

Enhancing Banking Operations with Artificial Intelligence and Machine Learning

Modhi Abdullah Alkhazraj

Contents

Abstract.....	3
Chapter 1.....	4
Introduction	4
Background	4
Problem Statement.....	5
Problem Domain	5
Describe the Problem	5
Highlight the Significance.....	5
Mention Existing Solutions	8
Justify the Need for Research	8
Research objective	9
Research scope	10
Chapter 2.....	12
Literature Review	12
Paper 1: ARTIFICIAL INTELLIGENCE AND ROBOTICS AND THEIR IMPACT ON THE PERFORMANCE OF THE WORKFORCE IN THE BANKING SECTOR.....	12
Paper 2: Customer Satisfaction Analysis with Saudi Arabia Mobile Banking Apps A Hybrid Approach Using Text Mining and Predictive Learning Techniques	14
Paper 3: Fraud Detection in Banking Data by Machine Learning Techniques.....	16
Paper 4: changing the ways of banking systematic literature review	18
Paper 5: Machine Learning Applied to Banking Supervision a Literature Review	20
Paper 6: Prediction of robo-advisory acceptance in banking services using tree-based algorithms	21
Paper 7: Bank CRM Optimization Using Predictive Classification Based on the Support Vector Machine Method	23
Paper 8: An Exploratory Study on the Effect of Artificial Intelligence- Enabled Technology on Customer Experiences in the Banking Sector	24
Paper 9: Operational research and artificial intelligence methods in banking.....	25
Paper 10: Waiting-Time Estimation in Bank Customer Queues using RPROP Neural Networks.....	26
Chapter 3.....	27
Research methodology	27
Expected outcomes.....	28
Gantt chart.....	29
References	30

Abstract

Every sector is experiencing a rapid move towards digital, and the banking industry has been at its peak because of an omnipresent integration of Artificial Intelligence (AI) & Machine Learning (ML). The study seeks to utilize AI and ML in order to address key industry questions, from increasing customer success rates and raising operational efficiency levels through all the way over reducing risks. The study has used a hybrid methodology that incorporates text mining and predictive modeling to concentrate more on finding the key drivers of consumer satisfaction, boosting customer acquisition as well retention with churn reduction. The banks capability to ensure financial risks are reduced will also be much more attainable through the real-time fraud detection advanced AI model. Additionally, it examines how AI could widen digital financial inclusion designed by underbanked populations to generate access to the formal finance system. AI enabled solutions will also be tailored for risk management so that banks can forecast and address operational risks in time, thereby making them more resistant to such events. Predictive analytics will also be used for better NPA (Non-Performing Asset) Management, which is key to stronger financial health. Most importantly, AI is set to automate banking operations greatly reducing costs allowing for better service delivery.

Chapter 1

Introduction

The Banking industry is undergoing a thorough digital transformation, predominantly powered by Artificial Intelligence (AI) and Machine Learning (ML). The potential impact of these innovations in terms of both operational efficiency and customer risk management are vast for the financial institutions. As much of these advancements have been made, a lot more concerns remain unsolved. The complexity of regulations needs to be effectively navigated by banks who are trying both meet the diverse consumer demands and guarantee secure data transactions. Further, traditional models tend to be inadequate for applications of fraud prevention and crisis management while serving the underbanked populations properly. This initiative is aimed at promoting research relating to creation of new and advanced AI/ML tools, specific for the banking industry. This study hopes to combine deep and machine learning approaches for better understanding customer behavior, effective fraud detection, and improved operational resilience.

Background

The banking sector is driving a massive digital transformation across banks with advanced technologies including Artificial Intelligence (AI) and Machine Learning (ML). These tools hold great promise for changing the way banks operate with massive potential leverage of customer satisfaction and support operations optimization and risk. Banking is challenging, of course: it means contending with the great range in customer needs and expectations, gaining trust through digital service delivery, managing an evolving regulatory landscape, and protecting financial data from cyber threats. Consequently, the research tries to propose AI and ML tools useful for dealing with different sort of critical areas in banking industry. The research will complement text mining analysis with regression-based machine learning models to aid in bettering customer satisfaction, strengthening fraud-detection systems and increasing financial-inclusion. This research was driven by the present-day necessity of banks to go digital, while ensuring security and trust, as well adhering to regulatory requirements today.

Problem Statement

Problem Domain

The problem domain is the banking sector, which is currently undergoing a digital transformation driven by the integration of Artificial Intelligence (AI) and Machine Learning (ML) technologies. (Hashemi et al., 2023)

Describe the Problem

Banking is largely a challenging industry especially when it comes to improving the customer experience and efficiency of operations considering language scale, trust mechanism for change in regulation impact security etc. This is despite various AI and ML innovations, which are not fully optimized to confront this complexity. Similarly, AI models for services that are customer-focused such as customer acquisition, retention churn prediction or credit scoring - may need to be complex to produce true personalized outcomes. However, other important topics such as Financial Inclusion, Microfinance operations, Fraud prevention, Risk assessment, Crisis mapping are not well covered and that will lead to weaker risk and treasury management, higher "Non-Performing Assets" and optimal bank operation. (Kalyani & Gupta, 2023; Tad et al., 2023)

Highlight the Significance

The significance of this problem is highlighted by the growing need to engage in more personalized and safe banking solutions that are vital for satisfying customers' changing expectations as well as protecting from competitor's pressure. It reflects the fundamental change in how consumers are beginning to engage with financial institutions and highlights that today flexibility and innovation have become key differentiators for banks. Solving these problems is essential for banks seeking to improve client satisfaction and operational resilience, both of which are key elements in acquiring a competitive advantage that will lead them to long-term success. The system uses a hybrid approach combining text mining and regression-based machine learning to yield an innovative new method that quantifies

customer satisfaction, giving us unique insights on consumer behavior and preferences. This strategy is especially applicable to the many characteristics of Saudi Arabia's culture and economics climate, which provides room for more personalized high performing banking perception in user experiences. Methodologically, the use of text mining enables the extraction of valuable insights from user reviews and feedback to identify key satisfaction drivers and pain points, while regression models offer a quantitative assessment of the factors influencing satisfaction, thereby aiding banks in strategizing improvements based on data-driven insights.

The research paper emphasizes the ever-increasing fraudulent activities that have started to occur at an exponential rate soon within banking sector which further pose major threats (for both consumer and financial institution) thereby bringing urgent need of efficient fraud detection methods. Moreover, for this paper one of the main challenges being considered is 19handling imbalanced datasets and building models that are more robust in fraud detection. Both training a model with bias represented or naive train/test splits could result in biased predictions consequently if not properly managed. From a methodology standpoint, the study is valuable in fraud-research to contribute due advanced ML models (CatBoost, XGboost, and LightGBM), through combining deep learning - for reduced false-positives and better prediction precision. In addition, the use of class weight-tuning hyperparameters guarantees that the model accurately reflects these imbalances and provides a stronger basis for detection.

The research paper associated with consumer reflection is important in the banking industry particularly, inclusion & an acceptability of any emerging technology will be due to this fact should certainly concern by means of banks which require a identify customer response connected with these kinds of technologies so as for you to include them effectively. The study is a unique piece that gives wonderful insights to behavioral researchers based on socio demographic with technology leaning enabling banks / advisers towards targeted offering. From a methodological perspective, the transparent and interpretable tree -based machine learning offers an improved way of consumer intention prediction than traditional methods which can help to increase effectiveness both in marketing strategies and service

offering for banks.

The Banking sector has long been recognized for the improvements it needs to make when it comes to customer experience and operational efficiency, a challenge that is further compounded by linguistic diversity concerns along with issues related to gaining trust from customers and managing data security. Because the factors impact customer satisfaction and retention which are two of most important bank success parameters (Mishra & Rajwani, 2020). the effect of effective communication in a variety of languages and dialects (Askar et al., 2022). Furthermore, with the rise of cyber threats today, it is essential that strong and secure AI/ML remains a critical tool in comprehensive of protecting mission-critical financial data-ultimately ensuring the integrity and trustworthiness within banks (Kamath et al., 2003). Although the improvements have been significant in Deep learning (DL) and Machine Learning (ML), they are still not advanced enough to meet all needs complexity wise of customer-centric services (Murindanyi et al., 2023). Banking functions, such as customer acquisition and retention, churn prediction or credit scoring require very high-end AI models that provide accurate results in a personal way Existing models are insufficient for the banks to serve customers' needs and their strategic business objectives (Arram et al., 2023). Similarly, digital financial inclusion and microfinance are also inadequately served areas restricting the penetration of banking services to less-privileged sections in society. This gap is proof that a more sophisticated AI-driven solution selectively catering to specific customer segments, created or under development within organizations (Faritha Banu et al., 2022). Further, AI implementations fail to focus on some very fundamental problems including fraud prevention and detection algorithms (not just risk scoring but also crisis management), forecasting of possible crises along with the NPA identification and resolution mechanism among other things. Fraud prevention and risk score is important to prevent loss, the prediction of crisis and correct handling when it (very) occurs for emergency response maintaining financial stability (Ngigi Nyakarimi et al., 2020). Additionally, the optimizing of bank operations and treasury functions for NPA management can go a long way to improve financial stability as well operational efficiency (Agarwal & Sharma, 2014). Thus, creating AI technologies that solve these problems are very important to leverage against the many challenges faced by

banks today such as serving clients better and protecting themselves more effectively (Mohd-Sanusi et al., 2015).

Mention Existing Solutions

In the banking industry when considering AI, consider not only how to improve customer service while maintaining data security; but also acknowledge that language variety and worrying customers can be obstacles now and for attempts at solving them later (Mat Yusof et al., 2021). Researchers should explore the strategic alliances with fintech companies that would help in facilitating implementation, especially within banks operating in India (Chhabra Roy & Prabhakaran, 2023). The studies must emphasize the effects of AI technology on banking performance, cost savings, customer experience and financial inclusion as well as evaluating common aspects across the effectiveness in improving bank productivity, individualized services offerings/next best proposals (NBP), loss reductions and aligning with consumer needs (Tiwari & Saxena, 2021). Machine learning-based natural language processing and text analytics are other areas where more research is needed to establish whether statistical relationships have meaningful predictive value in banking performance (Rita Jain, 2023). And more of the study is needed in fields such as customer-based services acquisitions, credit scoring, digital financial inclusion, microfinance, fraud prevention, risk assessment, crisis predictions, NPA management, TAD, governance and other bank operations & treasury functions. More studies on this topic are necessary in machine learning and can help to fill a gap through contributions of supervised data; therefore, banks have looks for other applications from DL /ML technologies that have remained unharvested (Tulcanaza-Prieto et al., 2023)

Justify the Need for Research

The research is significant to explore what there is and what is not in the field of using DL and ML techniques in banking industry (Okan Sakar, 2021). It helps in understanding the consequences, frontiers, and applications of these technologies in banking industries. In the field of DL and ML, research is important for aggregating existing knowledge to adequately summarize it as well as formulating new pathways forward in applications within banking

(Mehndiratta et al., 2023). Systematic literature reviews can classify studies, provide insights that are valuable for the field of study and guidance in methodology on data synthesis. The extended figuration of machine learning then makes it relevant and indeed right that there be studies on this within banking supervision for better utilization data scrutiny-based decisions making. This type of research can lead to the design and implementation of early warnings for bankruptcy as well stress testing, both crucial risk assessment features in banking. We have developed this research to investigate how some of the most popular ML techniques can be used as indicators for more effective best practices in supervision and regulation within banking, with good potential using a variety of other tools such k-nearest neighbors support vector machines tree-based models ensembles boosting methods deep learning feedforward neural networks dense artificial neural nets.

Research objective

The main aim of this research is to build advanced Artificial Intelligence (AI) and Machine Learning (ML) tools compliant with best practices, standards, etc. developed by the banking sector to improve efficiency at customer experience point of view which are due linguistic diversity, trust among customers towards banks and bank underestimated data security issues that can be solved using AI/ ML technologies.

- To develop Artificial Intelligence algorithms that are customized effectively with the customers regarding the diversity of dialects, languages, and nationalities.
- To optimize the customer experiences regarding trust and privacy to build more robust customer relationships and improve customers' confidence in banking systems.
- To suggest an overall approach for customer acquisition, retention and churn prediction using AI & ML by analyzing the consumer behavior while offering recommendations.
- To explore the potential of Artificial intelligence in enhancing digital financial inclusion and microfinance by creating products designed specifically for under-banked people, enabling more comprehensive services banking service.
- To build advanced AI-based fraud detection and predictive models providing futuristic

insights to real-time identification of fraudulent activities, helping in reduction of financial risks as well as operational security.

- To explore the application of AI technology in predicting and managing crisis banking operations to help banks by anticipating any possible crisis, preventing and reining it before escalating against.
- To optimize AI based predictive analytics that can be useful for Banks in managing Non - Performing Asset (NPA) optimization to minimize NPAs and hence salvage the financial stability of a Bank.
- To enhance bank operations and treasury functions by implementing innovative AI solutions to eliminate inefficient processes, decrease operational costs and increase efficiency.
- To evaluate the impact of using this AI and ML solution in real world banking use cases to provide actual results on how effective it is for improving customer experience and operational excellence.

Research scope

By utilizing AI and ML technologies, the research investigates some key challenges of banking industry by concentrating on customer service satisfaction and operational efficiency. The desired outcome of this research is to provide a set of more advanced AI/ML tools for banks to allow them to engage with their customers in deeper and better experience (i.e., via personalization) while boosting operational resilience. This study will investigate customer satisfaction analytics as one of the key areas. Utilizing text mining techniques to analyze large amounts of customer feedback. DL/ML models will help in recognizing the key drivers contributing towards satisfaction which may include service quality, communication and response times.

The study also deals with fraud detection by creating AI systems that catch fraudulent activities as they occur, protecting the bank from financial losses and preserving trust. It will also be useful for the AI in crisis management, as banks can start to predict and mitigate potential operational risks at an early stage before they become large enough to disrupt

financial services. Moving forward, the research is about Non-Performing Asset (NPA) management as to how predictive analytics would serve in a better way for managing NPAs and hence implying that banks are more stable on financial terms.

Finally, the research will explore how AI can enhance banking operations by automating common functions to reduce cost and increase accuracy as well as overall operational efficiency. Optimization of customer data and internal processes through AI will also enable the banks to provide services faster while offering high quality, thus increasing overall productivity. The research plays a crucial role in solving the pressing needs of banking, such as improving customer satisfaction, protecting confidential information and protecting against rising threats like frauds & NPAs that are extremely important for the survival of banking industry.

Chapter 2

Literature Review

Paper 1: ARTIFICIAL INTELLIGENCE AND ROBOTICS AND THEIR IMPACT ON THE PERFORMANCE OF THE WORKFORCE IN THE BANKING SECTOR

The potential impacts of AI on the Indian banking industry are studied in this paper, which shows that applying AI systems in the banking sector may enhance customer service and operational efficiency, along with a possibility for cost reduction. Until the technology matures, AI has plenty of potential to enhance efficiency, personalization, and financial inclusion, which remains untapped. This study would help to highlight that the AI operational within a bank can improve bank performance by a significant change. Linguistic diversity, customer trust, and data security are challenges that can still be addressed through partnerships with fintech companies. The study outcomes also recommend more research to exploit Artificial Intelligence gains in the banking sector (Tad et al., 2023).

Quantitative Analysis: In this section, after observing 200 banking staff members from various banks in Tamil Nadu and considering only complete responses, incomplete ones were rejected. The survey was then sent via email after securing approval from many banks. The survey results were very interesting, giving us a more comprehensive view of the Tamil Nadu banking industry. Descriptive analysis does not go beyond strict basic description to reveal characteristics about one more variable. Also, it offers extensive information about the nature of their sample for researchers. **Inferential Analysis:** This section should present the statistical results based on your study questionnaires. Pearson correlation coefficients for different banking performance indexes in AI-influenced reduced service costs, customer satisfaction and asset management. However, some of the data reveals a slight uptick in markets for AI with a weaker correlation to customer satisfaction. A regression model in the analysis proves that AI is an excellent player in the banking industry.

India cannot unleash its full capabilities on global adoption in financial institutions, AI, and blockchain. By digitizing client services, machine learning will help improve consumer

experiences and provide feedback criteria tools for internal use on the backend. At present, more than 36% of investment banks are investing in these technologies, with nearly 70% planning to adopt them soon. Artificial Intelligence in Largest Public Sector Bank in India with 420 million Customers HDFC Bank -Chatbot and in-store robotics; ICICI Bank automated 200+ processes using mobile technology. While steps have been taken, there is room for more innovation and growth. However, how can the banking industry make profits? Even though the study found a significant relationship between the excellent use of AI in banking and better bank performance, data source methods to detect this correlation are valid. Moreover, it offers unique insights into the role played by artificial intelligence in reshaping traditional banking practices. It recommends potential partnerships with fintech firms to resolve challenges, thereby contributing value to the discourse on artificial intelligence in banking. While Machine learning abilities do offer promise to enhance aspects of banking in India, much is left to be desired for Indian operations related to overall performance. Many questions remain to be resolved regarding AI in the banking sector - both technical, such as linguistic diversity and achieving customer confidence, privacy-protecting data, etc. Throughout the study, there is an emphasis on the idea that strategic collaborations with fintech companies are crucial to overcoming the weaknesses in the Indian banking sector that are primarily related to linguistic diversity, customer trust, and data security. Secondary data consists of published sources like documents, newspapers, news reports, unpublished banking databases, and different portals and websites of RBI. Two 200 banking staff from various banks in Tamilnadu, India, were surveyed quantitatively. Justified with the help of research findings that point towards successful banking performances because of AI implementation, this methodology again shows its effectiveness.

Paper 2: Customer Satisfaction Analysis with Saudi Arabia Mobile Banking Apps A Hybrid Approach Using Text Mining and Predictive Learning Techniques

From the perspective of this topic, the primary purpose is to use text data mining and machine learning techniques to improve customer satisfaction levels at Saudi Arabian banks' mobile. Combining Latent Dirichlet allocation from user-generated content (UGC), support vector regression (SVR), and principal component analysis can generate data. Based on elements obtained through text mining of user-generated content, the study demonstrates that machine learning helps assess user satisfaction with online banking apps. At LDA, it was used to analyze app review UGC and the main influencing factors that cause the user's satisfaction were identified while sitting in RI, thereby allowing SVR to predict the degree of enjoyment (Alrizq & Alghamdi, 2024).

The study innovated a hybrid method, integrating text mining techniques with prediction learning theories to evaluate customers' satisfaction towards mobile bank apps in Saudi Arabia. The specific methods used here are latent Dirichlet allocation for extracting topics from user-generated content or UGCs, support vector regression to predict customer satisfaction, and principal component analysis (PCA). Unsupervised and supervised learning was also applied in this research, with LDA for factor discovery and SVR about satisfaction. As per the research results, we see that updates, app functionality and design followed by installation, adaptability to users' needs, and navigation and transactions have a major (significant) effect on consumer satisfaction with m-banking apps where Saudi Arabia is concerned. The researchers applied text mining and predictive machine learning models to user-generated content (UGC) of mobile banking apps, bringing out these critical determinants of satisfaction. The study also proved that Machine Learning is eligible to predict and analyze customer satisfaction levels using the detected UGC-related factors by applying Support Vector Regression (SVR) along with Principal Component Analysis. Exploring the techniques of predictive learning, this article describes how hybrid text mining was implemented to assess consumer ratings of the mobile apps for banks in Saudi Arabia. For the application of predictive text mining, the study aims to find out the reasons behind customer satisfaction within mobile banking applications. One limitation of the research is

that it only focuses on apps in Saudi Arabia. The study also mentioned the difficulty of developers erasing reviews, as this could hinder future improvements or finding bugs. Both Support Vector Regression (SVR) and Principal Component Analysis (PCA) were used to predict and analyze customer satisfaction based on features identified through text mining. In other words, the research concluded that by extracting factors from user feedback in text mining UGC, it is possible to use machine learning to effectively evaluate customer satisfaction with internet banking apps. The study involved a Latent Dirichlet Allocation (LDA) analysis of 3304 reviews to learn the reasons why user dissatisfaction exists in banking software for mobile phones.

Paper 3: Fraud Detection in Banking Data by Machine Learning Techniques

The paper is about fraud detection in banking data using machine learning, and they are dealing with weight-tuning hyperparameters to class weights due to various degrees of imbalance. To address these research gaps, the objectives of this paper are as follows: to propose weight-tuning hyperparameters for unbalanced data in fraud-detection and further introduce CatBoost alongside LightGBM and XGBoost by showing its way on high-performance improvements by performing majority-voting ensemble-learning combination strategy among algorithms (response fusion); representing a branch point techniques so far discussed within the single-machine-classification area. F1 score applies all proposed methods at real-world-data experiment performance evaluation along F1 score criteria pointing MCC metric. This research tries to enhance the prediction of frauds, which will be profitable, particularly in fraud detection in real unbalanced datasets with some machine learning techniques available using respective datasets (Hashemi et al., 2023).

Class weight-tuning hyperparameters validate the introduced research paper and fix the loss of fraudulent and legitimate transactions. Bayesian optimization is applied for hyperparameter accounting for unbalanced data. A pre-processing approach for skewed data - and an associated optimization technique, plus a voting mechanism embedded into it to improve LightGBM method counter aside CatBoost C XGBoost counter. Learning is employed to fine-tune the hyperparameters - specifically utilizing this proposed weight-tuning technique - leading to a better-performing model.

The study was based on machine learning's applications in fraud detection within banking data. Class weight-tuning hyperparameters regulate the influence of fraud and non-fraudulent transactions. A composite learning technique was applied to combine algorithms and assess performance. Then, it is based on accurate unbalanced data that are being tested for performance using a majority voting ensemble approach.

Using class weight-tuning hyperparameters, Bayesian optimization of CatBoost, XGBoost and deep learning to improve fraud detection in banking data. The actual dataset "credit card" is used in the leads, and it contains 284,807 records of credit card transactions; there are only 492 among them that have been identified as fraudulent (this makes up to 172% out of all

available transactions), making this data set highly imbalanced. One of the main weaknesses is that fraudsters target the limitations in fraud detection systems, highlighting why technology is fundamental when addressing banking and insurance frauds. Furthermore, over-sampling approaches like SMOTE may also further raise the false- positive rates - which can be non-viable in a bank where you want to encourage customer orientation. This paper proposed the credit card fraud detection method by machine learning (LightGBM) with class weight tuning in different techniques and showed a significant improvement in fraud detection. The best performance was observed when using the combination of LightGBM and XGBoost algorithms, with an MCC value of 0.79 (F1-score = 0.79), surpassing other applied algorithms.

Paper 4: changing the ways of banking systematic literature review

This paper is a systematic literature review (SLR) that examines the use of artificial intelligence and machine learning specifically in the banking sector, reviewing 734 articles to find the different aspects they are being used in shaping bank business through various research streams over the years focusing at most times on fraud detection, risk management, credit scoring. In this regard, more research is necessary in AI and ML applications in banking to explore the relevant issues, barriers, and opportunities for betterment. This study examines academic research fields and banking applications relevant to AI and ML (Kalyani & Gupta, 2023).

The methods utilized for this paper follow Systematic Literature Review (SLR) guidelines as established from previous research and combine bibliometric analysis and a multi-phase review work process. The research also adopted meta-analysis to study the variables employed for explanation in the article and utilized a random effect model based on size. Banks' use of AI and ML has facilitated safer services, not only in terms of consideration to the consumer but also for complex systems at a low cost. They reshaped different sectors, including Algo trading, portfolio management, cyber security, sentiment analysis, and monitoring transactions. Banking risk management's main target is expected to save trillion dollars by 2030 on AI.

The literature review in this research paper is its power. The following work includes a systematic literature review (SLR) to study banking players' initiatives towards AI and ML applications, which further details the domain's critical needs. The methodology used within the study will begin with a comprehensive bibliometric analysis of banking research to determine concepts by reviewing top-ranked articles and citations.

The downsides of using AI and ML in banking services are unemployment threats, chatbot inefficiency, and bias-based algorithms from reviewing the history of data sets. How organizations tackle these challenges will determine the adoption rate of AI and ML. Concerns include the continued division of AI and labor, an estimated 50% potential job cuts and vulnerability to being replaced by robotics. This study systematically reviews the

literature and refers to 734 articles to investigate the application of Artificial Intelligence and Machine Learning across banking sectors and its evolution against various Banking sector needs. The articles were sourced from data using AI and ML applications in banking fields.

Paper 5: Machine Learning Applied to Banking Supervision a Literature Review

This paper applies machine learning methods to credit risk, stress testing and other perspectives on banking supervision. Several other machine learning options exist, such as K-Nearest Neighbors and support vector machines, tree-based models or ensembles, boosting techniques and artificial neural networks. Developing early warning systems for bankruptcy has also been part of recent trends and refining stress tests. The study points out the constraints in supervisory data and underscores ML tools for improving banking identification and decision-making (Guerra & Castelli, 2021).

This paper used various methods, such as k-nearest neighbors (KNN), support vector machines, tree-based models, ensembles, boosting techniques, and artificial neural networks. In addition, ada-boosts, bagging, random subspace, DECORATE, and rotation forests were used for analysis, along with neural networks, followed by decision trees, Naive Bayes, and random forests.

In the paper, data sources were also widely defined, including quarterly public datasets such as (1) financial statement information of banking firms in the Taiwan securities market and (2) profitability indicators from the Bank Scope database of 29 countries throughout the year. Private datasets from a Korean credit guarantee foundation were additionally used for the study. The study concludes by acknowledging limitations related to the limited application of machine learning to banking supervision and a lack of papers dedicated exclusively to post-2008 financial crisis regulation. The approach includes developing early warning systems (EWS) for bankruptcy prediction and improving stress testing in the banking sector. The paper utilized machine learning with quantitative data for risk assessment in the banking sector, applicable to a supervised learning model. Central banks have been instrumental in much of the research, adding to our understanding of how machine learning can influence policy and inform policymaking in banking.

Paper 6: Prediction of robo-advisory acceptance in banking services using tree-based algorithms

This research paper forecasts behavioral intent of consumers to start using robo-advisory services in banking while providing use case on the subject matter based on tree-based algorithms: random forest and adaptive boosting. The objective is to contribute to the unfilled hole in the research of forecasting robo-advisory acceptance, thereby demonstrating insight into recognizing possible users for targeted marketing activities. According to this, tree-based models were effective in consumer acceptance prediction with enough accuracy, whereas the ensemble method suggested the most accurate predictability by adaptive boosting. The paper seeks to achieve the following research aims: (i) build predictive models of consumer adoption for robo-advisory services in banking within a trees-like algorithms framework and (ii) estimate models' performance (Orzeszko & Piotrowski, 2024).

The study implemented tree-based algorithms for anticipation of robo-advisor adoption in banking services, which consist of decision trees and ensemble models, including random forest, adaptive boosting, random under-sampling boost, and total correction boost. This research team used these techniques to develop prediction models for consumer acceptance of robo-advisory services depending on socio-demographics, behaviors and attitudes towards digital tools, banking skills and trust in banks.

This research aimed at developing prediction models based on tree-based algorithms to predict consumer adoption of robo-advisory services among bank consumers using their socio-demography and behavior/attitude towards digital technologies/banking services. It indicated the importance of detecting potential robo-advisory service clients to inform them on targeted banking marketing initiatives, cost-effectiveness, and related reviews.

Given that a tree-based model (i.e., random forest, adaptive boosting, randomized under-sampling boosted and corrected boosted) can predict high levels of consumer acceptance toward robo-advisory services effectively. The survey concerning artificial intelligence technology applications in banks in Poland was one of the data sources that indicated factors that may influence the adoption of robo-advisory services. The weaknesses found in prior research were the near absence of predictive models on intention to use robo- advisory

services to date, thereby rendering this study first-of-its-kind effective by applying prediction with tree-based algorithms. Lastly, the results also point to our focus on portfolio analysis of robo-advisory in relation to financial instrument management as an area expanded upon across other market parts. The methodology implemented in this research paper is related to developing and testing the models that predict consumer acceptance of robo-advisory services within banking. To predict customers' attitudes towards using robo-advisory in banking services, a combination of decision trees and several ensemble models (tree-based) were fitted to the data collected. To predict customers' attitudes towards using robo-advisory in banking services, a combination of decision trees and several ensemble models (tree-based) were fitted to the data collected. The research attempted to find the answer by polling several groups in Poland about using artificial intelligence technology in banking and gathering data regarding preferences for digital service improvement.

Paper 7: Bank CRM Optimization Using Predictive Classification Based on the Support Vector Machine Method

The article offers a new and advanced solution to optimize customer relationship management (CRM) for banks through predicting the segmentation of customers. This method combines the Recency, Frequency and Monetary (RFM) model with k-means clustering algorithm, Support Vector Machines (SVM), Decision Tree (DT)-rule extraction. The research focuses on data from 12,016 credit card users at the First Bank of Montenegro, collected between October and December 2018. By using RFM attributes to segment customers, the study addresses the issue of class imbalance, specifically the small number of high-value customers, which often hinders effective segmentation.

Using SVM as a preprocessor highly increases the accuracy of Decision Tree model from 63.37% to 74.69%. Furthermore, the recall rate for high-value customers (which are crucial in CRM) increased from 16.3% to an impressive reading of 63.64%. The Decision Tree rules that followed from the outputs of SVM were precise and actionable, ensuring banks with dependable information to optimize customer targeting strategies. It allows the bank to be more precise in targeting customers according to income, region and transaction behavior which improves customer loyalty, profitability as well saving unnecessary marketing costs. The implications of this research are not limited to the banking sector. The hybrid SVM-DT model developed in the paper can also be employed to other industries with similar problems where customer segmentation and class imbalance are issues. The study contributes to CRM research by offering a solution for the dilemmas facing predictive classification which distinguishes high-value customers in banks more precisely than other models and therefore strengthens the role of customer management strategy inside them. (Djurisic et al., 2020)

Paper 8: An Exploratory Study on the Effect of Artificial Intelligence- Enabled Technology on Customer Experiences in the Banking Sector

This article reviewed the attempt to provide a comprehensive overview of the role that operational research (OR) and artificial intelligence (AI) play in banking based on published studies during the past decade. This article will examine how these methodologies have been applied to improve bank efficiency, risk management performance assessment profiling and benchmarking mergers acquisitions banking regulation customer relationship fintech. Currently, bank efficiency and performance are predominantly measured using OR techniques including data envelopment analysis (DEA), agent-based modeling (ABM), and Monte Carlo (MC) simulation.

The trend towards artificial intelligence in banking research is evident with a rapid uptake of AI across different areas such as risk management, bank failure prediction and the emergence of fin-tech solutions — peer-to-peer lending robo advisors. The article also highlights future research directions, notably the (i) integration of OR and AI techniques; (ii) attempts to take on model accuracy challenges from different perspectives; and (iii) further use of recent developments in AI applications for accurate decision-making specific to banking. (El-Gohary et al., 2021)

Paper 9: Operational research and artificial intelligence methods in banking

This study deals with an enduring problem which is the accurate calculation of waiting times for customers in bank queues, a key element that significantly affects customer experience and overall banking efficiency. As well, traditional methods of queue analysis fail to capture the dynamic features of real-world banking environments and unpredictable arrivals and service times that vary over time. Due to these restrictions the wait-time estimations are often incorrect and impact user experience negatively. In this research, it is examining the use of Artificial Neural Networks (ANNs), and particularly Resilient Propagation (RPROP) algorithm as a superior alternative for wait times prediction in bank queues. It analyzes how well a time-series model based on historical information, and another structural model that incorporates the current environment (such as queue size, number of servers available, and customer arrival position in head-offline (HoL)), can predict waiting times using data from queue management system of the banks. Results show that the structural approach offers considerable improvement in wait time prediction when compared to using a typical method for times series, and even more so if there is ready access to prior data of wait service. This provides further evidence of the necessity to learn static and dynamic pieces of information in wait-time estimation, as including real time queue conditions allows the model for providing more accurate predictions. Improving for precise wait-time estimates will help banks to streamline their queue management systems enhancing customer experiences and this will ensure that customers have higher expectations with a transparent service experience, while also enabling banks to alleviate queues in branches and optimize their operational flow. (Doumpos et al., 2023)

Paper 10: Waiting-Time Estimation in Bank Customer Queues using RPROP Neural Networks

The issue of estimating waiting times is one of the most important issues that banks and financial institutions employees face in queues, which have an enormous effect on customer satisfaction or operational efficiency. Extensive and unpredictable waiting times in banking can create dissatisfaction among customers, low-quality service delivery as well as resource indecision wastage. Simple methods such as Little's Law that assume static conditions do not capture the reality and oftentimes break because they don't represent dynamics of bank queues with changing customer arrival rates, service times, staff availability etc. Therefore, this present work attempts to overcome these deficiencies through the application of Artificial Neural Networks (ANN), with specifically Resilient Propagation (RPROP) algorithm in a bank queue waiting time prediction problem. Use of available data through queue management systems in Banks bringing the ability to test ANN model predicts real-world scenario. In this study, two modeling strategies are contrasted: one based on time-series techniques building models for predicting the future waiting times with historical queue data obtained before making a forecast and another using structural approach that constructs real-time forecasting model by incorporating environmental variables at each decision time, including current queue length as "server state", number of active servers (as dynamic), and customer position in the queue (head-of-line or HoL). (Hermanto et al., 2018)

Chapter 3

Research methodology

Artificial Intelligence (AI) and Machine Learning (ML) technologies are expected to resolve some of the most significant issues in the banking industry. This is what the research proposal aims for. The execution of digital transformation in banking does have a list of never-ending challenges, which includes the seamless customer experience, Linguistic diversity handling for that better user-friendly interface design on one platform etc. As Banks being widely trusted institutions, they can build this trust over time even through their digital platforms where it continuously improving the data security and working with regulators around the world to make things simple while at its best complying with regulatory requirements so as not breach any follows within a particular demographic area. This will result in increased efficiency and resilience with the help of smarter customer engagement, AI and ML enabled banking operations.

At the core of the research is a text mining solution where it mine feedback data to measure who satisfied customers are and which attributes drive satisfaction. This will drive the need for machine learning models to predict customer acquisition, retention and churn in banks so that they can better understand their customers and act. With better models of these patterns, banks can adopt increasingly refined customer relationship management strategies. It will also look across the horizon of possibilities where AI can be used for improving digital financial inclusion and building product integration targeting underbanked populations.

Fraud detection is one of the other main issues addressed by the research. This will allow for the development of artificial intelligence-designed fraud detection systems that immediately detect fraudulent transactions in real time, preventing financial risk, both banks and their customers are protected. It also seeks to establish AI models for operational risk forecasting and response in crisis management, helping banks adapt more readily to financial disruptions. The bank will use artificial intelligence to improve Non-Performing Asset (NPA)

management, which may help the banks in preserving their balance sheet and general financial health. In the end, through automation of many banking operations, AI will also vastly improve operational efficiency and increase cost-cutting gains for banks.

In summary, this research is tailored to meet demands of banking needs now and in future. It is focused on AI and ML solutions for enhancing customer experience, protecting financial data against frauds, monitoring NPAs etc. This research is aligned with the banking industry trend to add innovation in customer service and operational efficiency, thereby boosting bank success long-term as digital banks become more prevalent.

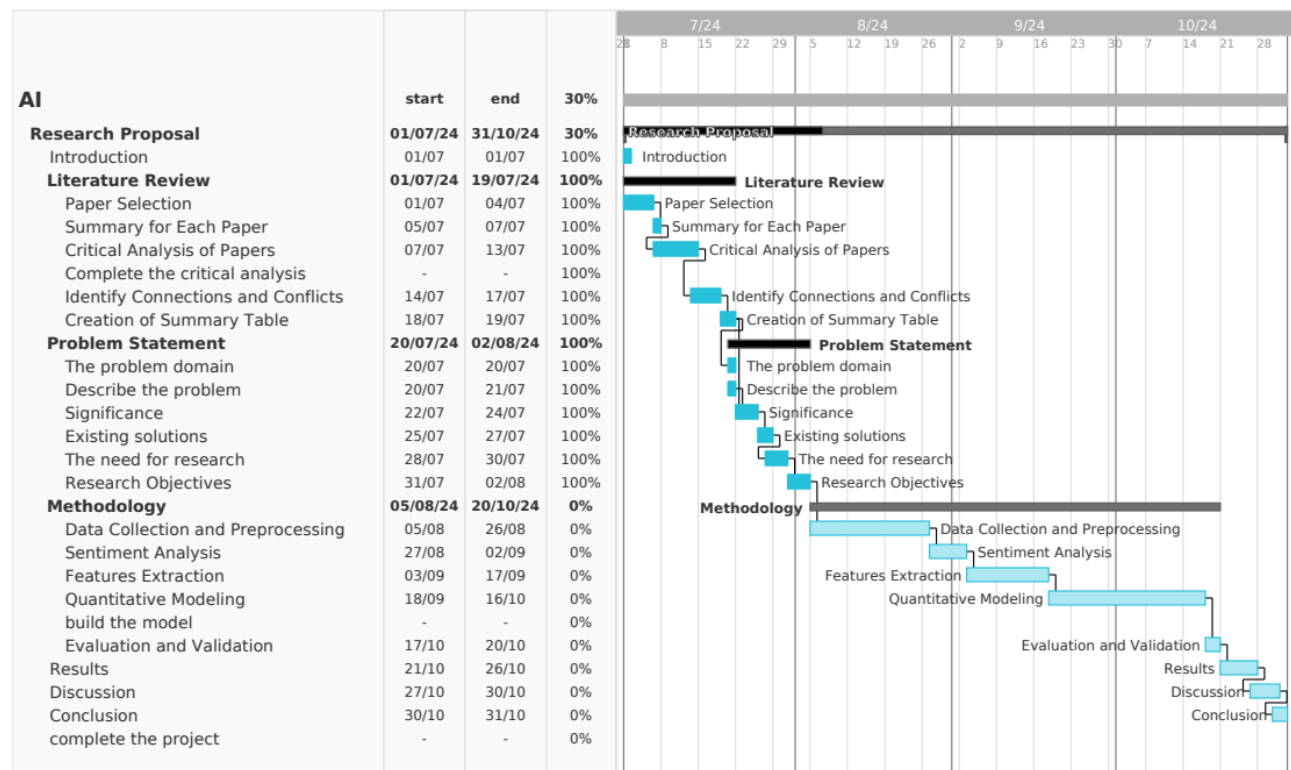
Expected outcomes

Expected results from this research are going to drive a major change in the banking industry which deals with Artificial Intelligence and Machine Learning. With next-generation AI techniques like text mining and predictive modelling, banks are expected to capture deeper insights into the determinants of customer satisfaction than ever before. These insights will enable banks to devise more relatable and accurate customer retention and acquisition strategies, which in turn result as lower churn rates and stronger attachment with the customers. Banks that can accurately identify what truly drives satisfaction and act accordingly by segmenting their services further in response not only deliver value to the customer but also improve lifetime profitability.

Additionally, it will bring the advancement of advanced AI models applied in fraud detection, propelling countries towards next-level accuracy and near-real-time detection speeds when it comes to catching those fraudsters. This means of detection will ultimately give banks more flexibility to recognize and rectify false positives faster which minimizes the threat to their financials and overall security. Each ML model will be created to flag off irregularities in the transaction patterns that could essentially help banks respond cautiously and minimize false positives. It will further increase trust in digital banking services for clients.

Lastly, automation will go a long way in the banking industry using AI for their day-to-day activities by cutting down operations cost and improving customer satisfaction through better service than before. By implementing AI within banking procedures. Banks can optimize back-end operations such as workflow management. Consequently, the banks will have greater access to improve their services more quickly and reliably. With AI supporting data-driven decision-making, banks will be in a position to streamline their entire business right from customer service through risk management all the way to financial planning.

Gantt chart



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