The Early Effects of Artificial Intelligence on the Mortgage Industry

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring 2024

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

In our rapidly transforming world of digital technology, Artificial Intelligence (AI) stands out as one of the pinnacles of innovation, constantly challenging the current way of thinking and our societal norms. Just like how the spread of electricity revolutionized industrial processes and the way of life during the 20th century (Smil, 2005), AI is projected to redefine many fields, change job descriptions, and alter how we experience things. This transformative potential of AI raises several ethical questions. Bostrom & Yudkowsky (2014) have argued that the ethical implications of AI advancements are profound, touching on issues like human well-being, autonomy, and justice. They emphasize the need for careful consideration when developing AI to make sure that these technologies will help society while reducing risks related to their decision-making. Adding to this conversation, Haenlein & Kaplan (2019) discuss how AI is set out to dramatically change the job landscape by automating tasks, leading the way for a new economy that is about human empathy and interpersonal skills. This would completely change job roles and the nature of work itself. The AI revolution is showing us that there is potential to turn even more of our remaining manual tasks into automated ones, leaving us with only the most valuable human-specific tasks.

However, these advancements are not only about working more efficiently but also about improving lives and providing new skills and opportunities to everyone. In recent years, a vast number of AI solutions have been built to tackle this challenge, with AI chatbots emerging as a prime example of these innovations. Among these chatbots, ChatGPT stands out as a cutting-edge language model, designed to simulate human-like conversation, offering a more dynamic and responsive experience compared to traditional chatbots. Eloundou et al. (2023) found that large language models like Generative Pre-trained Transformer (GPT) could affect about 80% of

the U.S. workforce. Their research estimated that 19% of jobs would be heavily influenced by AI models, including GPT-4, with at least 50% of tasks in these jobs being automated. They hypothesized that chatbot technologies will have a massive impact on higher-income jobs, especially with roles such as writers, web and digital designers, financial quantitative analysts, and blockchain engineers.

On the other hand, the Federal National Mortgage Association (Fannie Mae), a leading financial institution in the mortgage industry, engages with AI from a different perspective. They have traditionally been cautious in embracing AI advancements, prioritizing data privacy and security when it comes to managing sensitive financial information (Federal National Mortgage Association, 2022). Nonetheless, despite their conservative stance, Fannie Mae sees the potential benefits of integrating advanced AI solutions into their systems. Their long-term goal is not just to improve the company performance, but it is also to maintain their mission of making home ownership more accessible to everyone. By funding AI projects, they are attempting to offer more affordable mortgage options to future homeowners, aligning with their mission of creating a stable and sustainable housing market.

However, despite all the benefits of AI, many companies in the mortgage sector are still in the early stages of adopting these technologies. This paper will look into the challenges that different stakeholders in the mortgage industry face adapting to AI technologies, demonstrating how this slow adjustment could lead to significant social implications in the long term.

Artificial Intelligence in the Context of the Mortgage Industry

First, it is important to establish a basic foundation regarding AI for this discussion. Artificial Intelligence, the broadest concept among these terms, is a branch of computer science that tries to create machines that are capable of intelligent "human-like" behavior. This can include a variety of tasks that normally include human thinking, such as natural language, recognizing patterns, solving complicated problems, and learning from experience. The core of AI involves algorithms, which are sets of rules or instructions that guide the computer in doing those tasks. development of AI has been going off of our advances in computing power, data availability, and improved algorithms.

Machine Learning (ML) is a subset of AI, where computers are programmed to learn from data. Instead of explicitly being programmed to perform a specific task, these systems use statistical techniques to learn patterns in data and make predictions or decisions with minimal human intervention.

Deep Learning, a subset of ML, uses neural networks with many layers to analyze various factors of data inputs, made to mimic the way the human brain operates. Neural Networks are computing systems consisting of interconnected nodes (like neurons) that process information by responding to external inputs and relaying information between each unit. The process requires multiple passes at the data to find connections and derive meaning from undefined data. These networks can learn very intricate and complicated patterns and have played a key role in achieving breakthroughs in things like image and speech recognition.

Natural language processing (NLP) is a field at the intersection of computer science, AI, and linguistics. NLP is concerned with giving computers the ability to understand text and

spoken words in a similar way to humans. This is the technology behind virtual assistants, translation services, and chatbots. Aleedy et al. (2019) explains that NLP is a crucial part of chatbot technology, allowing them to navigate human language in a natural way.

In response to this development of AI, companies from a variety of fields have begun to incorporate AI into their regular workflow, mortgage companies being one of them. Mortgage companies have started to use AI for a number of tasks like credit assessment, automating document processing, and offering customer support through chatbots. Here, AI gives these companies the means for the efficient processing and analysis of large datasets. This, in turn leads to faster and more precise loan decisions, which can also improve the overall workflow of companies.

However, this integration comes with its own set of challenges and concerns. The handling of sensitive customer data, for example, raises important issues regarding privacy. This process requires strong security protocols to protect against breaches. Also, there's the concern of inherent biases within AI systems. If these systems are trained on biased datasets, they can perpetuate these biases, leading to unfair or skewed loan decision-making processes. Another key concern is regulatory compliance. The financial sector is known to be heavily regulated due to the impact level of the sector. This is why the adherence of AI systems to these regulations is crucial. This issue becomes grows even further as AI technology continues to rapidly evolve, sometimes overtaking the regulatory frameworks that are currently in place.

Fannie Mae's experience with managing vast volumes of mortgage data is a prime example of these challenges and opportunities. They have historically witnessed the difficulties that come with managing large volumes of data associated with mortgages and housing trends

(Federal National Mortgage Association, 2022). Efficiently accessing mortgage data is vital for daily operations, strategic decision-making, and maintaining market relevance.

Stakeholders and the SCOT Framework

The potential impacts of my AI chatbot on the dynamics of an entire company makes it clear that no advancements in technology, especially AI-related ones, exist in a vacuum. They are deeply embedded in our societal structures and human interactions. Humans are the architects of chatbots. They are the developers, end-users, and business associates.

Although, at a glance, the chatbot was made just for this group of actors, it affects an entire network of stakeholders who utilize this complex system. The securitization process (See Figure 1: Fannie Mae Portfolio Securitization Transaction (Federal National Mortgage Association, 2022)) at Fannie Mae involves the Delegated Underwriting and Servicing (DUS) lenders like Wells Fargo giving loans to borrowers, which Fannie Mae later purchases (Segal & Szymanoski, 1998). These loans are then grouped into Mortgage-Backed Securities (MBS) and sold to investors. Fannie Mae guarantees timely payments on these MBS, even if borrowers default. Auditing firms like KPMG make sure that these transactions are accurate and comply with regulations. The funds from MBS sales allow Fannie Mae to buy more mortgages, keeping liquidity flowing in the housing market.

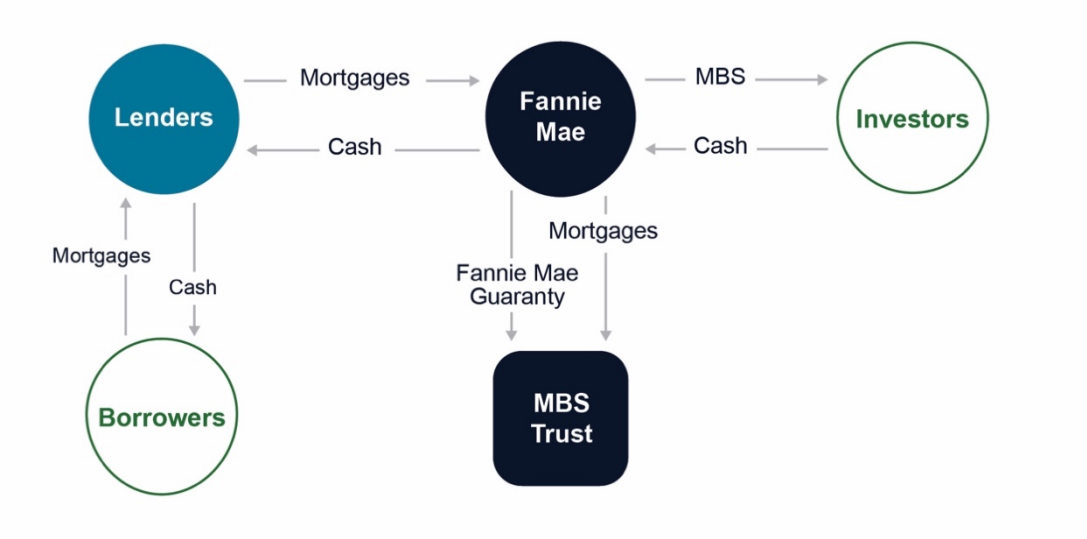

Figure 1: Fannie Mae Portfolio Securitization Transaction (Federal National Mortgage Association, 2022)

During my internship at Fannie Mae, my team and I identified that our process of running certain database queries was reserved only for a small group of business associates with the specialized knowledge to interpret them. This exclusivity made the process extremely time consuming and limited work efficiency since all other employees had to wait for the few associates to manually run the queries for them. Addressing this issue, I developed a deep learning chatbot to automate these processes and bring data access to all Fannie Mae employees.

For this chatbot, developers brought their technical skills and vision to the project, while business associates contributed with their business-specific knowledge and possible chatbot use cases (See Figure 2: Fannie Mae Chatbot Social Groups Diagram). The end-users, who could be any Fannie Mae employee, are the main beneficiaries of the chatbot. They will be providing feedback over time and molding the chatbot's features and UI designs. An experiment conducted

by Noy & Zhang (2023) revealed that the AI tool, ChatGPT, was most beneficial for the least skilled workers, helping to decrease the performance gap between employees. In this context, the "least skilled" workers are the general company employees who do not have the business expertise that will be benefiting the most from the chatbot. The project's success will be measured not just in terms of efficiency, but also in how it levels the playing field, giving all employees, regardless of their technical backgrounds, access to important data and knowledge.

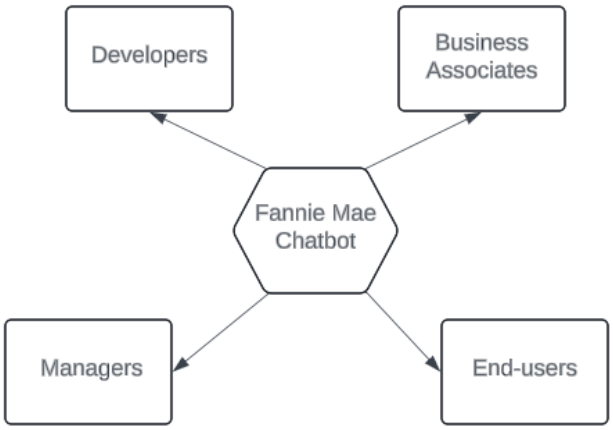

Figure 2: Fannie Mae Chatbot Social Groups Diagram

Additionally, the choices related to the technical elements of the chatbot reflect the environment of Fannie Mae, where the need for efficient data processing and easy access to mortgage information is key. Choosing TensorFlow, known for its powerful NLP capabilities, is in line with the goal of making the chatbot user-friendly and able to handle complex queries. Similarly, the chatbot being integrated with Oracle databases shows an alignment with Fannie Mae's existing internal systems so that data queries are run seamlessly.

As per the Social Construction of Technology (SCOT) framework, technologies display "interpretive flexibility" in their early stages, where different social groups can influence their development path (Pinch & Bijker, 2008). The chatbot project experienced this flexibility since multiple stakeholders played a role in defining its use cases. Business associates affected its functionality to make sure it addressed their time-consuming query issues, while feedback from general Fannie Mae employees or end-users could possibly change the chatbot UI and response accuracy (Figure 2). This collaboration will eventually lead to the design of the chatbot stabilizing, making it more and more difficult to change its core structure.

Furthermore, the chatbot's development brings about broader societal and ethical topics. As highlighted by Hagendorff (2020), AI technologies need rigorous evaluation not just for their functionality but also for their societal impacts. While the Fannie Mae chatbot is mainly a tool for efficiency, it also touches on data privacy, security, and equal accessibility issues. The fact that it can grant data access to all employees raises questions about data governance and the ethical use of AI in the finance field. Kazim & Koshiyama (2021) also reinforce this idea, emphasizing the importance of understanding AI ethics from a high-level perspective. They argue that it's very crucial to view AI not just as a tool but as something that re-shapes society's expectations and norms. The diverse impacts observed among different stakeholders, ranging from executives to end-users, highlight the interpretive flexibility of these technologies. Given this interplay, it is important to investigate more deeply how these technologies are shaping the mortgage industry.

Research Question and Methods

This leads me to ask the question: How are AI technologies affecting various stakeholders in the mortgage industry, particularly with respect to operational efficiency, compliance, underwriting processes, and their impact on applicants of different backgrounds?

To answer this question, I used a qualitative content analysis method, analyzing two types of sources: the "Mortgage Lender Sentiment Survey: Special Topics Report on Artificial Intelligence and Mortgage Lending - Comparison to the 2018 study" by Fannie Mae (2023) and selected academic papers that provide better information about how AI impacts different stakeholders. The report studies the trends, challenges, and future outlook of AI adoption in the mortgage lending industry, comparing data from 2018 to 2023 to evaluate progress and identify ongoing barriers. It is an analysis of survey results from 242 senior executives across various types of lending institutions: mortgage banks, depository institutions, and credit unions, representing lenders from smaller, mid-sized, and larger institutions (Fannie Mae, 2023).

First, the Fannie Mae report was reviewed to extract data on lenders' familiarity with AI technologies, adoption trends, objectives and use cases, anticipated future usage, and challenges to adoption. The study by Sachan et al. (2019) discusses an AI-driven decision-support system designed to automate loan underwriting, which is a prime example of one of these AI technologies being used in the mortgage world.

Next, relevant academic papers were identified and analyzed to add to the understanding from the Fannie Mae report. These papers were selected based on their focus on the socio-economic impacts of AI in the mortgage industry, specifically the effects on different demographic groups. In selecting the academic papers, I focused on recent studies published

within the last ten years in peer-reviewed journals. Criteria for selection included relevance to the mortgage industry, emphasis on the impact of AI on different demographic groups, and contributions to the discussion on technology and society. The analysis of these papers was intended to reveal potential biases or disparities in AI-driven mortgage processes.

The two types of sources were then discussed comparatively. By looking at both industry-focused and academic sources, I tried to provide a more complete picture of the complex impact of AI on the mortgage industry, with a specific focus on its societal implications. In analyzing the reports and papers, the SCOT framework served as a lens through which the narratives of different stakeholder groups were interpreted. This meant examining how each group, from developers to end-users, and regulatory bodies, influenced the development of the products.

Results

Key findings from the Fannie Mae report reveal a sizeable shift in the adoption of AI technologies, primarily focusing on enhancing operational efficiency and compliance. In addition, academic research papers provide a better understanding of the impacts of these technologies on diverse stakeholders, highlighting concerns around biases and disparities affecting applicants from different backgrounds. Together, these sources offer a contemporary view of the important role of AI in reshaping the mortgage industry.

The specific concentration on AI is because AI systems excel in analyzing large volumes of data, recognizing patterns, and making predictive models that are crucial for credit scoring, risk assessment, and optimizing the underwriting process. This automation is essential for

enhancing company efficiency and is therefore the focus for evaluating the current and potential impacts of AI technologies on the mortgage sector.

Report

The report indicates a moderate increase in lenders' familiarity with AI from 2018 to 2023, alongside a noticeable shift in usage, mostly on a trial basis (Fannie Mae, 2023). This transition represents the dynamic nature of technology, where various stakeholders, from large to smaller institutions, show varying degrees of engagement and adoption of AI technologies. This is a clear sign showing that technologies are molded and remodeled by their user groups, revealing that their trajectory is not just technologically driven but significantly influenced by social factors.

The report also sheds light on the challenges to AI adoption, citing integration complexity with existing infrastructure, lack of a proven record of success, and high costs (Fannie Mae, 2023). These barriers are not only technological but also socially constructed, since they symbolize the lenders' perceptions of risks associated with new technologies. This idea aligns with SCOT’s perspective that technological development and stabilization are deeply influenced by social elements, in this instance, the worries of the lenders.

Additionally, the report highlights perceived risks like misinformation, cybersecurity, and bias in AI usage (Fannie Mae, 2023). This growing awareness among lenders about the broader societal implications of technology resonates with the idea that technology is not just the physical artifact but also the knowledge and practices

associated with it. The concern about possible misinformation and bias shows the lenders' care for the social and ethical implications of AI within their industry.

Academic Papers

The first study I researched examines bias in mortgage applications via AI-based decision support systems (Zou & Khern-am-nuai, 2022). This work, delving into the inherent bias against Black applicants in AI systems, demonstrates a key aspect of SCOT: technological artifacts embody the values of their creators and users. The amplification of existing biases in AI decision-making shows the necessity of human oversight in AI applications. This resonates with the idea that technologies are not neutral but are shaped within their social context, replicating and even reinforcing societal norms and biases.

Complementing this, the paper by Perry et. al. (2023) explores AI's potential to dismantle historical barriers to homeownership for marginalized communities. The paper suggests that AI, when developed with ethical and legal considerations, can be instrumental in social transformation, challenging existing models and creating new avenues for mortgage accessibility. However, it also cautions against AI's propensity to mirror and recreate historical biases, demonstrating that the societal impact of technology is contingent on the values and contexts embedded within it.

The research by Guler (2015) focusing on explainable AI in mortgage fraud detection brings about another aspect of SCOT: the concept of closure. By integrating explainable AI components, the study addresses the demands for transparency and fairness in AI systems. This illustrates how AI evolves in response to social needs, where

different stakeholder groups, such as fraud detection experts and compliance officers, actively shape the technology's development and application (van Zetten et. al., 2022). This goes with SCOT's assertion that technological evolution is influenced by social dynamics and also explains the never-ending negotiation between technology and its societal context (Pinch & Bijker, 2008).

Finally, the report by Neal et. al. (2023) displays the variable applications of AI in the mortgage process and its potential to affect racial equity. The report emphasizes that the effectiveness of AI in promoting efficiency and equity heavily depends on the data and inputs it utilizes. This understanding follows the SCOT view that technology is shaped by human values and social structures. It also points to the disparities in AI adoption across different types of lending institutions, showcasing the influence of different social groups on technological adoption and evolution.

Comparison

When comparing the information from the Fannie Mae report with those from the academic papers, a complex picture of the AI landscape in the mortgage industry is created. The industry-focused Fannie Mae report emphasizes operational efficiency and compliance as key drivers for AI adoption, echoing the immediate practical concerns of the industry. However, academic papers delve deeper into the societal implications, especially the potential biases and discrimination that these technologies might spread against certain demographic groups. This contrast highlights the different priorities and

perceptions among various stakeholders, from lenders prioritizing efficiency to scholars and social advocates concerned about equity and fairness.

This duality perfectly describes the SCOT framework, which suggests that technological developments are not only the outcome of engineering progress but are also shaped by social, economic, and cultural contexts. Technologies gain meaning and significance within these contexts, shaped by the interpretations and needs of different social groups. The findings from both the Fannie Mae report and the academic papers illustrate this concept: the technology's role and impact are interpreted differently by various stakeholders, from lenders to applicants of diverse backgrounds.

Furthermore, the concept of closure versus non-closure in SCOT can be observed here as well. The industry's adoption of AI for efficiency signals a form of ‘closure,’ where a consensus appears to have been reached regarding the value of these technologies. However, the ongoing discussions and concerns raised in academic circles about biases and ethical implications signify a ‘non-closure,’ suggesting that debates around the broader societal impacts of AI in mortgage lending are still ongoing. This situation indicates the dynamic nature of technological evolution in society, where different interpretations and values continue to shape and reshape the technology's path.

Discussion

This study reveals a dual narrative: on one hand, the industry's focus on operational efficiency and compliance, and on the other, the potential for AI to perpetuate biases, particularly against certain demographic groups. The findings align with SCOT’s emphasis on the mutual

shaping of technology by society and vice versa. The variances in adoption and perception of AI across different lender sizes and types reflect the framework's central idea of interpretive flexibility and stakeholder influence (Shende, 2022). The technology's trajectory, as it evolves in the mortgage industry, is shaped by a network of socio-economic factors.

This discussion is also closely connected to recent developments in regulatory perspectives. Recently, on October 2023, the Biden administration announced steps to ensure the safe deployment of AI within key industries (Neal et. al., 2023). This move highlights the need for government oversight to protect consumers and promote equitable solutions, especially for communities of color which could be impacted by AI in mortgage lending.

A limitation of this research stems from the initial plan to conduct interviews with various stakeholders at a mortgage firm, which could not be achieved due to a lack of responses from industry contacts. This constrained the study to rely heavily on secondary sources, like the Fannie Mae report and academic papers. Therefore, the research may lack the depth and richness that firsthand accounts and primary data from interviews could have provided, especially when it comes to seeing the nuanced perspectives of different stakeholder groups directly involved in the mortgage industry.

In future research, a more diverse approach could be used, incorporating both primary and secondary data sources. Exploring alternative means of gathering primary data, such as conducting online surveys or virtual focus groups, might help as well. Additionally, expanding the range of academic papers to include more recent studies or expanding the types of stakeholders considered in the analysis could provide a better overall understanding.

Reflecting on this research, its findings will help me with advancing my engineering practice in the future, especially in the field of software and technology development. Understanding the socio-technical dynamics revealed in this study is necessary for developing any AI applications that are not only technically advanced but also socially responsible. This research truly demonstrates the importance of considering the societal implications and potential biases of new technologies, ensuring that they serve to enhance equity and fairness in industries like mortgage lending. This awareness will be helpful in guiding my future work, emphasizing the need for a holistic approach that balances technical innovation with social responsibility.

Conclusion

The amazing capabilities of AI technologies present both opportunities and challenges within the mortgage industry. It is not enough to acknowledge their potential. We must steer their trajectory toward ethical, fair, and transparent usage. Stakeholders at every level have a role to play in shaping the future of these technologies.

Regulators should prioritize the development of complete guidelines that address data privacy, algorithmic bias, and the ethical use of AI. Clear regulations will both protect consumers and guide lenders with how they adopt AI technologies, making sure that they contribute positively to the mortgage world. Mortgage institutions, both large and small, must commit to responsible AI deployment by looking into unbiased data sets, transparent algorithms, and ongoing audits to ensure equity is maintained. Additionally, promoting collaborations with tech developers can lead to more effective AI applications that serve diverse populations well. For tech developers, the emphasis should be on creating AI tools that have built-in ethical safety

nets and that are easily understood by non-technical users. These measures can help reduce risks and boost the overall confidence of users and lawmakers when it comes to AI. Educational centers and industry bodies must also collaborate to provide training and resources to pave the way for a workforce that is both tech savvy and ethically aware. This will help close the knowledge gap that is so present in our society today.

In essence, AI should not be a tool only for improving the efficiency of operations but a mechanism for inclusive growth. It is necessary that everyone involved ensures that AI in mortgage lending does not replicate historical inequities and instead leads the way for a more equitable and just financial system. Through an active effort and shared responsibility, we can use AI to both optimize our processes and protect the idea of fair access to mortgage services. The plan for the future is clear: utilize AI responsibly to build a mortgage industry that is efficient, transparent, and equitable for all.

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