 2016).

When it comes to Bosnia and Herzegovina, the insurance market has undergone significant changes over the past years, mirroring developments in other emerging economies. Privatization of state monopolies, reduced entry barriers, influx of foreign capital, and alterations in market structure and competition intensity have reshaped the industry. These transformations impact the profitability of insurance companies, making it imperative for insurers to discern the factors driving business success. Beyond individual firms, the broader economy stands to benefit from thriving insurance companies, which play vital roles in risk management and facilitating funds transfer between economic units. The fragmentation of the insurance industry in Bosnia nad

Herzegovina into regions with disparate regulations and complex institutional frameworks hindered the country's economic development. With 26 insurance companies operating in the relatively small B&H market, regulatory harmonization issues persisted both domestically and with EU standards. However, it is anticipated that mergers, acquisitions, and foreign investment will streamline the market and introduce new, higher-quality services. Despite challenges, the insurance industry in B&H experienced growth in gross written premiums, reaching €241 million in 2010, a 40% increase from 2005. Notably, the industry's resilience during the global financial crisis was attributed to underdeveloped capital markets and the dominance of mandatory insurance, particularly motor third-party liability coverage. This unique market dynamic, coupled with sustained premium growth amid global economic downturns, underscores the sector's stability in B&H (Pervan et al, 2012).

As of December 31, 2021, Bosnia and Herzegovina's insurance sector comprised 25 insurance companies and one reinsurance company headquartered in the Federation of Bosnia and Herzegovina. Among these, 16 insurance companies solely focused on non-life insurance, while the remaining nine were active in both life and non-life insurance. Preliminary data indicates that the total gross written premium in Bosnia and Herzegovina's insurance sector in 2021 amounted to 818,403,122 BAM, marking an increase of 8.27% compared to 2020. Within this, life insurance premiums reached 174,794,669 BAM, a rise of 11.77%, while non-life insurance premiums amounted to 643,608,453 BAM, up by 7.36% from the previous year. The largest share of the total gross written premium in Bosnia and Herzegovina's insurance sector in 2021 was attributed to motor vehicle liability insurance (49.96%). Life insurance followed with a share of 21.36%, while other significant segments included motor vehicle insurance (9.73%), accident insurance (6.18%), and fire and other property insurance (4.06%). Uniqa osiguranje d.d. emerged as the dominant player in the life insurance market in 2021, capturing a market share of 23.20%, with similar dominance by Adriatic osiguranje d.d. in the non-life insurance market, holding a 10.57% market share. Adriatic osiguranje d.d. also led in the combined life and non-life insurance market with a 9.08% market share. In terms of legislative developments, Bosnia and Herzegovina adopted two laws related to compulsory traffic insurance in 2020, with further amendments made to insurance laws in the Federation of Bosnia and Herzegovina in 2021. Additionally, representatives of the Insurance Agency of Bosnia and Herzegovina participated in various international meetings, conferences, and regional forums throughout 2020, with a new board appointed by the Council of Ministers of Bosnia and Herzegovina (Jahić, 2022).

2.2 Artificial intelligence applied to insurance

The concept of AI encompasses various aspects such as adaptive behavior, learning from experience, understanding natural language, scene recognition, and communication with

humans or other intelligent systems. Intelligent systems, often computer-based, are characterized by properties like information gathering and processing, interaction with the environment, communication with humans or other systems, knowledge acquisition and processing, reasoning, and planning. These systems exhibit adaptability, learning ability, use of vast amounts of knowledge, and sometimes even awareness. Artificial intelligence inherits ideas and approaches from various disciplines such as cognitive science, logic, psychology, biology, philosophy, linguistics, and mathematics. Major applications of artificial intelligence include computer games, expert systems, problem-solving, data mining, neural networks, automatic programming, intelligent agents, and others (Vladimir, 2019).

Artificial Intelligence (AI) is an analytical field that involves creating automated systems capable of performing tasks that would typically require human intelligence. The level of intelligence can be adjusted to a defined threshold, allowing it to be classified into Weak, Strong, and Superintelligent AI (Harris, 2010):

- weak AI, or Artificial Narrow Intelligence (ANI), focuses on performing specific tasks or solving particular problems
- strong AI, or Artificial General Intelligence (AGI), replicates human-level cognitive abilities and can perform a wide range of tasks
- superintelligent AI (ASI), surpasses human-level intelligence, exhibiting capabilities for creative and scientific thinking.

Artificial intelligence has a rich history spanning over six decades, marked by the development of computer systems aiming to replicate or surpass human-like intelligence. While there's no universally accepted definition of AI due to its multifaceted nature, it generally includes science and engineering of creating advanced machines that can do things like understanding language, learning, reasoning, and problem-solving. AI applications rely on vast datasets, often acquired through the Internet of Things (IoT), to train computer systems to recognize patterns and apply their knowledge to new situations. AI can be categorized into three types based on their level of intelligence: narrow AI, which specializes in specific tasks; general AI, capable of broader problem-solving and human-like responses; and super AI, which exceeds human intelligence across various domains, though it remains theoretical and distant (Eling et al, 2022).

While the origins of AI date back decades, the current focus is on intelligent machines with capabilities for learning, reasoning, and adaptation. These abilities enable AI methods to excel in addressing complex challenges, making them essential for the development of future societies. AI systems have become so advanced that they require little human involvement in their design and execution. But, in fields such as medicine, law, and defense, where AI decisions impact human lives, there is a growing need to understand how these decisions are made (Arrieta et al., 2020).

Artificial Intelligence has emerged as a significant driver of productivity across various industries, particularly in insurance. AI technologies not only automate tasks but also enhance service quality by aiding decision-making processes. The proliferation of data has fueled the growth of AI, with organizations, governments, and individuals generating vast amounts of data daily. Insurance companies are making significant investments in AI and cognitive technologies, with spending expected to increase from EUR 4.21 billion in 2016 to EUR 41.22 billion by 2020. Insurers are focusing on implementing AI in three main segments to capitalize on its potential benefits (Kumar et al, 2019).

In the insurance domain, it's essential to contextualize broad AI definitions within specific business or application scenarios. This approach adds significance to AI's importance and aids in comprehending the complex considerations associated with AI system implementation in insurance. Adopting a socio-technical perspective on AI systems involves embedding AI algorithms and machine learning technologies applied within a wider business framework, which encompasses various digital technologies relevant to a particular insurance product-market scenario. AI insurance system can be defined as follows: It constitutes a network of interconnected components which encompasses business operations, offerings, and the company’s overall business strategy (Holland & Kavuri, 2021).

The insurance industry traditionally experiences low customer engagement due to limited interaction between insurers and consumers, often relying on intermediaries like brokers. This lack of engagement, coupled with slow digitization, hampers insurers' ability to understand and meet customer needs effectively. Major problems in the insurance industry are (Kumar et al, 2019):

- missed opportunities: engaging potential clients at optimal moments can be challenging without the right approach
- tailored solutions: offering the most suitable products based on customer needs ensures better satisfaction
- inefficiency: slow claims processing for loyal customers can negatively impact customer experience
- expenses: expensive claims can reduce profit margins and strain company finances
- fraudulent claims: the rising occurrence of false claims and scams poses a threat to business integrity
- manual workload: processing large volumes of data manually can create inefficiencies and overwhelm operations.

These challenges can be addressed through AI technology, which is rapidly advancing and shows promise in enhancing various aspects of the insurance sector. AI's ability to learn from vast datasets offers significant potential for improving marketing, finance, and overall operational efficiency. With the exponential growth of data, estimated to reach 40

zettabytes by 2020, AI's role is poised to expand further in the coming years (Kumar et al, 2019).

The insurance industry's digitalization has progressed significantly, moving beyond simple digitization to encompass the combination of analog and digital realms through new technologies. Digitalization has already brought about notable changes across the insurance value chain, enhancing process efficiency, underwriting, product innovations, customer engagement, and distribution strategies, and introducing new business models. Studies indicate that digitalization activities positively impact the operational effectiveness of insurance companies. The widespread use of mobile and interconnected devices has significantly expanded access to customer data. The abundance of data opens up new opportunities for insurers to utilize cutting-edge technologies, particularly artificial intelligence, which relies on access to extensive customer data for implementation. The insurance industry primarily utilizes artificial narrow intelligence (weak AI) for specific tasks like analyzing customer images and estimating life insurance policy terms. This focus reflects the current market interest in practical AI applications over imitating the intelligence of humans (strong AI). Insurance companies should prioritize implementing narrow AI while keeping an eye on general AI advancements. These AI applications mainly enhance customer and operational efficiency, leveraging computational advantages for speed and accuracy. Notably, telematics-enabled usage-based insurance contracts are prominent using machine learning to analyze claim data and Lemonade employing AI systems to streamline various insurance processes (Eling et al, 2022).

Millennials, who represent a significant customer base for the insurance industry, anticipate prompt, personalized service that ensures long-term customer satisfaction and delight. The wealth of available data has underscored the importance of data management tools like AI. Insurers are now leveraging AI to assimilate various sources of information such as media, sensors, news, and weather reports, tasks that often overwhelm traditional statistical models. AI's unparalleled speed in execution, analysis, and compilation surpasses human capabilities. To broaden their reach, insurers are embracing digital platforms, integrating technologies like AI and Chatbots to enhance customer interfaces. With evolving consumer behavior characterized by time constraints, individuals increasingly prefer online interactions over traditional agent-based services, seeking to explore, understand, and purchase insurance policies independently. AI emerges as a pivotal tool for leveraging vast datasets to tailor policies to individual needs, optimizing efficiency, accuracy, and customer satisfaction. By harnessing digital information from various sources, including private data, robotic process automation, and audio/video analysis, insurers aim to offer products that meet customer expectations. Today's consumers engage in comparative shopping, expecting swift claim processing, round-the-clock services, and enhanced decision-making facilitated by technological advancements. Incorporating emerging technologies such as smart analytics, robotics, AI, and deep

learning into the insurance process promises to streamline procedures, making them more transparent and less cumbersome. Ultimately, the imperative is to utilize technology for the betterment of society (Gupta, 2020).

AI is used in the insurance sector across various phases of the business, leveraging rich and evolving datasets. It is employed in designing new products tailored to customer needs and predicting risks such as damages or life expectancy. Assessing the riskiness of potential clients is crucial for pricing products while ensuring non-discrimination. AI also facilitates customer-centric marketing campaigns and post-sale interactions through apps and chatbots. Additionally, AI is instrumental in fraud prevention, with various approaches such as the PRIDIT method and machine learning algorithms employed for detection. However, adversarial AI poses a challenge to these applications, with potential attacks compromising the integrity of data and algorithms, particularly in fraud detection (Amerirad et al., 2023).

Artificial intelligence (AI) systems are driving significant changes in the insurance industry across three main areas. Firstly, customer interactions, such as sales and customer service, are being revolutionized through online platforms and chatbots, allowing for faster and more accessible information and product purchasing. Secondly, AI is automating various business processes and decisions, leading to cost savings, improved accuracy, and faster claims processing, ultimately enhancing customer satisfaction. However, ethical and legal concerns regarding data usage and cybersecurity accompany this automation. Lastly, AI is reshaping insurance markets by creating new risks and opportunities, such as in autonomous driving and cyber risk insurance. These developments may lead to the emergence of new insurance markets while challenging the existence of traditional ones (Eling et al, 2022).

AI is extensively utilized across different phases of the insurance value chain, with research highlighting its potential in enhancing financial management. Applications of AI in insurance encompass fraud detection, claims reserving, risk assessment, and insurance pricing models. However, inherent biases in AI systems pose challenges to trust within the industry, stemming from both human input and algorithmic bias. Efforts are underway to create responsible AI systems and implement fairness principles to mitigate discriminatory issues. Enhancing trust in AI is crucial for its sustained use, with frameworks like the Chain of Trust proposed to bolster user confidence. Explanations in AI systems play a key role in fostering trust, which highlights the significance of openness, clarity and understandability in human-AI interactions within the insurance sector (Owens et al., 2022).

There is a lot of areas in insurance where AI can assist. Table 3. provides same use cases of AI for its corresponding areas.

Table 3: AI use cases in insurance

Healthcare insurance	Fraud and abuse detection system
Motor insurance	A fraud detection model incorporating multiple classifiers, including Random Forest, Principal Component Analysis, and Potential Nearest Neighbor, is introduced to enhance accuracy and reduce fraudulent claims in motor insurance.
Non-Life insurance reporting	A predictive model using Multilayer Perceptron is developed to forecast the insolvency risk of non-life insurance companies, leveraging a range of financial metrics as inputs.
Claims Reserving	Regression tree models are employed to determine the appropriate claims reserves based on detailed individual claims data, improving accuracy in reserve calculations.

Source: Smietanka et al. (2021)

Artificial intelligence is automating underwriting processes to reduce human errors. Techniques such as machine learning (ML), fuzzy logic, and natural language processing (NLP) have been utilized for this purpose. AI is also employed in prospecting clients for different insurance policies, addressing challenges like imbalanced and missing data through appropriate techniques. Additionally, geospatial analytics aids in targeting new business by leveraging demographic and socioeconomic information. Furthermore, AI enables the provision of personalized services to customers by analyzing their preferences, behaviors, and demographic data. Customer segmentation is crucial for understanding diverse customer groups in the insurance industry, with methods like multinomial regression and count regression models aiding in this process. Various algorithms, including logistic regression and decision trees, are used for predicting customer churn, while customer lifetime value prediction involves ML algorithms like CART and SVM. Fraud prediction utilizes ML and DL algorithms such as RF and SVM, with hybrid models showing promise. Loss prediction and claim rate prediction also benefit from AI algorithms, helping insurance companies stay competitive in a dynamic market. AI is important in life event marketing by targeting the right audience at the right time and extracting special life event data for personalized marketing. Recommendation engines help in offering appropriate products based on customer preferences, while insurance chatbots revolutionize customer service through online conversations. However, the unique and complex challenges of data in the insurance industry require customized solutions, especially with emerging technologies like drones and IoT devices. ML algorithms are utilized to predict individual awareness based on various data sets, but traditional statistical and ML methods may not be effective for nonlinear classification problems. Integrating geolocation data and data from various sources enhances automation processes using AI techniques. AI methods like chatbots, NLP, ML, and DL can assist in product development, marketing, and risk ratings, but proper application is crucial to avoid setbacks. AI also aids in analyzing customer behaviors, predicting buying

patterns, and improving campaign strategies, ultimately benefiting the insurance industry by enhancing customer satisfaction, reducing costs, and increasing efficiency. Collaboration between data science and engineering professionals is essential while ensuring sustainability and societal service (Singh & Chivukula, 2020).

In the insurance sector, AI-driven analytics are poised to revolutionize operations, enabling companies to attract new business by tailoring insurance products and addressing the evolving needs of existing clients. The implementation of more precise models will lead to more accurate premium assessments, which often suffer from overestimation due to data scarcity. Machine learning techniques offer various avenues for advancement in the insurance industry (Smietanka et al, 2021):

- personalized product offerings: automated processes play a pivotal role in analyzing vast datasets, providing insurers with deeper insights into client activities. This enables the customization of products and solutions to meet the specific needs of niche segments. For instance, Lemonade insurance utilizes AI-driven Chatbots to deliver personalized policies to customers quickly
- behavioral product pricing: utilizing telematics, wearable sensors, and IoT devices, insurers can gather extensive data to profile clients' risks. AI algorithms can then adjust premiums dynamically based on health indicators or driving behaviors, reflecting the insured's risk profile and fostering greater engagement in health or safe driving practices
- enhanced risk assessment: machine learning algorithms offer superior predictive capabilities compared to traditional methods, enabling insurers to generate targeted forecasts on coverage changes and potential losses for policies. By leveraging diverse data sources, insurers can manage risks more effectively and make informed decisions
- improved fraud detection: fraud remains a significant challenge for insurers, with estimates suggesting billions lost annually. Machine learning algorithms mitigate human errors and uncover hidden fraud patterns by analyzing large datasets from multiple sources. AI-powered scoring systems assess the likelihood of fraud in each claim, enhancing detection accuracy
- business processes automation: AI-powered systems streamline monotonous tasks boosting efficiency. These systems excel in analyzing complex documents and extracting essential information, automating processes and enabling humans to focus on more important tasks

Prajapati (2021) listed several companies from various countries that have implemented AI for the business to reap the advantages of improved customer satisfaction, cost savings, and a more resilient operation. The companies are listed in Table 4.

Table 4: AI implementation in insurance companies

Company (Country)	AI implementation
Ageas (UK)	AI-driven image recognition technology, developed in collaboration with insurtech specialist Tractable, automates motor insurance claims. It enables quick loss notifications and estimations, allowing for payouts within minutes, all without human intervention.
AIG (US)	Together, AIG, Hamilton, and Two Sigma launched Attune, a platform designed to enhance customer experience and simplify underwriting processes. Additionally, AIG introduced Valic, a robo-advisor for the annuity market, aimed at streamlining operations and boosting profitability.
AVIVA (Canada)	Aviva, in partnership with Snapsheet, developed a virtual claims platform for both personal and commercial insurance sectors. In a pilot program, 93% of customers opted for this platform, achieving claims processing 20–40% faster.
Lemonade (US)	Offering homeowners' and renters' insurance, Lemonade utilizes AI technology to automate its processes. Their system includes integrated claims algorithms, 18 anti-fraud algorithms, and a chatbot named Jim. The company has attracted investments from notable backers such as Google Ventures and Allianz.
Libery Mutual (US)	In 2017, Liberty Mutual launched an AI-powered app aimed at enhancing driver safety by combining company data with external sources like government and weather data. Additionally, Liberty Mutual established Strategic Ventures, its venture capital arm, to fund AI-driven insurtech startups.

continuing

Table 4: AI implementation in insurance companies (cont.)

Swiss Re (Switzerland)	In 2015, Swiss Re partnered with IBM Watson to harness AI and big data for its life and health underwriting division. This collaboration aimed to gain deeper insights, such as predicting a potential policyholder's smoking habits without the need for fluid tests.
USA (US)	USA has leveraged AI for personalized marketing, enhancing cross-selling and up-selling efforts. The company worked with Google TensorFlow to develop machine learning models, and collaborated with Google Advanced Solutions Lab to create insurance-specific AI capabilities.
Zurich (UK)	In partnership with SPIXII, Zurich introduced the chatbot Zara, designed to streamline and automate the claims process for its motor and home insurance customers. This investment is expected to improve customer value and operational efficiency for Zurich.

Source: Adapted from Prajapati (2021)

3 BENEFITS OF AI IN INSURANCE

There is a lot of benefits that AI offers in insurance industry. Ladva & Grasso (2023) list three use cases of AI in insurance:

- underwriting – enhanced risk evaluation and customer insight: insurance providers now have access to a wealth of data during the underwriting process, thanks to the digitization of various touchpoints and collaboration with digital partners. This includes data from sources. The capability to effectively leverage this for underwriting purposes is a significant competitive advantage, enabling insurers to offer more personalized coverage and pricing to customers. AI methods like supervised learning can complement traditional underwriting processes by improving efficiency and decision-making. For instance, Swiss Re utilizes AI-driven predictive models to streamline triaging in Life & Health underwriting, simplifying the customer journey

- claims - streamlined processes and expanded coverage: AI capabilities pave the way for new insurance strategies covering risks that could not be insured. Swiss Re's parametric Flight Delay Compensation, for instance, employs an AI model to forecast flight delays. Customers who purchase this insurance receive instant compensation in the event of a delay, without needing to file a traditional claim. The AI-powered pricing engine, fueled by over 200 million historical data points and real-time flight data, enables dynamic rate adjustments to ensure accurate compensation
- claims - leveraging computer vision for accident fraud detection and driving behavior analysis: a startup in Italy has developed a groundbreaking system that combines edge computing and AI to address car accident fraud and evaluate driving behavior. This system records the visual surroundings of a vehicle in motion and certifies unfortunate events. Upon ignition, the device records a video, transmitting it securely to the cloud for processing. Advanced computer vision algorithms then analyze the anonymized video to extract accident dynamics and driving behavior insights while guaranteeing adherence to data privacy laws like GDPR.

Insurance applications, such as personalized products for individual clients, would necessitate an intelligent virtual agent/broker and advanced cognitive computing, though there are uncertainties as mentioned earlier. It remains unclear whether machines will achieve human-level interaction capabilities in the near future. While some optimists claim we already possess the necessary technology, human-level interaction remains quite limited. Another potential application of AI in insurance is in claims validation. While Robotic Process Automation can simplify claims management activities, claim approval still requires judgment and evaluation beyond RPA's scope. AI could enhance customer service and call centers once it attains a sufficiently developed level. Combining AI with human intervention could be employed. AI algorithms could also leverage social data to create fraud detection indicators, predicting fraud risks.

Roberts (2021) mentions following benefits of using AI in insurance:

- enhanced customer experience and interaction: interacting with insurance companies, whether for a quote, claim filing, or information submission, can often be daunting for customers. AI streamlines these traditionally cumbersome processes, offering a swift and seamless experience
- increased employee productivity and job satisfaction: through intelligent routing of customer service requests, insurance personnel can prioritize high-impact interactions, fostering better customer engagement while reducing stress and boosting morale. For instance, leveraging AI in sales processes has shown to increase the close rate by 41%
- accelerated claims processing: manual handling of insurance claims can be time-intensive, often taking weeks to complete. Traditional methods involve numerous phone calls and emails to gather necessary information, leading to backlogs in claims resolution. AI-powered smart bots expedite claims management, significantly

reducing processing time. This results in easier access to claimants with fewer attempts, enhancing efficiency and improving the overall customer experience

- reduced operational expenditure: by integrating AI into daily operations and automating previously manual tasks, insurance companies can achieve substantial cost reductions. Projections by Juniper Research indicate that AI adoption in claims management could yield annual savings of $1.2 billion for the insurance industry by 2023
- increased focus on high-value interactions: conventional insurers spend significant time fielding calls and directing emails to the appropriate personnel or departments. AI solutions alleviate this burden, allowing staff to concentrate on addressing complex issues and fostering more meaningful interactions with customers.

There are few potential socio-economic benefits of AI in insurance that are listed in the Table 5.

Table 5: Socio-economic benefits of AI in insurance

Expand the scope of risk pooling	Extend insurance coverage to new customer segments that were previously underserved or uninsured, such as individuals with pre-existing medical conditions, by offering personalized products. Broaden the types of risks covered by insurance policies, integrating insights into emerging threats, such as cyber risks, to ensure that more diverse and complex risks are addressed effectively.
Reduce the cost of risk pooling	Leverage automation technologies to reduce administrative and operational costs, improving overall cost-efficiency. Through better risk assessments, insurance companies can more accurately price policies and reduce unnecessary expenses. Use advanced data analytics to identify and mitigate moral hazard and adverse selection, ensuring that insurance coverage is more fairly distributed and reducing the overall cost to policyholders.

continuing

Table 5: Socio-economic benefits of AI in insurance (cont.)

Mitigate and prevent risks	Utilize advanced analytics and AI to discover new patterns and insights that can help prevent and mitigate risks before they occur, providing a more proactive approach to risk management. Develop systems that detect potential risks early, allowing insurers and clients to take preventative measures and reduce the impact of losses by responding quickly to emerging threats.

Source: Adapted from Keller (2020)

4 CHALLENGES AND BARRIERS

4.1 Ethical and legal challenges

The media frequently discusses both the potential benefits and risks of artificial intelligence, prompting questions about the extent of our concerns and the specific issues we should focus on. While some anticipate the emergence of superintelligence, others question its inevitability and ponder its ethical implications, including consciousness and moral considerations. AI encompasses various forms, from robotics to data manipulation to machine learning, with implications across multiple domains, including healthcare, economy, politics, and culture. Applications range from medical diagnosis to robotic surgery to personalized therapy sessions. AI also influences sectors like commerce, manufacturing, education, and creative endeavors. Given the diverse and complex nature of AI applications, discussions about its risks and benefits require careful consideration. Developing ethical codes for AI involves navigating these complexities and addressing a wide array of ethical, social, and technical issues (Boddington, 2017).

The increasing use of AI in organizations brings forth ethical considerations that need to be addressed to prevent potential harm and legal ramifications. While unethical behaviors in traditional contexts often occur by design, AI may lead to unintended consequences due to its complex and evolving nature. As AI continues to evolve, it becomes challenging to define clear thresholds between AI and non-AI technologies, making it essential to establish guidelines for managing AI ethics (Brendel et al., 2021).

The significance of insurance to the modern economy and society is undeniable. Despite the scarcity of academic faculties specializing in insurance, sociologists and historians have emphasized its central role. Insurance is fundamentally a risk-sharing practice with ethical considerations and welfare outcomes at its core. The insurance market plays a

crucial economic and welfare role in society, producing both positive and negative externalities. Life, health, and non-life insurance categories significantly contribute to social inclusion. Therefore, proactively identifying future socio-technological challenges within the data-driven insurance landscape through reflective foresight is beneficial (Holland et al, 2021).

Because of the importance of the insurance industry, tailored socio-technological approaches to digital and data ethics are essential. The digital economy brings new consumer risks and often exacerbates information asymmetry between clients and insurers. From a regulatory perspective, challenges include ensuring fairness, preventing discrimination, and regulating the reuse of data for business profitability. Regulators and supervisors must balance enabling the European insurance sector to leverage digital innovation while safeguarding consumer and citizen interests (Bernardino, 2020).

Table 6 contains an overview of AI applications in insurance alongside the main ethical issues faced.

Table 6: Overview of ethical issues of AI applications in insurance

Insurance value chain	Insurance value chain	AI Systems	Main ethical issues
Product design and development	Market research	Analyzing past customer behavior and survey results to guide the creation of new products.	Excluding market segments that are deemed vulnerable or unlikely to be profitable.
	Product development	Conducting A/B testing on various digital interfaces, insurance services, and innovative offerings, such as parametric, usage-based, or behavioral insurance models.	Addressing customer preferences, which often favor established companies, over newer market entrants.

continuing

Table 6: Overview of ethical issues of AI applications in insurance (cont.)

Pricing and underwriting	Risk assessment	(a) Conventional data sources, such as customer details, exposure records, and claims history, used to assess the risk profiles of customer groups. (b) Emerging sources of big data, including behavioral insights, Internet of Things (IoT) data, telematics, personal tracking devices, and GPS data, utilized for advanced behavioral analytics.	Algorithmic bias resulting from insufficient or skewed training datasets. Challenges in justifying and explaining the use of non-risk-related data in insurance pricing. Customer data enhances the effectiveness of algorithms, but the value created may not be equitably shared with the customers themselves.
Pricing and underwriting	Risk assessment		Micro-segmentation can potentially disrupt the broader risk pool, excluding smaller groups of high-risk individuals. The risk of weakening the fundamental risk-sharing model of insurance, leading to reduced societal solidarity. Privacy concerns, including issues related to surveillance and the erosion of personal autonomy. Ethical dilemmas surrounding data management, the resale of personal information, and the commodification of customer data.

continuing

Table 6: Overview of ethical issues of AI applications in insurance (cont.)

Pricing and underwriting	Pricing	(a) Utilizing machine learning to create pricing models tailored to specific customer segments. (b) Implementing micro-segmentation and personalized pricing driven by individual behavioral data.	Pricing determined through micro-segmentation can be challenging to justify due to the numerous variables and complexity of the algorithms involved. Concerns about social solidarity and its potential erosion. Issues with information asymmetry and the difficulty in explaining complex pricing models. Market exclusion driven by high pricing for individuals or micro-segments deemed to have exceptionally high risks. The use of non-risk factors in pricing, such as social data or clickstream data, may lack sufficient justification.
Sales, distribution and marketing	Sales and marketing	Digital marketing strategies that leverage real-time analysis of online search behavior to tailor campaigns.	The risk of exploiting customers by pressuring them into purchasing unnecessary or overpriced insurance products. Exclusion of vulnerable groups and the challenge of ensuring fair treatment of protected characteristics within the value chain.
	New customer acquisition	Virtual assistants and chatbots powered by Natural Language Processing (NLP) and insurance-specific frameworks to enhance communication and customer support.	The potential for automated systems to provide incorrect or harmful advice to customers. The fragmentation of offerings, which could lead to insurance products unintentionally becoming financial advice. The possibility of biased customer selection during new customer acquisition processes.

continuing

Table 6: Overview of ethical issues of AI applications in insurance (cont.)

Sales, distribution and marketing	Customer retention	Models for predicting customer churn and understanding customer switching behavior.	Exploiting customer tendencies, such as inertia, to limit competition and maintain inflated profit margins.
	Customer relationship management	AI-driven proactive communication strategies to engage customers and cross-sell related services.	Lock-in effects that decrease customers' willingness to search for better options, leading to potential biased or inaccurate advice.
Sales, distribution and marketing	Behavioral analysis of customers	Behavioral risk analysis applied to sectors like health and automotive to assess individual risk profiles.	Unintended outcomes, such as customers exploiting the system, could encourage unsafe behaviors, like exercising while unwell or being distracted by insurance-related safety advice while driving. The monitoring of behavior could evolve into surveillance, raising data privacy concerns, such as the confidentiality of visited locations on GPS routes. Shifts in the power dynamics between consumers and insurance providers, altering the balance of control. Insurers becoming more interconnected with non-financial entities, leading to less stringent regulation.
E-service	Insurance policy management	Robotic Process Automation (RPA)	While small in scale, RPA could introduce unintended bias in the rules-based processing of policy documents, claims, and e-services.
	Customer self-service through multiple channels	NLP, Voice recognition, insurance ontology maps and Virtual assistants	These technologies could inadvertently exclude or discriminate against customers with limited technology skills, as well as create a risk of providing inaccurate advice, potentially leading to unsuitable policy changes or purchases.

continuing

Table 6: Overview of ethical issues of AI applications in insurance (cont.)

E-service	Customer complaints	Automated resolution of a large percentage of customer complaints across various marketing channels	There is a risk of algorithmic bias in the complaint resolution process, potentially disadvantaging certain customer segments.
Claims management	Claims prevention 1	AI-based safety warning systems in automotive and buildings, automotive blind spot, image recognition for automatic emergency braking to avoid collisions and lane departure warning	The balance between personal safety and the safety of others is not always straightforward, and there is a possibility of unintended consequences stemming from imperfections in safety mechanisms.
	Claims prevention 2	Linked to behavioural data, coaching to improve behaviour and reduce risk, e.g. in driving performance	Behavioral nudges might result in a reduction of personal autonomy and hinder independent decision-making.
	Claims prevention 3	AI-driven analytics in both healthcare and automotive fields can offer insightful recommendations based on large datasets.	There is also a risk of misleading guidance that could have negative impacts on the individual receiving the advice.
Claims management	First notice of loss (FNOL)	Telematics systems enable automated emergency alerts, triggered by vehicle sensors and GPS data.	These technologies can predict potential accidents, although their primary drawback is the economic impact associated with false alarms.
	Loss reserving	Use machine learning to estimate the value of large and significant losses	Negligible to the customer
	Claim processing	Utilizing AI-powered image analysis to assess repair expenses across various sectors, such as residential property insurance, commercial properties, and vehicle repairs.	There is a risk of underreporting the true value of a claim, for example, by offering quick payment incentives. Additionally, automated systems may lack transparency, making it harder for stakeholders to understand the decision-making process.

continuing

Table 6: Overview of ethical issues of AI applications in insurance (cont.)

Claims management	Fraud detection	Leveraging AI for fraud detection to spot irregularities in individual claims and uncover fraudulent patterns across all claims.	Algorithmic bias, influenced by past fraudulent claims, could lead to false fraud accusations, potentially disadvantaging certain groups and increasing the risk of profiling.
	Automated payments	Seamless payment systems that are directly integrated into the workflow for automatic processing.	Minimal impact on the consumer in regions with high bank account penetration.

Source: Adapted from Holland et al (2021).

Ethical application of AI has sparked a global debate, leading to the emergence of core principles including transparency, fairness, safety, accountability, and privacy. In the insurance industry, these principles are governed by various laws and regulations. However, implementing them in the context of AI raises complex questions for insurers and regulators. The Geneva Association's report addresses these challenges, focusing on transparency, explainability, and fairness, which present intricate issues in insurance. While definitive answers are elusive, the report aims to identify and discuss key trade-offs associated with implementing responsible AI principles in insurance. Ensuring transparency and clarity in AI systems is vital for gaining trust from stakeholders. While certain guidelines emphasize the need for explanations, the extent of required explainability varies based on the context and the significance of the decision's impact. Complex "black box" algorithms pose challenges for interpretation, but efforts in computer science are addressing this through reverse engineering and design approaches. Encouraging the use of interpretable models can enhance trust, particularly when outcomes significantly affect customers. Using intuitively understandable data sources for risk selection and pricing can also foster trust, as overly complex models may sacrifice interpretability without sufficient benefit. Ensuring fairness in AI decision-making poses complex challenges due to differing interpretations and cultural contexts of fairness. Ethical guidelines emphasize the need to eliminate bias and discrimination in AI-driven decisions, which can impact large groups if not addressed. In insurance, concepts like actuarial fairness, non-discrimination, and solidarity are particularly relevant. Insurers must identify and mitigate bias specific to each AI application, leveraging existing frameworks and norms in the industry (Keller, 2020).

An effective data governance framework is imperative. General Data Protection Regulation (GDPR) mandates that automated decision-making, such as profiling individuals based on personal data, must adhere to strict guidelines. This includes

ensuring transparency, obtaining explicit consent, and offering individuals the opportunity to dispute decisions. For instance, in insurance, using AI analytics for fraud detection must not result in claim denials solely based on algorithms, aligning with the GDPR's emphasis on protecting individuals' rights and autonomy. However, while these regulations provide a baseline, organizations must strive for a human-centered approach, as recommended by the European Commission, to ensure AI systems are trustworthy and ethical. Furthermore, transparent rules are essential, particularly in contexts like insurance in the USA, to prevent unfair discrimination. Actuarial justifications, which establish relationships between insured individuals' characteristics and outcomes, must be scrutinized, especially regarding traits like race due to their historical context and societal impact. Predictive models used by insurance companies may inadvertently perpetuate social inequalities and historical biases. This underscores the importance of regulatory oversight in order promote fairness and accountability in insurance practices (Ho et al, 2020).

Participatory mechanisms offer a pathway to enhance transparency and public trust in the management of personal data, especially in the context of big data analytics. By involving individuals in decisions regarding data consolidation and sharing with insurers, biases can be minimized, and confidence in fair treatment can be bolstered. This approach aligns with principles of privacy outlined in regulations like the General Data Protection Regulation and underscores the importance of a human-centered approach advocated by the European Commission. Empowering individuals through participatory mechanisms can also facilitate the implementation of value-based insurance designs aimed at improving quality and reducing costs by promoting access to high-value clinical services. In the realm of collaborative governance, decentralized and collaborative regulation of big data analytics is gaining prominence. Establishing platforms for insurers and governance bodies to collaborate ensures greater transparency and accuracy in data analytics practices. Addressing issues such as unfair discrimination requires close collaboration to identify and rectify flaws in analytical models, data quality, and subjective judgments. Despite the proliferation of big data, concerns about data quality and reliability remain significant, necessitating efforts to enhance interoperability in data infrastructures. As financing systems become more complex, effective collaboration between insurers and regulators becomes imperative to navigate these challenges effectively (Ho et al, 2020).

4.2 Technical challenges

While AI offers numerous advantages, it also has affected the economy, mobility, security, and the environment. The risks and benefits associated with AI will manifest over different time frames depending on how quickly AI applications are implemented in the real world. The pace of adoption hinges on the level of investment in research and development across various fields. As responsibility shifts from humans to machines,

companies encounter new liability scenarios and challenges. Insurers face a dual-edged sword due to the volume of data they possess: managing and extracting meaningful insights can be difficult, yet it also demands significant computing power and careful management to produce valuable learning. Developing AI is costly due to its complexity, and its repair and maintenance also require substantial expenses. Moreover, AI's tendency to replace human labor will disrupt the job market, causing job losses and economic displacement while altering long-established roles. Although some jobs will be lost, particularly among those lacking the necessary skills, many higher-skilled positions will emerge. Concerns about personal data are heightened, especially regarding its use to enhance AI intelligence. The insurance industry will need to better address new exposures such as cyber-attacks, business interruptions, product recalls, and reputational damage from negative incidents. Developing effective risk management strategies will be crucial to maximizing the benefits of AI as it becomes more integrated into society (Ayyaswamy, 2023).

The challenges in AI adoption can be categorized into two main areas: challenges related to algorithms, including transparency, reliability, and bias, and issues stemming from AI's ever-evolving nature. In addressing the latter group, several key challenges emerge (Smietanka et al, 2021):

- technological stack and lack of technical expertise: organizations must possess a comprehensive understanding of current AI technologies and their limitations to implement AI applications. It is necessary for adopted technologies to align with business needs and offer flexibility for integrating various data sources. Additionally, AI solutions require rapid processing capabilities, necessitating robust foundation
- data strategy: managing vast amounts of data from customers, core systems, and brokers is crucial. AI often deals with diverse data types, including text, voice, video, image, and IoT sensor data. Leveraging AI to its fullest potential requires utilizing all available data sources, which may vary in structure, semi-structure, and unstructured nature, as well as real-time, historical, and third-party data. Integrating and managing these diverse data sources while ensuring data quality poses significant challenges. Moreover, insurance companies need efficient mechanisms to retain authority over their data and prevent disintermediation by brokers
- resistance to AI adoption: convincing both employees and customers of the benefits of AI innovation is essential. Staff need to understand that AI is aimed at enhancing decision-making efficiency, leading to improved operational processes, while customers can benefit from more accurate risk assessment and personalized product offerings. Overcoming aversion towards AI requires a concerted effort to demonstrate its positive impact on all stakeholders.

5 FUTURE TRENDS AND OPPORTUNITIES

5.1 The future of AI in insurance industry

The rapid advancement of AI is driven by various factors including the proliferation of accessible data, enhanced computing capabilities, and evolving consumer expectations. Its widespread adoption across various industries has surged in recent years, presenting numerous business opportunities and significantly enhancing organizational efficiency across sectors, including insurance. Major corporations like IBM, Apple, Facebook, and Amazon are harnessing AI platforms to deliver benefits to their customers, employees, and partners. This technology operates on data to govern machines, generate forecasts, and execute actions. Insurers are increasingly investing in virtual assistants such as Chatbots to enhance customer experiences. These Chatbots, designed to mimic human behavior, offer digital services capable of engaging in natural-sounding conversations with humans. They play a pivotal role in providing customer support and other assistance, thereby fostering brand loyalty by offering services like basic advice, checking billing information, and addressing common inquiries. AI technology continues to evolve and refine various tasks, overcoming historical challenges that were once daunting for computers. With advancements in computing power, memory capacity, big data analytics, cloud computing, and global connectivity, machines now perform tasks faster and more accurately than ever before (Gupta, 2020).

AI holds the potential to revolutionize the operational framework of insurers in following ways (Gupta, 2020):

- enhancing task efficiency through robotic process automation (RPA), which streamlines simple, repetitive tasks previously handled by operational teams, while trained AI models now inform or execute more intricate actions
- fine-tuning the service delivery, or 'next best action,' provided to customers, brokers, and external stakeholders, leveraging insights from their relationships, preferences, and past engagements
- unveiling novel insights for adjusting and ultimately optimizing insurers' pricing strategies, product distribution channels, and risk management approaches
- undergoing a fundamental shift in operational paradigms, both in daily operations and long-term strategies. This evolution entails transitioning from traditional coding methods for complex processes to iterative utilization of trained AI models with extensive enterprise datasets.

Data science and AI are fundamentally transforming the insurance sector, giving rise to a new wave of InsurTech firms that prioritize data-driven approaches, akin to industry giants like Amazon. Events such as the Covid-19 pandemic are acting as catalysts, hastening changes in how we conduct work and make purchasing decisions. With the

insurance industry already amassing vast amounts of data, there are significant chances to use machine learning to discern concerned trends, unforeseen connections, customer behaviors, and potential risks. This facilitates risk assessment for both institutions and individuals, as well as the development of intricate models that can forecast extended scenarios. However, while data science technologies provide unprecedented data volumes and analytical capabilities, their transformative impact also introduces novel business challenges. To fully grasp the potential of data-driven insurance, it's imperative to comprehend the array of data science technologies contributing to this paradigm shift (Smietanka et al, 2021).

5.2 Four AI-related trends shaping insurance

5.2.1 Explosion of data from connected devices

In industrial settings, sensor-equipped technology has been common for a long time, but in the coming time, there will be a major increase in the number of connected consumer devices. The proliferation of devices such as cars, smartphones and smartwatches will still rise swiftly, alongside emerging categories such as wearable clothing, eyewear and household appliances. Experts predict that by 2025, there could be as many as one trillion interconnected devices. The influx of data generated by these devices will allow service providers to gain deeper insights into their customers, resulting in the development of new product categories, personalized pricing models, and faster service delivery (Balasubramanian et al, 2021).

For instance, a wearable device linked to an actuarial database could compute an individual's personalized risk assessment derived from their everyday routines.

In swiftly changing realm of data management, combining Internet of Things (IoT) technology with master data management is proving to be a transformative force, revolutionizing how organizations manage and extract value from their data assets. As we move through the era of digital transformation, the connectivity of devices and the explosion of data have introduced new opportunities and challenges. This introduction offers a comprehensive overview of the key concepts, motivations, and goals driving the integration of IoT into master data management systems. The rapid increase in IoT devices has resulted in an overwhelming influx of insights, such as sensors, smart devices, industrial machinery, and consumer products. While this influx holds immense potential for insights, it also creates complex data management challenges. Traditional data governance and management methods are inadequate for handling the volume, velocity, and variety of data produced by IoT devices. This is where integrating IoT with master data management becomes crucial (Pansara, 2022).

In the evolving digital economy, the concept of data ownership is often likened to the trade of commodities. However, this perspective may not fully address the complexities

and needs of the digital economy, especially concerning connected devices. Users of such devices typically require access to real-time data rather than ownership of entire datasets, which is essential for connecting multiple devices or enabling third-party services. For instance, data portability is crucial when switching service providers, but generally, users need continuous access to live data rather than a one-time data transfer. Connected devices collect and process various types of data, depending on their specific functions. Simple devices like smart meters or smoke detectors collect specific data, while more complex devices like connected cars collect and analyze data to operate autonomously. These devices use data analytics, machine learning, and AI to make independent choices driven by data from embedded sensors and external inputs, such as other connected devices. For example, autonomous cars rely on data sharing among vehicles and infrastructure to navigate safely, highlighting that the value lies in the information derived from data analysis rather than the raw data itself. The complexity of data generation and analysis in connected systems poses challenges for defining data ownership. Data is produced through multiple stages of analysis, often involving numerous contributors, including device manufacturers, software developers, and external data providers. Identifying a single data producer is difficult, and granting ownership rights could lead to overlapping claims and legal complexities. Instead, focusing on data access rights, where parties with legitimate interests can access necessary data, may be more practical. This approach avoids the pitfalls of stringent ownership rules and facilitates technological development and innovation. For example, farmers should have access to data collected by machinery operating on their land, reflecting their legitimate interest in that data. Data access rights are less intrusive and can be tailored to specific scenarios, ensuring that essential data sharing is not hindered by legal uncertainties (Drexl, 2018).

Drexl (2021) broadly defines ‘connected devices’ as those that (1) connect with other entities through wired or wireless communication and (2) generate data. These devices do not need to be 'intelligent' or have embedded AI systems, nor do they need to make autonomous decisions. This broad definition includes larger networks where specific functions are distributed across multiple units. For example, in a medication monitoring system, a drug with an embedded sensor can send information about patient ingestion to a wearable device, which then communicates with the pharmaceutical company's central server for analysis and subsequent actions by either humans or autonomous agents. The term ‘connected devices’ is used in a technologically neutral way, encompassing various forms of data generation, including sensor technology in cars, farming machines, and wearables, as well as devices without sensors, like smart meters. These devices are not limited to those communicating autonomously via the Internet of Things; devices such as PCs, tablets, and smartphones used for human communication also fall under this definition. Human decisions often influence data collection through connected devices, as illustrated by the example where a patient initiates data collection by taking a drug. The extent of human influence is irrelevant to whether a data access right should exist. Additionally, connected devices may share dynamic data in real-time within larger

networks, without necessarily storing the data. These devices operate using both autonomously generated data and data received from other sources through wired or wireless means.

5.2.2 Increased prevalence of physical robots

Realm of robotics witnessed numerous remarkable advancements recently, and this progression will continue to revolutionize human interactions with their surroundings. Additive manufacturing, commonly referred to as 3-D printing, significantly transforms manufacturing processes and shapes the landscape of future commercial insurance products. It is anticipated that by 2025, buildings constructed via 3-D printing will become commonplace, prompting insurers to reassess their approaches to risk evaluation. Furthermore, programmable, autonomous drones, self-sufficient agricultural machinery, and advanced surgical robots are poised to become economically feasible in the next years. By 2030, a considerable portion of conventional cars will incorporate self-driving technology. Insurers must understand the impact of the increasing use of robotics in everyday life and various sectors, as it changes risk patterns, reshapes consumer expectations, and pave the way for new products and distribution methods and facilitates the emergence of novel products and distribution channels (Balasubramanian et al, 2021).

While the notion that robots and humans should remain separate was long-held, a shift has emerged, especially over the past decade, suggesting that humans and robots can and should coexist in the same environments. Robots are increasingly becoming part of daily life, serving as companions for the elderly, aids for children with autism, surgical tools, delivery agents, and security guards. Due to the lack of clear ontological and legal definitions for this emerging technology, the law often relies on familiar metaphors and existing frameworks to navigate the new and unknown. In 2017, the European Parliament proposed guidelines on Robotics, suggesting the creation of an electronic personhood for "intelligent" robotic entities. In legal terminology, "legal person" refers to an autonomous entity capable of holding legal relations. This concept assumes that all legal relations occur between natural persons (humans) and artificial legal persons (such as corporations). Therefore, "natural person" denotes a human being, while "legal person" or "legal entity" refers to an artificial legal person (Avila Negri, 2021).

Gunkel (2018) emphasizes the need to differentiate between whether AI "can" and "should" be granted legal personhood, as well as distinguishing between natural and legal personhood. While legal personhood can be separate from the human substrate, meaning AI could theoretically be considered a legal person, this does not necessarily imply it should be done. It's crucial to distinguish between moral personhood and legal rights, noting that recognizing certain legal rights for AI doesn't equate to acknowledging them as moral persons or granting them comprehensive legal personality. The concept of a legal entity serves as a decision-making structure in law, simplifying complex problems

through heuristics or mental shortcuts. In the discussion surrounding electronic legal status, the process of granting legal status to corporations is often assumed to be straightforward, but it is not without its challenges. It underscores the need of understanding the term "legal person" within legal contexts, beyond anthropomorphic analogies and simplistic comparisons to corporations.

The connection between technology and law often relies on metaphors, which help achieve a persuasive impact by contrasting various concepts. In managing various robot types, multiple competing metaphors arise, and the choice of metaphor significantly impacts the success or failure of regulatory efforts. For instance, equating drones with “aircraft” has resulted in stringent usage limitations. Similarly, in USA, regulatory agencies likened surgical robots to laparoscopic surgery, expediting their approval process. A particularly appealing metaphor, both in law and other robotics fields, is viewing robots through anthropomorphic rhetoric, as if they were humans. Given that popular imagery of robots often includes human-like artefacts, it seems natural for the law to adopt this comparison. However, it is essential to first gain a deeper understanding of the technology. There are three key characteristics of robots: embodiment, emergence, and social meaning. Embodiment, a primary feature of robots, enables them to coexist in the same physical space as humans. This corporeality enables robots to perceive other bodies and objects, requiring them to be programmed to avoid collisions using sensors that provide information about their surroundings. Despite appearances, uncertainty is inherent in robotics because robots operate in environments where it is challenging to determine their precise condition and the state of their surroundings. The physical nature of robots is not just an aesthetic concern; it influences their design and societal expectations. It can be questioned whether society views robots as virtual butlers, pets, or children, noting that these perceptions shape their physical presentation and configuration. The attributing responsibility to robots involves experiencing and perceiving their form and performance. This refers to the responsibility humans assign to one another and certain non-humans, depending on how they are perceived or experienced. Sophia, the humanoid robot, exemplifies how human appearance can mislead people into thinking of robots as humans, which can be dangerous for regulatory initiatives. The anthropomorphic form creates false assumptions about a robot's capabilities. Even robots without human-like shapes can have human qualities projected onto them, such as consciousness and intelligence. As robots become more autonomous and the connection between their inputs and behavior becomes less clear, analogies with human beings are reinforced. This complicates ethical debates and legal issues, such as determining liability for damages caused by robots (Avila Negri, 2021).

5.2.3 Open-source and data ecosystems

With the widespread availability of data, open-source protocols will arise to facilitate the sharing and utilization of data across different sectors. Both public and private

organizations will collaborate to establish ecosystems aimed at sharing data for diverse purposes, operating within a unified regulatory and cybersecurity framework. For instance, wearable data could be seamlessly transmitted to insurance providers, while data from connected home and automotive systems could be accessed through platforms like Amazon, Apple, Google, and various consumer device manufacturers (Balasubramanian et al, 2021).

In recent years, the effective use of machine learning and AI has become a critical factor for the competitiveness of individual companies and entire economies. With advances in algorithms and computing power, tasks previously requiring human intelligence can now be automated, significantly increasing efficiency and enabling new products and services. However, the availability of data has been a major challenge, particularly for companies without extensive digital resources. Typically, AI applications have relied solely on within-company data, limiting the quality and feasibility of AI deployment (Hecker et al, 2022).

Large language models are significantly transforming various aspects of software engineering. Large languague models have greatly influenced software engineering methodologies, as illustrated by tools like MetaGPT, which can generate code from human language descriptions. MetaGPT mimics the software development process by simulating team collaboration and utilizing the programming capabilities of large languague models. Despite its simplicity compared to agile development and its lack of security and quality assurance measures, MetaGPT showcases the potential of large languague models in software engineering. Researchers have developed numerous code models, categorized into pre-trained code models (small) and foundational code models (large). Notable pre-trained models include CodeBERT, CodeGPT, and GraphCodeBERT, while foundational models include CodeLlama, StarCoder, and CodeT5+. These models have become essential AI-based software engineering tools, such as the bug-fixing tool SWE-agent. Expert models, such as code repair models, are being trained based on these pre-trained or foundational code models. Currently, open-source code models are primarily developed and published by single teams using open-source data. However, there are three major limitations in this approach: limited access to high-quality code data, insufficient community support, and inadequate training hardware resources (Lin et al., 2024).

First, the quality of data is crucial for the performance of AI models. Currently, most open-source code models rely on publicly available code datasets, but the growth rate of high-quality open-source code data has not kept pace with the rapid improvement of large languague model capabilities. According to the law of scaling, the performance of a model is directly proportional to the amount of high-quality data it is trained on. Therefore, there is an urgent need for more high-quality code data to develop more powerful code models. Second, despite their widespread application in areas like vulnerability detection, open-source models lack the strong community support typical of

traditional software engineering tools. These models often function as isolated information islands, with individual entities independently training and releasing models using open-source data. In the era of large languague models reshaping software engineering, this pattern needs updating. For instance, if someone notices underperformance in vulnerability detection systems, they might retrain the model with additional data to address the issue. However, the improved model remains isolated and unverified for maintaining its original performance levels. Similar independent upgrades by different individuals lead to difficulties in locating and trusting these enhancements. Third, the current model of unipartite participation is economically inefficient, as different developers or teams redundantly train on the same dataset. The training process for AI models consumes significant resources, such as electricity, leading to wastage when the same work is repeated by multiple entities (Lin et al., 2024).

According to Curry et al. (2023), the intertwined ecosystems of AI and data significantly influence our modern computing environment. These ecosystems have a symbiotic relationship: the data ecosystem supplies the raw material for data-driven AI models, while the AI ecosystem provides the tools to extract value and insights from data. Recent advancements in AI and machine learning are driving a shift towards creating large, task-agnostic models pre-trained on vast amounts of web-scale data. These foundational models are then tailored to specific tasks through transfer learning and fine-tuning techniques. Such models have the potential to revolutionize how society interacts with and creates digital resources, enabling new methods of information retrieval, content creation, and digital work. Simultaneously, there is a trend towards developing large-scale data-sharing infrastructures and platforms to support data flows within data ecosystems. One significant effort in this area is Data Spaces, which is central to the European Data Strategy. Data Spaces aim to provide access to high-quality data for AI, offering the necessary technical and governance frameworks to facilitate data flow among participants within a data ecosystem.

The development of a digitally sovereign, secure, and economically viable architecture for shared data spaces and digital ecosystems across different partners is a game changer for the use of machine learning and AI. By sharing data along the value chain or with complementary partners, new data sources can be integrated into machine learning applications in an organized and self-determined manner. Participants in the ecosystem control data availability and accessibility, enabling more data to be shared. Additionally, the semantic interoperability and unified data modeling of the data space allow for the integration of different data sources with significantly less effort compared to traditional approaches. As more complementary data sources become available, the quality and scope of machine learning results improve dramatically. The distributed nature of a data space allows companies to leverage novel, distributed machine learning approaches, where data can be processed locally at the edge of data space nodes. This ensures data confidentiality and offers considerable savings and scalability potential. Embedding

machine learning and AI applications into data ecosystems using data space architectures not only makes AI accessible to organizations outside the traditional data-intensive digital sector but also provides significant benefits for those already using AI by enabling a distributed perspective on AI systems (Hecker et al, 2022).

Although the concept of a "data ecosystem" is not new, its frequent usage began in the early 2010s. Rooted in biological-ecosystem theories that highlight the interactions among different species in a natural environment as an interconnected system, this perspective has led to new research areas, each inheriting specific aspects of the biological-ecosystem view. In business and management, the concept of a "business ecosystem" was developed to describe an economic community of actors such as producers, suppliers, competitors, and stakeholders. Through cooperation and competition, this community creates new products or services for customers, who are also part of the ecosystem. With digital transformation and the rise of digital technologies, the term "digital ecosystem" emerged, referring to a collection of digital entities like software, hardware, and processes within a virtual environment. Unlike traditional ecosystems, digital ecosystems are generative, not controlled by tightly enforced rules of a platform owner, and have open boundary resources, allowing the use of heterogeneous digital resources to create new products. A digital ecosystem is described as a collective of firms united by a common interest in advancing a digital technology to enhance their product or service innovation, leveraging network effects to grow and aligning intellectual capacities to improve the technology. A "digital business ecosystem" combines these concepts, defined as a socio-technical environment of individuals, organizations, and digital technologies with collaborative and competitive relationships that co-create value through shared digital platforms. This concept recognizes the crucial role of digital technologies and interconnected entities in value co-creation. Technologically, it represents a distributed computing infrastructure supporting small and medium-sized enterprises in global competition. As a project, it involves a research program focused on developing tools for global collaboration and competition using information and communication technologies. This view attributes four key characteristics to digital business models: platforms, symbiosis, co-evolution, and self-organization. Platforms consist of tools, innovations, and services that actors in the ecosystem can use to enhance performance, collaboration, and innovation, encompassing hardware, software, and networks, such as Apple’s iPhone or the App Store. Symbiosis refers to the interconnectedness of the ecosystem’s actors, technologies, and processes. Co-evolution denotes the ability of a digital business ecosystem and its actors to transform collectively from one stage to another, while self-organization is the capacity to learn from and adapt to the changing environment (Toorajipour, 2024).

The rapid expansion of AI systems across various sectors such as healthcare, education, and industry offer significant opportunities for societal and scientific advancement. However, it also introduces several challenges that must be addressed:

- lack of data availability: data serves as the essential raw material for data-driven AI, enabling AI models to learn and perform tasks effectively in real-world settings. Sufficient high-quality data is crucial for effective learning and minimizing bias in AI models, thus ensuring the development of robust AI systems
- trust and provenance: effective sharing of AI models within ecosystems requires strategies to establish and maintain trust in the models' performance across different environments. Understanding data quality and provenance, along with protecting sensitive data, is essential to ensure the integrity and trustworthiness of AI models
- computational infrastructure: the creation of large-scale AI models, trained on massive datasets with billions of parameters, demands extensive computational resources and data storage. Scaling up the appropriate computational infrastructure is necessary to manage these resources effectively and to develop models capable of operating efficiently under resource constraints.

5.2.4 Advances in cognitive technologies

Convolutional neural networks, currently predominantly employed for tasks like image recognition, speech recognition, and processing unstructured text, will undergo evolution to find applications in a broad spectrum of fields. These cognitive technologies, modeled after the human brain’s ability to learn through analysis and reasoning, are set to become the standard method for managing the complex and extensive data flows generated by "active" insurance products tied to individual behaviors and activities. As these technologies become more commercially accessible, insurers will gain access to models that continuously evolve and adjust to their surroundings. This will facilitate the emergence of novel product categories and engagement strategies, while simultaneously enabling insurers to promptly adapt to shifts in underlying risks or behaviors (Balasubramanian et al, 2021).

Cognitive technology, also known as cognition-related technology, serves as an overarching term encompassing technologies that aid, enrich, or emulate cognitive processes or those utilized by humans to accomplish cognitive objectives. First introduced in the realm of educational psychology, the concept of cognitive technology described methods and instruments facilitating cognitive functions like learning and problem-solving. With the progression of individual computing, cognitive technology has broadened to include digital environments, novel computer devices, and software applications, as well as other informational tools and resources that enhance or expand human cognition (Dascal & Dror, 2005).

In the past decade, alongside the progress in AI, the concept of cognitive technology has surged in significance within computer science and the information and communication technology industry. Cognitive technology refers to information technologies that can execute cognitive functions, particularly when applied to aid and impact human cognitive

processes. IBM has emphasized cognitive technology in their business evolution, labeling it the cognitive era (Ienca, 2019).

Artificial intelligence and cognitive technologies are now common terms in science, business, and technology. However, in broader society, they are often associated with science fiction films. This is particularly true for AI, despite many people using AI-based solutions without realizing it. The term cognitive technologies are less well-known, although cognitive systems and tools are used daily. Cognitive technology is defined as a branch of computer science that replicates human brain functions using different techniques. Predictions suggest these technologies will significantly influence human-technology interactions in areas like automation, robotics, machine learning, and IT. Cognitive technologies are considered a subset of the broader field of AI, which is often viewed as a part of biomimetics. AI research has a long history, while cognitive technologies have primarily evolved from the Internet, particularly the web and cloud. IBM's Watson is a notable example of cognitive technology, and its use in Netflix's streaming service has been a key factor in the company's success. Some definitions also consider cognitive technologies to encompass AI, advanced analytics, high-performance computing, and cyber-physical systems (Kuzior & Kwilinski, 2022).

Cognitive technology is a broad domain that includes, at minimum, two primary subdomains (Ienca, 2019):

- neurotechnologies: devices or systems connecting with human nervous systems to aid, amplify, or observe inherent cognitive functions
- AI systems: synthetic systems emulating (parts of) intelligence and demonstrating it in various processes such as logic, strategizing, education, linguistic analysis, perception, and physical interaction with objects.

According to Ienca (2019), neurotechnologies encompass a range of tools and systems such as brain-computer interfaces (BCIs), electrical and magnetic brain stimulation, neurosensor-driven vehicle control systems, real-time neural monitoring, and neural prosthetics, to name a few. These technologies facilitate connections between the human nervous system and computing devices for various purposes. Neurotechnologies and artificial intelligent systems are considered cognitive technologies when they aim to influence, assist, or enhance human cognitive abilities. They differ in their approach to affecting cognition: neurotechnologies typically intervene directly in internal information processing by mapping or modifying neurobiology, while artificial intelligent systems operate on external processing systems, emulating human intelligence and providing external cognitive resources without directly interfacing with the nervous system. This external support can sometimes function similarly to internal cognitive processes, leading some researchers to consider these technologies as extensions of the human mind.

According to Hollowell et al. (2019), cognitive technologies are frequently discussed in relation to the fourth industrial revolution and the advancement of Industry 4.0. They are also associated with contemporary business service solutions.

The insurance industry is fundamentally built on the promise of trust, traditionally represented by agents. However, the advent of digital virtual assistants and cognitive systems is challenging this foundation by significantly enhancing the quality and quantity of available assistance. While using cognitive systems as advisory tools may initially benefit intermediaries, these systems are becoming increasingly capable of acting as standalone insurance experts, potentially reducing the necessity for human staff. The possible drawbacks of automation are reduced human interaction, systemic bias in algorithms, and increased vulnerability to cyberattacks. These risks counterbalance the potential benefits that automation provides (Apergis, 2024).

There has been limited academic research on the intersection of cognitive scripts and insurance. Alford's (1998) article examined the sequence of activities undertaken by individuals visiting professional services, such as dentists, and tested the use of scripts in evaluating service delivery. Alford's study found that offering dental insurance was beneficial, but it differed from online settings as it involved physical visits to the dentist. The second article, by Ainscough (1996), explored the use of cognitive scripts in the context of life insurance sales and computerized expert systems. This study involved 40 expert sales agents across four sales regions. Ainscough found that expert systems, which mimic human expert reasoning to provide advice, were highly effective in processing customer information quickly and intelligently. The results indicated that life insurance sales benefited from these systems due to the need for rapid and intelligent customer interactions. The life insurance industry was noted for its high profitability, with significant sales growth reported in recent years.

5.3 The state of insurance in 2030

Artificial intelligence and its associated technologies are poised to bring about profound changes across every facet of the insurance sector, spanning from distribution and underwriting to pricing and claims processing. The utilization of advanced technologies and data is already reshaping distribution and underwriting processes, enabling policies to be priced, bought, and finalized almost instantaneously. A comprehensive exploration of the potential landscape of insurance in 2030 reveals sweeping transformations throughout the entire insurance value chain (Balasubramanian et al, 2021).

The process of buying insurance has become quicker and requires less active participation from both the insurer and the customer. With AI algorithms generating risk profiles based on individual behavior, the time needed to complete the purchase of auto, commercial, or life insurance policies will be reduced to mere minutes or even seconds. While auto and home insurers have been offering instant quotes for some time, they will continue to

enhance their ability to issue policies immediately to a broader customer base as telematics and in-home Internet of Things devices become more widespread and pricing algorithms advance. Although many life insurers are exploring simplified issue products, these are currently limited to the healthiest applicants and are priced higher than fully underwritten products of similar nature. However, as AI becomes integrated into life insurance underwriting processes, allowing carriers to identify risks in a more precise and sophisticated manner, a new wave of mass-market instant issue products is anticipated. Blockchain-enabled smart contracts enable instant authorization of payments directly from a customer's financial account. This eliminates or streamlines contract processing and payment verification, thereby reducing customer acquisition costs for insurers. The purchase of commercial insurance is likewise expedited through the utilization of drones, IoT devices, and other available data sources, which provide sufficient information for AI-driven cognitive models to generate bindable quotes proactively (Kaesler et al., 2020).

By 2030, the role of insurance agents undergoes significant transformation. The number of agents dwindles as active agents retire, and those remaining rely heavily on technology to enhance productivity. Agents shift to becoming facilitators of processes and educators on products. The agents of the future have the capability to sell various types of coverage and provide value by assisting clients in managing their coverage portfolios across different aspects of life, including experiences, health, life, mobility, personal property, and residential needs. They utilize smart personal assistants and AI-powered bots to optimize their tasks and find potential deals for clients. These tools enable agents to serve a much larger client base while making customer interactions, whether in-person, virtual, or digital, more efficient and meaningful, as each interaction is tailored to the specific current and future requirements of individual clients (Balasubramanian et al, 2021).

According to Balasubramanian et al. (2020), by 2030, traditional underwriting processes for most personal and small-business insurance products in life and property and casualty insurance will be rendered obsolete. Underwriting is streamlined to a matter of seconds, with automation playing a dominant role and supported by a blend of machine and deep learning models integrated into the technological infrastructure. These models draw upon both internal and extensive external data accessed through application programming interfaces and external data and analytics providers. Data gathered from devices provided by major insurers, reinsurers, product manufacturers, and distributors are consolidated in various data repositories and streams. This wealth of information empowers insurers to make informed decisions regarding underwriting and pricing in advance, facilitating proactive engagement by offering a customized product bundle tailored to the buyer's risk profile and coverage requirements. Regulators are tasked with reviewing AI-driven, machine learning–based models, necessitating a transparent approach to trace the derivation of a score (similar to the methodology used currently with regression-based coefficients). To ensure the appropriateness of data usage for marketing and underwriting purposes, regulators evaluate a combination of model inputs. They also devise test

policies for providers when determining rates in online plans to ensure that algorithmic outcomes fall within approved parameters. Public policy considerations impose restrictions on access to certain sensitive and predictive data (such as health and genetic information), which could otherwise limit underwriting and pricing flexibility and heighten the risk of adverse selection in certain segments.

By 2030, claims processing remains a core function of insurers, yet automation has revolutionized over half of claims operations. Cutting-edge algorithms manage initial claims routing, significantly enhancing efficiency and precision. Traditional manual methods for first notice of loss are largely supplanted by IoT sensors and various data-capture technologies like drones. Automated claims triage and repair services are frequently initiated immediately following a loss event. For instance, in the event of a car accident, a policyholder captures streaming video of the damage, which is then translated into loss descriptions and estimated amounts. Vehicles equipped with autonomous features, sustaining minor damage, autonomously navigate to repair shops for servicing, while another autonomous vehicle is dispatched temporarily. Within homes, IoT devices are increasingly utilized for proactive monitoring of water levels, temperature, and other critical risk factors, promptly alerting both occupants and insurers of potential issues before they escalate (Fong et al., 2020).

Automated customer service applications now handle the majority of interactions with policyholders, utilizing self-learning scripts to engage via voice and text across various systems such as claims, fraud detection, medical services, policies, and repairs. Claim resolution times have drastically reduced, often resolved within minutes. Human involvement in claims management primarily focuses on complex cases, contested claims, systemic risks from emerging technologies, and manual reviews for oversight. Claims organizations emphasize risk monitoring and prevention, utilizing IoT and new data sources to intervene when risks surpass predefined thresholds. Real-time alerts and interventions aim to prevent potential losses, especially during catastrophes, where integrated IoT, telematics, and mobile data are employed to monitor properties and vehicles. In case of power outages, insurers can prefile claims using real-time data aggregation from various sources, ensuring accurate loss estimations and prompt reinsurance capital flow (Balasubramanian et al, 2021).

Balasubramanian et al. (2021) offer following advice on how insurers can prepare for accelerating changes:

- gain expertise in ai technologies and trends: while industry changes will be heavily tech-focused, managing these shifts isn't solely the responsibility of the IT team. Board members and customer-experience teams need to invest time and resources to deeply understand AI-related technologies. This involves exploring hypothesis-driven scenarios to predict potential disruptions and their impact on different business lines. For instance, insurers shouldn't rely on small-scale IoT pilot projects in isolated

business areas. Instead, they should have a clear strategy for participating in the IoT ecosystem on a large scale. Pilots and proof-of-concept (POC) projects should test not only the technology's functionality but also the insurer's ability to operate effectively within a data- or IoT-based ecosystem

- formulate and implement a comprehensive strategic plan: based on insights gained from AI explorations, insurers must determine how to integrate technology into their business strategy. Senior leadership should create a long-term strategic plan involving a multiyear transformation covering operations, talent, and technology. Some insurers are already innovating by establishing venture-capital arms, acquiring insurtech companies, and partnering with academic institutions. Insurers need to decide where to invest to stay competitive and whether to form new entities or build in-house strategic capabilities. This plan should encompass all dimensions of large-scale, analytics-based initiatives, including data, people, and culture. It should provide a roadmap for AI-based pilots and POCs and identify areas needing skill development or change management. A detailed schedule of milestones and checkpoints is crucial for regularly adjusting the plan in response to AI technology advancements and industry changes. In addition to understanding and implementing AI technologies, insurers must develop strategic responses to macro-level changes. As the industry shifts towards a "predict and prevent" approach, insurers need to rethink customer engagement, branding, product design, and core earnings. Self-driving vehicles will reduce auto accidents, IoT devices will prevent in-home flooding, buildings will be reprinted post-disaster, and healthcare improvements will save lives. However, vehicles will still break down, natural disasters will occur, and people will need medical care and support in times of loss. As these changes take effect, profit pools will shift, new product lines will emerge, and consumer interactions with insurers will evolve significantly. Future successful insurers will develop and execute strategic plans that align their brand, products, customer interactions, and technology with the new economic landscape. These efforts will lead to a coherent analytics and technology strategy that addresses all business aspects, focusing on value creation and differentiation
- develop and implement a comprehensive data strategy: data is becoming one of the most valuable assets for any organization, including the insurance industry. Effective risk management depends on the quality and volume of data collected throughout a policy's life cycle. AI technologies require vast amounts of data from diverse sources to function optimally. Therefore, carriers must establish a robust and actionable data strategy encompassing both internal and external data. Internal data should be organized to support agile development of new analytical insights. For external data, carriers need to secure cost-effective access to high-quality, complementary data. Given the fragmented nature of the external data ecosystem, identifying and acquiring valuable data affordably will be challenging. A comprehensive data strategy should include multiple approaches to obtain and integrate external data, such as direct acquisition, licensing, using data APIs, and forming partnerships with data brokers

- build the right talent and technology infrastructure: in AI-augmented environments, average players aided by AI often outperform experts with the same AI due to their willingness to embrace and understand the technology. To make advanced analytics a core capability, insurers need sustained investments in talent. Future insurance organizations will need employees with the right mindset and skills, capable of handling semi-automated, evolving tasks. Generating value from AI will require integrating skills, technology, and insights across the organization to deliver unique customer experiences. This shift will necessitate a cultural change driven by executive leadership. Developing an aggressive strategy to attract, cultivate, and retain talent is essential, including roles such as data engineers, data scientists, technologists, cloud computing specialists, and experience designers. Organizations should implement reskilling programs to retain knowledge while acquiring new skills. Additionally, identifying external resources and partners will help augment in-house capabilities. Future IT architecture will differ significantly from today's. Carriers should invest in migrating to a forward-looking technology stack that supports a two-speed IT architecture. Rapid technological advances will lead to disruptive changes in the insurance industry. Successful carriers will leverage new technologies to create innovative products, harness insights from new data sources, streamline processes, reduce costs, and exceed customer expectations for personalization and adaptability. Carriers that see disruptive technologies as opportunities rather than threats will thrive in the insurance industry by 2030.

6 RESEARCH

6.1 Results

As previously mentioned, this thesis will employ a research methodology that consists of case study and structured interview. In this part of the thesis, the results of the research will be presented.

6.1.1 The interview

The interview contains five questions about AI implementation and it is conducted with two insurance professional that have been working for over 10 years in one of the most prominent insurance companies in Bosnia and Herzegovina.

First question was: "How can AI impact critical processes such as underwriting, risk assessment, and claims processing?".

The answer of respondent one: AI can significantly transform the critical processes such as underwriting, risk assessment and claims processing in insurance. Traditional underwriting often relies on historical data and manual evaluations, which are often

lengthy and prone to mistake. AI algorithms, particularly those involving machine learning, can analyze vast volumes of data, including unconventional sources like social media activity and real-time information. This allows underwriters to assess risk more accurately and efficiently, resulting in better pricing models and reduced underwriting time. Apart from that, AI enhances risk assessment by utilizing predictive analytics to identify potential risks and trends. AI-driven risk models can constantly evolve and adjust based on new data, providing insurers with up-to-date risk profiles and enabling proactive risk management strategies. AI revolutionizes claims processing by automating many of the tasks traditionally handled by human claims adjusters. Natural language processing and image recognition technologies can rapidly process and validate claims documents, photos, and other supporting materials. AI chatbots and virtual assistants can handle initial customer interactions, guiding policyholders through the claims submission process and providing real-time updates on claim status. This not only accelerates the claims process but also lowers operational costs and improves customer satisfaction by delivering quicker and more precise claim resolutions.

The answer of respondent two: AI can streamline underwriting, risk assessment, and claims processing by automating routine tasks and improving decision-making accuracy. In underwriting, AI can analyze broader data sets, enabling faster and more accurate risk evaluation. For risk assessment, AI models can identify emerging risks and predict future trends, helping insurers stay ahead of potential issues. In claims processing, AI-driven tools can expedite the validation process, reducing the need for manual intervention and enhancing overall efficiency. This leads to reduced costs, quicker service, and a more personalized customer experience.

The second question was: "How can AI contribute to operational efficiency, financial performance and customer service in insurance?".

The answer of respondent one: AI can greatly enchance operational efficiency, financial performance and customer service. Regarding operational efficiency, AI automates routine and routine tasks, like data entry, policy processing, and initial claim evaluations. This significantly lowers the time and effort required for these activities, which allows staff to concentrate on more complex and value-added tasks. Aside from that, AI systems are capable of quickly analyzing extensive data sets to uncover trends and insights. This helps in making informed decisions faster and more accurately. For example, AI can evaluate consumer data to predict policy lapses or identify high-risk areas. When it comes to financial performance, by automating tasks and reducing manual errors, AI helps in cutting down operational costs. Fewer errors mean fewer costly rectifications and better resource allocation. AI's advanced abilities to identify patterns are also instrumental in detecting deceptive claims. By identifying suspicious activities early, we can prevent significant financial losses and maintain the integrity of our claims process. In the field of customer service, AI enables personalized customer interactions by analyzing

individual customer data to provide tailored policy recommendations and services. This leads to the increase in customer satisfaction.

The answer of respondent two: AI can drive operational efficiency by streamlining processes like underwriting and claims processing, reducing manual effort and improving turnaround times. It helps financial performance by predicting trends and optimizing pricing models based on data insights, allowing for better risk management. For customer service, AI-powered chatbots and virtual assistants enhance response times and provide 24/7 support, improving overall customer experience and accessibility.

The third question was: "What challenges companies face when integrating AI into insurance operations?".

The answer of respondent one: First of all, data quality and data management are a complex issue that insurance companies face with AI integration. Since AI systems need vast quantities of high-quality data to operate efficiently, lots of insurance companies struggle with data that is incomplete, outdated, or inconsistent, which can hinder the performance of AI models. Integrating data from various sources into a cohesive format that AI can process can be very challenging. Data privacy can also be an issue. AI systems handle large volumes of personal and sensitive data, making it essential to ensure they adhere to privacy regulations and customer data protection. Apart from that, talent and expertise can also be a problem since. Therefore, many insurance companies are faced with a talent gap, as finding and retaining professionals with these skills can be difficult. There are also infrastructure barriers. Many insurance companies still depend on outdated systems that are incompatible with current AI technologies. Therefore, finances can also be a problem because AI implementation requires substantial investment.

The answer of respondent two: One of the key challenges is the resistance to change within the organization. Employees may be reluctant to adopt AI technologies, fearing job displacement or disruption of established workflows. Additionally, insurance companies face difficulty in selecting the right AI solutions for their specific needs, as there are many options available, and not all of them are suitable for every company. Finally, the cost of ongoing AI maintenance and updates can be a significant burden, especially for smaller companies with limited budgets.

The fourth question was: "What opportunities do you see for AI in the future of the insurance industry?".

The answer of respondent one: AI offers a lot of opportunities. First of all, it can improve customer experience in a way that it offers highly personalized insurance products and services by analyzing customer data to grasp personal needs and preferences, which can increase both customer satisfaction and loyalty. Artificial intelligence can also help insurance with risk assessment. It can predict risks by examining large volumes of data from diverse sources, such as social media, IoT devices and environmental sensors which

can enable more precise underwriting and risk assessment. AI can also automate the entire claims process, from initial filing to final settlement which results in faster claim resolutions and reduced operational costs. Besides that, it can also assist in detecting fraud by recognizing patterns and irregularities that signal deceptive behavior. As previously mentioned, AI can improve operational efficiency and it can reduce costs by automating various tasks like policy renewals, data entry, compliance checks etc.

The answer of respondent two: AI has great potential to transform the insurance industry by enabling more efficient decision-making and enhancing predictive analytics. It could improve underwriting accuracy, helping insurers better assess and price policies based on a deeper understanding of customer behavior and market trends. AI-powered chatbots and virtual assistants could further streamline customer service, offering real-time support and reducing human intervention. Additionally, AI could foster innovation in product development, allowing insurers to offer new, tailored solutions that better address emerging risks, such as those related to climate change or cybersecurity.

The fifth question was: "What ethical concerns have arisen from the use of AI in insurance operations?"

The answer of respondent one: There are a lot of ethical concerns that can stem from the use of AI. One such concern is the issue of prejudice. AI systems can unintentionally reinforce existing prejudices present in the training data. This may result in biased or unfair practices in underwriting and claims processing, where certain groups of people might be unfairly treated based on their personal characteristics. Privacy and data security is another area of ethical concerns. Since AI systems depend on large volumes of data, insurance companies need to make sure that the data is gathered and distributed in accordance with privacy regulations. Besides that, customers need to be informed about how their data will be utilized in AI systems. AI can also lead to job displacement. The automation of tasks using AI may result in job displacement, especially for positions involving repetitive duties, raising ethical issues regarding its impact on employees and their job security.

The answer of respondent two: One key ethical concern with AI in insurance is transparency. AI models can be complex, and it can be difficult for customers to understand how decisions are made, particularly in claims or underwriting. This lack of transparency may undermine trust in the insurance process. Another concern is accountability—if an AI system makes an error, it may be unclear who is responsible for the consequences, especially when it comes to denying claims or setting premiums. Finally, there are concerns about the potential for AI to create monopolies, as large companies with access to more data may dominate the market, limiting competition.

6.1.2 Case studies

6.1.2.1 Nordic - automating claims processing

After the interview, two case studies of AI implementation in insurance will be presented. First of two examples is a practical example of how insurance company uses AI to automate claims processing (EY, 2023).

Insurance companies face a daunting challenge in managing vast amounts of unstructured claims data, complicating efforts to automate routine tasks effectively. Embracing advanced technologies like automation and artificial intelligence (AI) is crucial for driving significant changes across insurance organizations. A leading Nordic insurance firm, facing the complexities of manually processing diverse claims data from sources such as invoices, receipts, and medical documents, sought to modernize its operations. This labor-intensive process hampered customer service efficiency, as existing technology infrastructure lacked the capacity for comprehensive automation. To address these issues, the insurer partnered with EY to assess their technological landscape and operational needs. The objective was to introduce an AI-powered system that simplifies the claims process, automates routine tasks, and enables agents to dedicate more time to strengthening customer relationships. By emphasizing human-centric AI integration, the insurer aimed to boost agent capabilities and job satisfaction, empowering them to collaborate effectively with AI for impactful outcomes. This strategic initiative not only aimed at technological enhancement but also positioned the insurer for future market expansion, leveraging AI as a catalyst for transformative growth.

Shifting the insurer’s conventional work environment necessitated the implementation of a powerful AI-driven solution. Previously, manual processing of claims required labor-intensive tasks, then submitting relevant documents to their systems. EY teams introduced EY Fabric Document Intelligence to streamline this process. The process involved agents uploading digitized copies to EY Fabric Document Intelligence, which carried out image enhancement by identifying key data, eliminating backgrounds, adjusting rotations, and minimizing noise. The tool then conducted preprocessing, document analysis, and layout analysis. Using optical character recognition (OCR) and natural language processing (NLP), it converted and classified unstructured data. Finally, the organized data was integrated into the insurer’s central claims system, significantly enhancing efficiency.

The product's capacity to process increasing volumes of documents over time signifies ongoing improvement and potential long-term value for the insurer. Beyond digitizing and organizing unstructured data, our solution leveraged EY's business insights and industry expertise within a strategic technological framework to revamp the insurer's operations. EY experts provided a wide range of services, including solution development, system integration, data analytics, project oversight, and cloud technology

proficiency, all while prioritizing a human-focused approach. Collaborating across teams from Sweden, Denmark, Spain, the US, and the UK, EY integrated Fabric Document Intelligence with the insurer's legacy system. This effort demonstrated that AI, led by humans, acts as a potent facilitator for accelerating operations.

The insurance company now experiences nearly real-time processing of claim documents. Since implementing the solution, around 70% of documents entered into the system are correctly extracted and analyzed. This improvement not only accelerates decision-making but also allows agents to focus on providing better customer service. With more time available, agents can now offer personalized guidance, strengthening relationships and building trust with clients, ultimately creating added business value. The solution was designed to provide the insurer with precise control over automation and AI, ensuring outputs are based on predefined confidence levels, thus maintaining transparency in AI usage. The client was fully involved in the decision-making process, ensuring clarity and understanding of how the solution works. The AI solution has significantly supported the insurer’s global expansion goals, driving operational efficiency and customer service improvements. These advancements have sparked interest across multiple departments within the company, which is now seeking further opportunities to modernize and capitalize on the benefits of appropriate technology. EY’s tailored solution has not only optimized the insurer’s operations but has also encouraged a broader rethink of their business strategy. The implementation has shown how AI can bring about major transformation in the industry, enhancing human capabilities while delivering significant value. Through close collaboration between EY and the insurer, the project ensured that human involvement remained central, resulting in a sustainable solution that delivers lasting impact throughout the organization.

6.1.2.2 AXA - AI virtual agents

The global pandemic accelerated AXA's digital transformation efforts, pushing the multinational insurance company towards fully implementing e-travel solutions. Today, AXA provides self-service support through various channels using virtual agents and employs state-of-the-art Born Digital technologies for data analysis and automating email processing. During the pandemic, AXA experienced a surge in contact center volumes due to complex travel restrictions. Initially focusing on enhancing customer interactions related to travel insurance, the first phase of the project introduced a voice assistant from Born Digital to automate routine inquiries. The success of Born Digital's voice assistant prompted AXA to expand its self-service capabilities, adding a chat channel and broadening the scope of topics handled by digital agents. Through an omni-channel strategy facilitated by Born Digital's solutions, AXA also implemented automated classification and processing of customer emails, completing a comprehensive suite of digital communication channels (Born Digital, 2023).

During the pandemic, AXA faced a surge of 250% in customer interactions, prompting the implementation of the Voice Assistant. Lukáš Klozík, Travel Assistance Manager at AXA, highlights that the voice assistant primarily addressed routine inquiries, providing essential information and alleviating operators from repetitive queries. The voice assistant continues to be instrumental during peak periods by gathering crucial information when all operators are occupied, directing customers to web forms and self-service options. In addition to aiding with travel insurance inquiries, it handles processes such as claim settlement, initial loss authentication (FNOL), health assistance, and damage reporting. Lukáš Klozík emphasizes that, on average, the voice assistant saves operators 3 minutes per 15-minute call, resulting in significant time and operational cost savings for AXA.

All of this helped AXA achieve:

- over 100.000 voice bot interactions,
- 20% of interactions fully automated,
- 87% of conversations handled by the chatbot.

Furthermore, due to AXA receiving a majority of evidentiary documents and information via email, automating email processing naturally followed as the next step in their digital transformation. Born Digital's email classifier swiftly categorizes incoming customer emails (e.g., medical reports), forwards them to the relevant agent, and highlights critical information. This process spares contact center employees from reading entire emails, ensuring they promptly know how to manage them. In addition, AXA integrated Born Digital's fraud detection technology. Artificial intelligence promptly assesses whether attached documents have been altered. "This helps prevent double reimbursements of insurance claims," says Lukáš Klozík from AXA.

6.2 Discussion and recommendations

The interview addressed five key questions regarding AI's impact on critical processes, operational efficiency, financial performance, customer service, challenges of AI integration, future opportunities, and ethical concerns. AI significantly transforms underwriting, risk assessment, and claims processing. Traditional methods often rely on historical data and manual assessments, leading to inefficiencies and human errors. On the other hand, AI algorithms process large volumes of data, including real-time information and social media, enhancing the accuracy and speed of underwriting and risk assessment. AI improves workflow effectiveness through the automation of repetitive tasks like data entry and policy processing, enabling employees to concentrace on complex tasks. AI's ability to analyze large data volumes aids in quicker, more accurate decision-making. Financial performance benefits from reduced operational costs and early fraud detection, which prevent significant financial losses. In customer service, AI offers personalized interactions, tailored policy recommendations, and 24/7 support via

chatbots, leading to higher customer satisfaction and loyalty. Companies face several challenges when integrating AI. Data quality and management are critical, as AI requires high-quality, cohesive data, which many companies struggle to provide. Privacy and data security must be ensured to comply with regulations. Additionally, many companies depend on legacy systems that do not support modern AI technologies, making integration costly and time-consuming. Financial investment in AI infrastructure and expertise is substantial.

According to the interview, AI presents numerous opportunities for the insurance industry. It can offer highly personalized insurance products, improving customer satisfaction and loyalty. AI enhances risk assessment by analyzing diverse data sources, enabling precise underwriting and proactive risk management. Automated claims processing leads to faster resolutions and cost reductions. AI's pattern recognition capabilities are crucial for fraud detection. Overall, AI's ability to automate various tasks enhances operational efficiency and reduces costs. Bias in AI systems has the potential to result in unfair and discriminatory practices in underwriting and claims processing, unfairly treating certain groups. Privacy and data security are paramount, requiring compliance with privacy laws and transparent data usage. AI can also lead to job displacement, raising concerns about employees' job security. Addressing these ethical issues is critical to ensuring fair and responsible AI implementation in the insurance industry.

In this research, two different case studies were presented. A leading Nordic insurance firm faced complexities in manually processing diverse claims data from invoices, receipts, and medical documents, impacting customer service efficiency due to inadequate technology infrastructure. Partnering with EY, the insurer aimed to modernize operations with an AI-driven solution that streamlines claims management, automates tasks, and enhances customer relationships through agent empowerment and collaboration with AI. The implementation not only digitized and organized unstructured data but also leveraged EY's expertise in various fields. Collaboration across international teams demonstrates AI's role in accelerating operational efficiency with human insight guiding its deployment. Achieving nearly real-time processing of claim documents post-implementation, the insurer now accurately extracts and interprets 70% of documents, accelerating decision-making and enabling agents to focus more on personalized customer interactions. This shift towards meaningful engagements strengthens client relationships, enhances trust, and drives additional business value. The solution ensures precise control over automation and AI technologies, employing a transparent approach guided by client involvement in decision-making processes. The AI has played a crucial role in driving the insurer’s global expansion efforts, garnering interest across organizational departments for further modernization opportunities. EY's tailored solution not only streamlined operations but also sparked a reimagining of the insurer's enterprise, illustrating AI's potential to transform the industry by enhancing human

capabilities and creating significant value. This collaborative effort prioritizes human-centric AI integration, delivering sustainable solutions that empower individuals and foster impactful outcomes throughout the organization.

The second case is about the implementation of virtual agents by AXA insurance business. During the COVID-19 pandemic, AXA accelerated its digital transformation initiatives, focusing particularly on implementing robust e-travel solutions. This strategic shift involved deploying virtual agents and leveraging advanced Born Digital technologies for data analysis and automating email processing. The surge in customer interactions, which increased by 250%, prompted AXA to introduce a voice assistant to manage routine inquiries effectively. This initiative not only provided essential information to customers but also relieved contact center operators from repetitive tasks, saving significant operational time and costs. The successful deployment of Born Digital's voice assistant prompted AXA to enhance its self-service capabilities further. This expansion included adding a chat channel and broadening the range of topics handled by digital agents, aiming to improve overall customer experience and operational efficiency. Additionally, AXA integrated automated classification and processing of customer emails using Born Digital's solutions, completing a comprehensive suite of digital communication channels. As a result of these efforts, AXA achieved over 100,000 interactions with the voice bot, with 20% of interactions fully automated, and 87% of conversations handled by the chatbot. Furthermore, recognizing the majority of evidentiary documents and information came via email, AXA seamlessly integrated Born Digital's email classifier. This technology swiftly categorizes incoming emails (e.g., medical reports), forwards them to the appropriate agents, and highlights critical information. This streamlined process enables contact center employees to promptly address customer queries without the need to sift through entire emails.

7 CONCLUSION

The services sector, bolstered by globalization and technological advancements, has become a vital component of the global economy, with the insurance industry playing a crucial role in economic development. Insurance services not only mitigate risks for businesses, thereby promoting investment and trade, but also support infrastructure development by covering large-scale projects like airports and power plants. Moreover, insurers contribute to financial stability by transferring risks and investing premiums, influencing stock markets and facilitating economic growth. Effective insurance regulation is essential to balance policyholder protection with industry flexibility, ensuring insurers can support economic activity through their products and investments.

AI offers numerous benefits in the insurance industry. Firstly, in underwriting, AI enhances risk assessment and customer insights by leveraging vast data sources like telematics and digital health records. For instance, Swiss Re uses AI to streamline Life &

Health underwriting, improving efficiency and decision-making with predictive models. Secondly, in claims processing, AI streamlines operations and expands coverage by predicting risks such as flight delays through models like Swiss Re's parametric Flight Delay Compensation. Additionally, AI-driven computer vision systems detect accident fraud and analyze driving behavior, exemplified by an Italian startup's technology, which records and processes video data securely. Looking forward, AI's potential in insurance includes developing intelligent virtual agents for personalized customer interactions and enhancing claims validation through advanced data analytics and predictive modeling. While AI already improves customer experience and operational efficiency in insurance, its future advancements could revolutionize fraud detection and customer service further, ultimately transforming how insurers interact with clients and manage risks.

The interview addressed AI's impact on critical processes, operational efficiency, financial performance, customer service, integration challenges, future opportunities, and ethical concerns in the insurance industry. AI significantly transforms bussinesses by covering lots of data, including real-time and non-traditional sources, improving accuracy and speed. AI increases operational efficiency, which enables shifting focus on complex issues, and aids in quicker, more accurate decision-making. Financial performance benefits from reduced costs and early fraud detection, while customer service improves through personalized interactions and tailored recommendations.

Challenges in AI integration include ensuring data quality and management, complying with privacy and data security regulations, addressing the talent gap in data science and machine learning, and upgrading outdated systems. AI implementation requires substantial financial investment in infrastructure and expertise. Despite these challenges, AI presents numerous opportunities, such as offering personalized insurance products, enhancing risk assessment, automating claims processing, and improving fraud detection. Ethical concerns include potential bias, as well as job displacement. Addressing these concerns is key for fair AI implementation in the insurance industry.

The research presented two case studies. One of them focuses on Nordic Insurance firm's challenges with manually processing diverse claims data, impacting customer service due to inadequate technology. Partnering with EY, the insurer sought to modernize operations through an AI-driven solution, enhancing claims management efficiency, automating tasks, and improving customer relationships. Collaboration across international teams enabled achieving near real-time processing of claim documents and enhancing decision-making. This AI solution not only streamlined operations but also supported the insurer's global expansion goals, emphasizing human-centric AI integration to drive sustainable solutions and create significant business value.

The second one focuses on AXA insurance company. During the COVID-19 pandemic, AXA accelerated its digital transformation efforts, focusing on robust e-travel solutions. This included deploying virtual agents and leveraging Born Digital technologies for data

analysis and email automation. With a 250% surge in customer interactions, AXA introduced a voice assistant to manage routine inquiries effectively, saving operational time and costs for contact center operators. Following the success of the voice assistant, AXA expanded its self-service capabilities by adding a chat channel and broadening the scope of topics handled by digital agents. They also integrated Born Digital's solutions for automated email classification and processing, completing a comprehensive suite of digital communication channels. AXA achieved significant milestones with over 100,000 interactions handled by the voice bot, 20% of which were fully automated, and 87% managed by the chatbot. They seamlessly integrated Born Digital's email classifier to swiftly categorize and forward emails like medical reports to the right agents, streamlining customer service operations.

To conclude the answers to the research questions will be provided. The first research question was: "How does artificial intelligence influence critical processes within the insurance industry, including underwriting, risk assessment, and claims processing?".

AI is transforming key processes in the insurance industry, particularly underwriting, risk assessment, and claims processing. In underwriting, AI enhances efficiency by analyzing vast amounts of data, such as social media and real-time information, leading to faster, more accurate risk assessments and improved pricing models. In risk assessment, AI uses predictive analytics to identify emerging trends, adapting to new data for more precise risk profiles. This enables insurers to proactively manage risks and make informed decisions. AI also aids in long-term planning, keeping insurers competitive in a changing environment.

For claims processing, AI automates tasks traditionally handled by human adjusters. Technologies like natural language processing and image recognition speed up the validation process, while AI-powered chatbots improve customer experience by guiding policyholders and providing real-time updates. This results in quicker resolutions, lower costs, and enhanced customer satisfaction.

The second research question was: "What advantages does AI bestow upon insurance companies concerning their operational efficiency, financial performance, and customer service?".

Artificial intelligence offers significant advantages to insurance companies in operational efficiency, financial performance, and customer service. AI automates routine tasks like data entry, policy processing, and initial claim evaluations, freeing up employees to focus on more complex tasks. It can also analyze large data sets quickly, uncovering trends and enabling more informed decision-making, such as predicting policy lapses or identifying high-risk areas.

In terms of financial performance, AI reduces operational costs and minimizes human errors, improving resource allocation. Its pattern recognition abilities help detect

fraudulent claims early, preventing financial losses and ensuring the integrity of the claims process. For customer service, AI-driven tools like chatbots and virtual assistants enhance accessibility, provide 24/7 support, and offer personalized recommendations based on customer data. This not only boosts customer satisfaction but also strengthens loyalty, benefiting the company's reputation and retention rates.

The third research question was: "What challenges does the AI integration pose in the insurance industry?".

Integrating AI into the insurance industry presents several challenges, primarily related to data quality and management. AI relies on large amounts of accurate, up-to-date data, but many companies struggle with incomplete or outdated data, making integration complex. Additionally, handling sensitive data raises privacy concerns and requires compliance with regulations.

A shortage of skilled professionals also hinders AI adoption, as many insurance companies face difficulties hiring and retaining experts to develop and maintain AI systems. Many companies still rely on outdated systems, which complicates AI integration further. Resistance to change within organizations is another barrier, as employees may fear job displacement or workflow disruption. Choosing the right AI solutions is also challenging due to the wide range of available options. Finally, the high costs of AI implementation and maintenance can be a financial strain, especially for smaller companies.

The fourth research question was: "What opportunities and future trends does AI introduce to the insurance domain?".

AI offers numerous opportunities in the insurance industry, particularly in personalization, operational efficiency, and innovation. By analyzing customer data, AI enables insurers to offer tailored products and services, boosting satisfaction and loyalty.

In underwriting and risk assessment, AI enhances accuracy by processing diverse data sources like social media and IoT devices, leading to better-informed decisions. AI also automates the claims process, reducing time and costs. Additionally, AI aids in fraud detection by identifying patterns early, protecting financial interests. It also fosters innovation by enabling insurers to develop new products for emerging risks, such as climate change or cybersecurity, helping companies stay competitive.

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APPENDIX

Appendix 1. Summary

Zmožnost umetne inteligence, da avtomatizira naloge, analizira velike nabore podatkov in izboljša sprejemanje odločitev, povečuje učinkovitost, produktivnost in zadovoljstvo strank v zavarovalništvu. Vendar pa integracija umetne inteligence sproža etične, družbene in zasebnostne pomisleke, zlasti glede zaupnosti podatkov, algoritemske preglednosti in morebitnih pristranskosti. Namen tega magistrskega dela je raziskati transformativni učinek umetne inteligence na zavarovalniško industrijo in preučiti njene aplikacije na ključnih področjih, kot so sklepanje zavarovanj, ocena tveganja in obdelava zahtevkov. S celovito oceno študija raziskuje, kako umetna inteligenca izboljša operativno učinkovitost, finančno uspešnost in storitve za stranke, hkrati pa obravnava izzive, povezane z njeno integracijo, kot so vprašanja glede zasebnosti, prilagajanje delovne sile in težave s skladnostjo. Raziskava uporablja kvalitativno metodologijo, ki združuje študije primerov globalnih aplikacij umetne inteligence v zavarovalništvu s polstrukturiranimi intervjuji strokovnjakov iz panoge, da bi zagotovila niansirano razumevanje priložnosti, tveganj in prihodnjih trendov, ki oblikujejo industrijo.