Addis Ababa University

College of Technology and Built Environment

School of Mechanical and Industrial Engineering

Masters of Science in Industrial Engineering

Enhancing Motor Insurance Claims Processing Efficiency through Simulation Modeling Approach: A Case Study of Tsehay Insurance S.C.

By:

Natnael Bayinessagn

ID:-GSE /6045/15

Advisor:

Dr. Kasu Jilcha (Assoc.Prof.)

September 2025

Addis Ababa Ethiopia

APPROVAL STATEMENT

This research proposal, titled “Enhancing Motor Insurance Claims Processing Efficiency through Simulation Modeling Approach: A Case Study of Tsehay Insurance S.C.”, has been prepared and submitted to Addis Ababa University, School of Graduate Studies, for assessment under my supervision in accordance with the university's academic requirements.

APPROVED BY BOARD OF EXAMINERS

Kassu Jilcha (PHD) _____

Advisor Signature

_____ _____

External Examiner Signature

_____ _____

Internal Examiner Signature Signature

DECLARATION

I, Natnael Bayinessagn, hereby declare that the research entitled as “Enhancing Motor Insurance Claims Processing Efficiency through Simulation Modeling Approach: A Case Study of Tsehay Insurance S.C.” is my classic work. This research is not done in any diploma or masters at other university, and the whole information source is appropriately acknowledged. I confirm that this research is the real expression of my accomplishment to the ethical standards of academic integrity. I understand that any form of plagiarism or misconduct will result in appropriate action as per the guidance of Addis Ababa University.

_____	_____	_____
Student Name	Signature	Date

This is admitted that the above declaration made by the student is correct to the best of my acknowledge and I hereby endorse his proposal for approval

_____	_____	_____
Main Advisor	Signature	Date

ACKNOWLEDGEMENT

First and foremost, I would like to thank Almighty God for providing me with the tenacity, wisdom, and perseverance to complete this study. His guidance has been a source of inspiration throughout my academic journey.

I extend my sincere gratitude to my advisor, Dr. Kassu Jilcha (Associate Professor), for his invaluable guidance, encouragement, and expertise. His insights have been instrumental in shaping this research and helping me navigate the complexities of simulation modeling in claims processing.

A special thank you goes to the management and staff of Tsehay Insurance Company for their generous cooperation and willingness to share their experience and data. Their support has been invaluable to my research. I am particularly grateful for the primary data collected, which included direct customer feedback and examinations of claim files, as well as the secondary data provided through the company's statistical records and relevant literature on claim service quality.

Lastly, I wish to express my appreciation to my family and friends for their unwavering support and encouragement. Their belief in my abilities has motivated me to persevere through challenges and strive for excellence,

This study is dedicated to all those who aspire to improve the efficiency of the insurance sector process and to enhance the customer satisfaction. Thank you all for being a part of this journey.

APPROVAL SHEET

Enhancing Motor Insurance Claims Processing Efficiency through Simulation Modeling Approach: A Case Study of Tsehay Insurance S.C.

By: Natnael Bayinessagn

This is certify that the thesis prepared by Natnael Bayinessagn entitled "Enhancing Motor Insurance Claims Processing Efficiency through Simulation Modeling Approach: A Case Study of Tsehay Insurance S.C.", is submitted for the approval of dissertation work for the fulfillment of MSc in Mechanical Engineering (Industrial Engineering). It complies with the university's regulations and meets the accepted standards with respect to originality and quality.

Dr. Kassu Jilcha (PHD)	Oct 17, 2025		
Supervisor	Date		Signature
Dr. Solomon Bayu	Oct/17/2025	for Solomon	
Internal Examiner	Date		Signature
Shemels Nesibu	Oct 17, 2025		
External Examiner	Date		Signature
Dr. Abdulkadir Aman	17/10/25		
Interim Head, SMIE	Date		Signature
Dr. Shegaw Ahmed	_____	_____	
Interim vice Executive dean	Date		Signature
For Academic Affairs CTBE			

ABSTRACT

This study investigates the enhancement of motor insurance claims processing efficiency at Tsehay Insurance S.C. in Ethiopia through a simulation modeling approach. The research systematically integrates primary qualitative data gathered from stakeholder interviews with comprehensive secondary data sourced from historical claims records. This dual approach aims to identify and analyze critical bottlenecks that adversely affect processing times and customer satisfaction. Through meticulous analysis, the research reveals significant variations in processing durations, with some claims extending over a staggering 853 days to resolve. Such delays not only undermine customer trust but also erode the competitive edge of the insurance provider. The simulation modeling conducted in this study demonstrates that implementing automation technologies could potentially reduce overall claims handling processes times by approximately 30%, effectively addressing these inefficiencies and enhancing service delivery. The study provides actionable recommendations, emphasizing the need for standardized procedures, improved communication among stakeholders, and continuous training for staff to adapt new technologies. This study uniquely contributes empirical evidence regarding the impact of automation on claims processing efficiency and demonstrates how simulation modeling can effectively identify and mitigate workflow bottlenecks. Moreover the quantifiable benefits of automation, the research emphasize actionable recommendations aimed at refining claims processing practices. These include the establishment of standardized procedures that can enhance consistency, fostering improved communication channels among stakeholders and improving continuous training programs for staff. Furthermore, this study advocates for a customer-centric approach in the redesign of claims processes, emphasizing the importance of actively incorporating customer feedback to inform decision-making. By harnessing simulation modeling techniques, the study aims to promote data-driven strategies that enhance operational efficiency and elevate customer satisfaction within the insurance industry. The implication of these findings are profound for insurers aiming to optimize their claims processes in an increasingly competitive market, landscape, as they pave the way for future research endeavors focused on operational improvements and technological advancements in insurance practices.

KEYWORDS*: Motor Insurance, claim processing, Simulation Modeling, Automation, operational efficiency, customer satisfaction*.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

S.C.	Share company
PT	Processing Time
RPA	Robotic Process Automation
DES	Discrete Event Simulation
KPI	Key Performance Indicator
AI	Artificial Intelligence
EIC	Ethiopian Insurance Corporation
SOP	Standard Operating Procedures
CRMS	Customer Relationship Management Systems

CHAPTER ONE

1. INTRODUCTION AND PROBLEM APPROACH

1.1 Introduction

Motor insurance claim processing is a critical function within in insurance sector, significantly impacting policyholder satisfaction and company operational performance. In an increasingly competitive market, policy holders are demanding faster and more transparent claims processing. Research has shown that the speed of settlement directly influences policy holder's satisfaction, often outweighing other factors such as the accuracy of the claim or quality of customer service (Garrett, 2023). Therefore the prioritization of speed in motor insurance claims processing is crucial as it directly affects policyholder's satisfaction and retention. Quick resolutions reduce stress for customers and build trust, making them less likely to switch insurers. The implementation of Generative AI in claims processing can streamline operations by automating labor-intensive tasks and improving accuracy, thereby addressing key inefficiencies in existing workflows (Bilakanti, 2025)

In the modern insurance landscape, efficient claim processing has become essential, as it directly correlates with customer loyalty and competitive advantage (Kumar & Singh, 2022). The demand for fast and transparent claims resolution continues to escalate, driven by rising customer satisfaction and the proliferation of the digital service (Patel & Johnson, 2023).

Processing cycle time is a critical factor influencing customer satisfaction and operational efficiency in the insurance industry. By establishing a clear understanding of the critical factors influencing processing time, this study seeks to enhance operational performance and improve customer satisfaction at Tsehay Insurance Company. The efficiency of the vehicle insurance claim process is critical as it directly impacts customer satisfaction and operational efficiency, with delays leading to dissatisfaction and increased costs (Pramudya et al., 2025).

The integration of machine learning techniques can enhance prediction accuracy regarding claims payouts, thereby assisting insurers in managing risks effectively and optimizing pricing strategies (Han, 2024).

The complexity of the claims process makes it susceptible to various inefficiencies. Factors such as inadequate data handling, insufficient staff training, and lack of effective communication can contribute to delays. These bottlenecks can be exacerbated by increasing

claim volumes, particularly in regions experiencing economic growth or rising vehicle ownership. Therefore, identifying and mitigating these bottlenecks is crucial for enhancing the overall efficiency of the claims process.

Simulation modeling emerges as a powerful tool for analyzing and optimizing claims processing. By creating a virtual representation of the claims work flow, stake holders can visualize the entire process, identify bottlenecks and test different scenarios without incurring the cost associated with real-world changes. Through simulation, it becomes possible to assess the impact of various interventions, such as reallocating resources or altering workflows, thereby enabling data- driven decision-making (Brown & Taylor, 2021). In an increasingly competitive market, policyholders are demanding faster and more transparent claims processing. Research has shown that the speed of settlement directly influences policyholder satisfaction, often outweighing other factors such as the accuracy of the claim or quality of customer service (Garret, 2023).

Tsehay Insurance Company, like many of its competitors, faces challenges related to lengthy processing cycles. Long cycle times can lead to dissatisfaction among policy holders, resulting in potential loss of business as dissatisfied customers may seek alternatives (Ellison. 2023).

1.2 Background and Problem Justification

Motor insurance claims processing is a vital component of the insurance sector, significantly affecting customer satisfaction and operational performance (Garrett, 2023). As customer expectation for rapid service increase, long processing times can lead to frustration and decrease loyalty, prompting policyholders to seek alternatives (Ellison, 2023). The complexity of the claims process, involving multiple stakeholders such as repair shops, adjusters and legal representatives, often results in inefficiencies due to poor communication and inadequate technological integration (Mckinsey & Company, 2021). Research indicates that insurers adopting advanced technologies, such as simulation modeling, can achieve significant improvements in processing times and operational efficiency (Accenture, 2020). By creating a virtual representation of the claims workflow, simulation modeling allows for the identification of bottlenecks and testing of various scenarios to optimize processes (Kumar & Singh).

Motor insurance claims can be complex, involving various stakeholders, including policy holders, insurances adjusters, repair shops, and legal representatives. Each party plays a vital role in the claims life cycle, and delays at any point can lead to longer processing times. According to a study by McKinsery & company (2021), inefficiencies in communication and work flow management can result in processing cycle times that are significantly longer than industry benchmarks. These inefficiencies can stem from factors such as data entry errors, lack of standardize procedures, and inadequate integration of technology.

The Ethiopian insurance market is characterized by a unique blend of growth potential and significant under development. Despite being the second most populous country in Africa, its insurance penetration remains one of the lowest on the continent (Africa Re, 2024). Inefficient claims processing can significantly impact both customer satisfaction and the overall performance of insurance companies. Research indicates that delays in claims processing lead to heightened customer dissatisfaction. A study by Muhammed (2021) found that 65% of customers experienced dissatisfaction due to slow claims resolution, often resulting in customers shifting to competitors. According a survey conducted by Oladunni (2024), 58% of policy holders stated that their trust in an insurance company decreased significantly after experiencing delays in claims processing. A case study from Ethiopian Insurance Corporation (EIC) revealed that prolonged claims resolution times increased administrative costs by 30%, directly affecting profit margins (Global Data, 2024).

Cycle time refers to the total time taken from the initiation of a claim to its final settlement. Long processing times can lead to customer frustration and increased operational costs. The claims workflow often encounters delays due to various factors, such as inefficient communication, manual bottlenecks, and absence of integrated technology. The primary purpose of reducing processing time in motor insurance claims is to enhance customer satisfaction by delivering faster resolutions, which directly impacts policy holder loyalty. Streamlining the claims process improves operational efficiency by optimizing resource utilization, reducing costs, and minimizing errors that can lead to disputes. Faster processing times help companies to maintain a competitive advantage in the market, aligning their operations with industry benchmarks and best practices. Additionally, reducing processing times lowers the financial impact of prolonged claims by minimizing operational costs. By using simulation modeling tools, companies can facilitates efficient workflows and support continuous improvement to meet customer expectation and market demands

Simulation Modeling allows organizations to create a virtual representation of their claims processing workflow. By simulating different scenarios, insurance companies can analyze the impact of various factors on cycle time and identify optimal solutions. It is used to visualizing processes, identifying bottlenecks, and experimenting with changes without disrupting actual operations. The motor insurance sector plays a critical role in in the overall economy, providing necessary support to policyholders while also contributing to the stability of the automotive market. However, the efficiency of the claims processing cycle is a significant concern for insurers, particularly as customer expectations for rapid service continue to rise. Research indicates that the speed of claims resolution is a key determinant of customer satisfaction and loyalty (Deloitte, 2022).

A study by Accenture (2020) highlights that insurer who implements advanced technologies, such as simulation modeling and analytics, can achieve notable improvements in processing times and overall operational efficiency. Simulation modeling, in particular, has gained traction as a method for optimizing claims processing. By creating a dynamic representation of the claims workflow, insurers can identify bottlenecks, evaluate the impact of potential changes, and implement strategies that lead to more efficient operations (Kumar & Singh, 2023). This approach not only helps in understanding the current state of the processing cycle but also facilitates continuous improvement through iterative testing and refinement.

In light of these insights, this study seeks to analyze and optimize the processing cycle time for motor insurance claims at Tsehay Insurance Company. By leveraging simulation modeling the research aims to uncover inefficiencies with in the current process and propose actionable recommendations for improvement, the findings of this study are expected to provide significant value not only Tsehay Insurance Company but also to the wider insurance industry, offering insights in to best practices for claims management.

The efficiency of motor insurance claims processing is a critical concern for both insurers and policy holders. Lengthy claim processing times can lead to significant dissatisfaction among policy holders, affecting their loyalty and willingness to renew policies with the same insurer. According to a survey conducted by J.D. Power (2023), nearly 80% of consumers indicated that the speed of claims resolution is a primary factor influencing their satisfaction with their insurance provider.

The challenges surrounding claims processing are particularly pronounced. The organization is experiencing increasing claim volumes, which, when coupled with existing inefficiencies,

results in prolonged cycle times that can reach several weeks. Such delays not only frustrate customers but also impact the company's bottom line by increasing operational cost and resource allocation for unresolved claims (Brown & Lee, 2022).

Furthermore, the lack of streamlined processes can lead to errors, miscommunication, and ultimately, higher rates of claim disputes, further complicating the resolution process. In the context of the broader insurance industry, inefficiencies in claims processing have been well documented. A report by PwC (2022) highlights that insurers could improve their processing times by up to 30% through the adoption of advanced analytics and automation technologies. However, many companies, including Tsehay Insurance, have yet to fully leverage these opportunities, resulting in a competitive disadvantage. As more insurers embrace digital transformation, those that fail to optimize their claims process risk losing market share to agile competitors.

Simulation modeling offers a promising avenue for addressing these challenges. By providing a data-driven approach to understanding and optimizing the claims process, simulation allows organizations to visualize workflows, identify bottlenecks, and test potential improvements without disrupting ongoing operations (Kumar & Singh, 2023). This method not only helps pinpointing specific inefficiencies but also provides the flexibility needed for insurers to adapt to changing business environments. In conclusion, the problem of inefficient claims processing at Tsehay Insurance Company presents significant challenges that impact both customer satisfaction and operational efficiency. By justifying the need for optimization through simulation modeling, this study aims to provide actionable insights that can lead to enhanced performance and improved customer experiences in the motor insurance sector.

Tsehay Insurance Company, a key player in the Ethiopian insurance sector, has been serving policy holders by providing a range of insurance products, including motor insurance. Like many insurers, Tsehay Insurance Company, faces challenges in its claims processing. With the increasing volume of the claims, particularly in urban areas where vehicle ownership is on the rise, the company must adapt its process to maintain competitiveness. Lengthy claims cycle time results in operational inefficiencies, which includes lack of standardize workflows, and limited integration of advanced technologies. By recognizing the critical need for improvement, Tsehay Insurance is exploring innovative solutions, such as simulation modeling, to optimize its claims processing.

The dataset presents a comprehensive analysis of claims processing times across several stages, highlighting both efficiency and challenges with the claims handling process. Each claim is segmented in to five key stages: initial review, documentation verification, claim assessment, and payment processing. The total time taken to process claims shows significant variability, ranging from a minimal 13 days to an extensive 853 days, indicating potential inefficiencies or complexities in certain cases. The initial review phases typically spans 1 to 127 days, suggesting that more complex submissions may require longer reviews. Documentation verification exhibits considerable variability, with some claims taking up to 308 days, reflecting delays that can impact overall processing times. Claim assessment is crucial, with some assessments exceeding 431 days, likely due to the need for additional information or disputes. While payment processing usually takes less time, it can still contribute to significant delays. Overall, the data reveals clear areas for improvements, particularly in stages where delays are prominent. Streamlining documentation verification and assessment processes could enhance efficiency and minimize processing times, leading to better service delivery and increased customer satisfaction.

1.3 Problem statement

Research's indicates that the speed of claim settlement is critical factor in determining customer satisfaction, often outweighing other elements such as accuracy and the quality of customer service (Garrett, 2023). As a result, the company risks losing its competitive edge as more customers seek faster, more transparent claims process. Inefficiencies in the claim process are further compounded by an increasing volume of claims, particularly in regions with rising vehicle ownership or economic growth, creating a strain on existing workflows. As customer expectation for quick transparent claims process rise, companies face the risk of losing competitive advantage.

The efficiency of motor insurance claim processing is increasingly crucial for insurers, as traditional methods are often hampered by manual efforts that lead to delays and increased operational costs (Bilakanti, 2025).

The efficiency of the vehicle insurance claim process is critical as it directly impacts customer satisfaction and operational efficiency, with delays leading to dissatisfaction and increased costs (Pramudya et al., 2025). Accurate prediction of insurance claims and their amounts is crucial for optimizing premium pricing, managing financial risk, and enhancing competitiveness in the market (Han, 2024).

The efficiency of motor insurance claims processing at Tsehay Insurance Company is currently suboptimal, resulting in prolonged cycle times that negatively impact customer satisfaction and operational performance. Recent data from 60 claim cases indicates that significant delays, with resolution times ranging from as little as 12 days to as long as 815 days. For instance, the longest claim takes 815days to settle, with breakdowns including 123 days for initial reviews, 215 days for documentation verification, 309 days for claim assessment, and 168 days for payment processing. These inefficiencies lead to frustrated policyholders and increased operational cost. Delays in claims processing have become a significant concern, ultimately affecting customer retention and the overall operational efficiency of the company. This is particularly concerning given the projected shift to digital claims processing, where customers will increasingly expect immediate, transparent and customer-centric claims experiences.

These issues lead to frustrated policy holders and increased operational costs. A 2024 report highlighted that delays in claims processing have become a significant concern, ultimately affecting customer retention and the company's overall operational efficiency (Insurance Review, 2024). A significant portion of claims processing inefficiencies is attributed to prolonged waiting times and deviations from Standard Operating Procedures (SOPs), emphasizing the need for systematic analysis and process improvement (Pramudya et al., 2025).

As the industry moves towards digital claims processing by 2025, customers will increasingly expect immediate, transparent, and customer-centric claims experiences. However, Tsehay Insurance faces significant challenges in adapting to this shift. Bottlenecks in workflow, inefficient communication among stakeholders, and inadequate use of technology hinder the company's ability to meet evolving customer expectations and achieve competitive parity. As a result, the average processing time for claims can extend well beyond industry benchmarks, leading to frustrated policyholders and increased operational cost.

1.4 Research Questions

- What are the variables affecting the processing cycle time for motor insurance claims?
- What potential improvements in processing cycle time can be achieved through the implementation of the simulation model?

- What effects does an optimized processing cycle time have on overall operational efficiency and resource utilization at the company?
- What specific strategies can be derived from the simulation model to enhance the claims processing workflow?

1.5 Objectives

1.5.1. General Objective

The general objective of this research is to systematically optimize processing time for motor insurance claims through advanced simulation modeling techniques. This involves analyzing current workflows, identifying bottlenecks, and evaluating various scenarios to improve efficiency, reduce processing times, and enhance customer satisfaction in the claims management process. The goal of the thesis is to enhance operational efficiency and improve the overall effectiveness of motor insurance claim processes.

1.5.2. Specific Objectives

- To identify variables that affects processing cycle time of claim process
- To assess improvements in processing cycle time through simulation modeling
- To assess the impact of optimized processing cycle times on operational efficiency and resource utilization by measuring key performance metrics before and after optimization.
- To formulate strategies for enhancing the claims processing workflow

1.6 Scope of the Study

The research focuses on specifically on motor insurance claims processing cycle time at Tsehay Insurance Company, examining the work flow from the initial claim submission to final resolution. While the claim process may extend beyond Tsehay Insurance to include interactions with external stakeholders such as repair shops and legal representatives, this study concentrates solely on the internal process with in Tsehay Insurance Company to minimize complexity.

The scope of this study excludes claims processing for other types of insurance products, such as health, property and life insurance, as well as claims from other insurance companies. Additionally, the study not addresses external factors affecting the insurance market. By focusing specifically on motor insurance claims within Tsehay Insurance

Company, this research aims to provide a detailed and manageable analysis that can lead to actionable insights for optimizing the claims processing cycle.

1.7 Limitation of the study

The research has several limitations that may impact its findings. The quality and completeness of the collected data, could affect the accuracy of the simulation modeling outcomes. The research incorporates subjective data from interviews and questionnaires, which may introduce bias based on personal perception and experiences. Time constraints during the research timeline may restrict the thoroughness of data collection and analysis, ultimately affecting the comprehensiveness of the findings. Finally, the complexity of the claims process might lead to oversimplification in simulation model, potentially failing to capture all variables that affect processing time.

1.8 Significance of the Study

The significance of this research focuses on optimizing the motor insurance claims processing cycle at Tsehay Insurance Company, which is crucial for enhancing customer satisfaction and operational efficiency. By investigating the claims workflow through simulation modeling, this study aims to identify inefficiencies and propose actionable strategies that can lead to faster claim resolutions. Improving the claims process is vital for several reasons. Firstly, a more efficient processing cycle directly enhances customer experience, as policy holders increasingly expect quick and transparent service. Satisfied customers are more likely to remain loyal and recommend the company to others, which is essential for market competitiveness. Secondly, optimizing claims processing can lead to substantial cost savings for Tsehay Insurance Company. By reducing processing times and minimizing errors, the company can lower operational costs associated with claims management, ultimately improving its financial performance.

This study also has significant academic implications, contributing to the body of knowledge in insurance management and operational efficiency, and providing a framework for future studies on claims processing optimization. In the community context, enhancing the efficiency of claims processing ensures that policyholders receive timely support, fostering trust and satisfaction in insurance sector. By improving operational practices, this study has economic implications, potentially leading to lower operational costs and improved financial performance in the insurance industry.

For decision-makers and implementers within Tsehay Insurance Company, the findings of this research will provide actionable strategies to optimize claims processing. This can lead to faster resolutions, improved financial performance and minimized operational costs, ultimately enhancing the company's competitiveness in the market.

Additionally, this study contributes to the broader insurance industry by providing insights in to best practice for claims optimization. As insures face increasing competition, understanding how to streamline operations is beneficial not only for individual companies but for the industry as a whole. Overall, this research is significant as it targets enhancing the efficiency of motor insurance claims processing, benefiting both Tsehay Insurance and its customers, while contributing to best practice in the insurance sector.

1.9 Organization of the paper

This research paper is organized into five main chapters. Chapter One introduces the significance of motor insurance claims processing, outlining the challenges faced by Tsehay Insurance Company and emphasizing the role of simulation modeling in optimizing these processes. Chapter Two provides a literature review, defining key concepts and examining critical factors that affect processing time, while also identifying gaps in existing research. Chapter Three details the research methodology, including the study area, approach, design, and data collection methods, with a focus on simulation modeling techniques. In Chapter Four, the result and discussion are presented, analyzing the collected data, identifying challenges in the claims processing workflow, and exploring the demand for automation and potential improvements. Finally, Chapter Five concludes with a summary of findings, actionable recommendations for Tsehay Insurance to enhance its claims processing efficiency, and suggestions for future research.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Introduction

In this section, a comprehensive literature review on motor insurance claims processing is presented, examining the factors that influence the efficiency, the importance of cycle time, and the role of simulation modeling in optimizing processing times and workflows. Several performance measures, such as operational efficiency and customer satisfaction, are discussed alongside advanced methodologies like deep learning and machine learning applications in enhancing claims processing. Furthermore, the review highlights operational inefficiencies and challenges faced by insurers, along with case studies that illustrate best practices for improvement. Finally, gaps in the existing literature are identified, providing directions for future research in this critical area of the insurance industry.

2.2. Definition

Processing Time (PT) is defined as the total duration from the submission of a claim to its resolution **(**Miller& Davis, 2018). This metric is crucial in evaluating the efficiency of claims handling.

Simulation Modeling: A technique used to replicate analyze processes through mathematical models. It allows insurers to visualize different scenarios, assess outcomes, and identify areas for improvement (Jones, 2021). This technique is particularly valuable in the insurance sector, where understanding complex processes is essential for optimization. According to Martinez & Zhao (2025), Simulation modeling effectively replicates complex claims processes, enabling insurers to visualize scenarios and assess outcomes to understanding operational inefficiencies and enhance workflows.

Claims Resolution: is the final output of a claim processing cycle, which includes the determination of claim validity, payment authorization, and communication of the decision to the claimant.

Bottleneck: refers to a stage in a process that causes delays and reduces overall efficiency. In claims processing, identifying bottlenecks is essential for improving workflow.

Workflow optimization: is a systematic approach to improving effective efficient work process within an organization. In motor insurance, this involves streamlining the claims process to reduce delays and enhances customer satisfaction.

Key performance Indicators (KPIs): are metrics used to measure the performance of the company activities. In claims processing, KPIs may include PT, claim approval rates, and customer satisfaction scores.

Scenario Analysis: involves considering alternative possible outputs by analyzing future events. In the context of simulation modeling, it allows insurers to test various operational changes and their potential impacts.

Claims processing in insurance have several advantages, such as improved efficiency through streamlined workflows, which can lead to faster claim resolution and enhanced customer satisfaction. The use of data analytics enables insurers to identify trends and make informed decisions, potentially reducing fraud and optimizing resource allocation.

However, there are also significant disadvantages, including an overemphasis on processing time that can compromise the quality of claims assessments. Subjectivity and communication issues can lead to inconsistencies in claims resolution, while identifying bottlenecks often proves challenging, with staff resistance hindering necessary improvements.

Furthermore, over-optimization of workflows may create inflexibility, making it difficult to adapt to changing market conditions. In summary, while claims processing can enhance efficiency and customer satisfaction, it is essential to balance these advantages with the potential drawbacks to ensure a fair and effective claims experience.

2.3. Critical Factors Influencing Process Time

Several critical factors influence the processing time of insurance claims. First, technology integration is paramount. Chen and Liu (2020) argue that the adoption of automated systems significantly reduces manual errors and expedites claims processing. By eliminate repetitive tasks, technologies such as Robotic Process Automation (RPA) and Artificial Intelligence improve efficiency.

Second, staff training is essential. Thompson (2019) highlights that well-trained personnel can navigate the claims process more effectively, directly impacting processing times. Finally, customer communication is vital. Garcia (2022) suggests that effective

communication enhances customer satisfaction and can reduce the need for follow-ups, which often delay processing.

The advantage of integrating technology, well trained staff, and effective customer communication collectively enhance processing efficiency by reducing errors, accelerating turnaround times, and reducing delays caused by follow-ups.

However, there are drawbacks associated with these critical factors. The high upfront cost of implementing advanced technologies like RPA and AI can be a barrier. Additionally, the resource-intensive nature of staff training may detract from claims processing time, there is also the risk of communication overload, which can lead to confusion and the potential vulnerabilities associated with overdependence on technology, which can disrupt the claims process during system failures.

In summary the processing time of insurance claims is influenced by technology integration, staff training and customer communication, while these factors can an enhance efficiency and satisfaction, they also pose challenges such as high costs and potential overload.

2.4 Simulation Modeling in Insurance

Simulation modeling serves multiple purposes within the insurance sector. It allows insurers to test various scenarios in claims processing, enabling them to forecast outcomes and assess the impact of changes in procedures or technology (Patel & Kahn, 2021). This modeling technique is particularly useful for identifying processes bottlenecks and evaluating the effect of resource allocation (Rogers, 2020). By simulating different conditions, insurers can better prepare for real-world challenges, ultimately leading to more efficient operations.

Simulation modeling in insurance offers several advantages, including enhanced risk assessment by visualizing potential future events and their impacts on claims processing. It facilitates scenario testing, allowing insurers to forecast outcomes and evaluate the effects of procedural or technological changes. Additionally, it effectively identifies process bottlenecks, helping streamline operations and improve efficiency. Finally, simulation modeling supports informed decision-making through a data-driven approach, enabling better strategic planning and resource allocation.

Simulation modeling in insurance has several drawbacks, including its complexity, as developing accurate models can be time-consuming and require significant expertise and

resources. The effectiveness of these models is heavily dependent on the quality and availability of data, with inaccurate or incomplete data potentially leading to misleading results. Additionally, the implementation of simulation modeling can incur substantial costs related to software, training, and ongoing maintenance. There is also a risk of over-reliance on simulation results, which may cause insurers to overlook qualitative factors and real-world complexities not captured by the models. Finally, the limited scope of simulation models may result in oversimplified conclusions, as they may not account for all variables in the claims process.

Simulation modeling is a valuable tool in the insurance sector, enabling effective scenario testing and outcome forecasting. It helps identify bottlenecks and optimize resource allocation, leading to improved operational efficiency. However, challenges such as model complexity, data dependency, and potential over-reliance on outputs must be considered. Understanding both its advantages and limitations is essential for informed decision-making. Simulation modeling can be employed to enhance operational efficiency with in insurance sector (Burri et al. 2020). To reduce the overall claims processing cycle time automated claims processing system that incorporates computer vision and natural language processing to enhance identification of vehicle damage and streamline documentation process (Fernando ,2023).

The implementation of effective simulation modeling better for optimization of processing times and insurers can derive valuable insights that contribute to improved cycle times (Fernando, 2023). The paper also notes that increasing the adoption of artificial intelligence, machine learning and simulation modeling by insurance sectors to reduce operational challenges. Effective simulation modeling is analyzes the claims processing cycle, emphasizing its potential for identifying inefficiencies (Kinyua Weru and Waititu, 2020). They utilize Extreme Value Theory (EVT) to model extreme occurrences and understand the behavior of large claims which is crucial for assessing risks associated with motor insurance.

2.5. Tools and Strategic for Optimizing Claim Processing

The optimization of motor insurance claims processing is an essential focus area with in the insurance sector. Efficient claim management is critical, as it directly impacts customer satisfaction and operational cost. A study by Baldwin and Smith (2020) emphasizes that delays in claims processing can lead to customer dissatisfaction, ultimately affecting a company's reputation and profitability.

Several strategies can optimize claims processing. One effective method is process automation. Walters (2019) discusses hoe automating unvarying works like claims validation, can significantly reduce processing times and increase accuracy. Data analytics plays critical roles in decision making Nguyen and Lee (2021) illustrate that leveraging data can help insurers identify trends and optimize resource allocation. Continuous improvement methodologies, such as Lean and Six Sigma, focus on eliminating waste and improving process flow, leading to enhanced efficiency in claims processing (Harris, 2020).

For effective optimization of claims processing in insurance industry, several strategic approaches can be employed. These strategies focus on enhancing operational efficiency, reducing lead time, and improving customer satisfaction.

Technology Integration: Leveraging advanced technology like machine learning (ML) and Artificial intelligence (AI) can subject to the claims processing landscape. AI can used to routine processes, analyze claims data to identify fraudulent claims more swiftly (Smith & al., 2021)

Lean technology: By applying lean principles, such as eliminating waste and improving process flow, can significantly enhance claims handling efficiency. According to Womack and Jones (2016), organizations that deploy lean practices are able to streamline operations, reduce lead time, and improve service quality. By identifying non value added activities and focusing on the core process, insurers can create more efficient claims handling framework.

Continuous Training and Development: Investing training for claims personnel is crucial for maintaining high service standards. Regular training sessions on emerging technologies and best practices can empower staff to utilize new tools effectively and mange claims more efficiently (Keller & Flores.2022). a well-informed team is better equipped to handle complex claims and maintain customer satisfaction.

Enhancing customer communication: Effective communication channels with customers throughout the claims process can significantly improve satisfaction and operational efficiency. Proactive updates regarding claim status and estimated processing times can reduce customer anxiety and minimize follow-up inquires (Alvarez, 2023). By utilizing chat bots and automated messaging systems can facilitate timely communication and enhance the overall customer experience.

Data-Driven Decision Making: Monitor claim process by using data analytics to provide valuable insights in to performance and areas needing improvement. By analyzing trends in processing times and identifying bottlenecks, managers can make informed decisions to optimize resource allocation and operational strategies (Martin &Lee, 2022). Implementing real time performance indicators can support continuous improvement efforts.

Feedback Mechanism: Incorporating customer feedback in to the claims process can help identify pain points and areas for enhancement. Regular surveys and feedback forms can provide insights in to customer experiences; enabling insurers to adapt their processes to meet client expectations better (Nguyen & Patel, 2023). This customer-centric approach fosters loyalty and strengthens the company's reputation.

Accurate forecasting of motor insurance claims is essential for determining cash flow and pricing (Poufinas et al., 2023). This study introduces machine learning techniques, including Support Vector Machines and Random Forests, alongside new variables like weather conditions and car sales, improving prediction accuracy. Findings show that these models outperform traditional methods, highlighting the value of incorporating external factors into claims forecasting. The research underscores the need for further exploration in machine learning applications within the insurance sector.

Machine learning Applications: Machine learning (ML) has emerged as a critical tool and playing a critical role in analyzing and improving insurance claims process, with applications ranging from automated product offering to fraud detection, ML significantly enhances efficiency and reduces cycle times, allowing to respond to claims more swiftly (Brati, E., Braimllari 2025). The integration of ML Algorithms in claims processing not only accelerates settlement times but also improves the accuracy of predictions regarding claims cost this operational efficiency is important for reducing the cycle time related with processing insurance claims. However, the implementation of ML in the insurance industry is not without challenge like necessity for data quality, effective training of AI models and ensuring data security. A study by Brati et al. (2025) highlights that the role of ML in automating several aspects of the claims process, such as fraud detection and claims validation. By leveraging algorithms, insurers analyze bulky datasets quickly, leading to faster decision-making and reducing the processing times. The study emphasizes that ML not only accelerates the claims process but also enhances accuracy in predicting claims costs.

Robotic Process Automation (RPA) has transformed insurance claims processing, achieving remarkable efficiency, with processing times reduced from 72 hours to less than 5 minutes and accuracy rates reaching 99% (Pingili, 2024). The integration of RPA and artificial intelligence (AI) has led to significant cost reductions of 40-70% in claims operations, enhanced fraud detection capabilities, and increased customer satisfaction scores by an average of 30 points (Pingili, 2024). However, despite the technology's potential, many insurers still struggle with manual claims handling, highlighting a critical need for digital transformation in the industry.

Robotic Process Automation (RPA): is a technology that uses software robots or "bots" to automate highly repetitive and routine tasks typically performed by humans. It enables organizations to streamline their operations by mimicking the actions of a human interacting with digital systems to execute a business process; it can handle tasks such as a data entry, data validation and processing transactions with high accuracy and speed (IT Convergence, 2024).

Pinigili (2025) investigates the transformative impact of AI-driven Intelligent Document Processing (IDP) on the insurance sector, where the management of vast quantities of documents often leads to inefficiencies and errors. The research highlights that integrating technologies such as Machine learning (ML), Natural Language Processing (NLP), and Robotic Process Automation (RPA) can reduce document processing times by 80% and error rates by 90%. The study demonstrates that how IDP streamlines workflows, enhances patient care and accelerates claim processing. The findings emphasizes that IDP brings significant operational improvements and mitigate risks associated with automated decision making.

It plays a critical role in enhancing the efficiency of the claims by automating repetitive and time-consuming tasks, the implementation of RPA in claims processing which minimizes manual errors and speeds up the overall workflow Chen and Liu (2020). This technology is very important for reducing time taken for claims data entry and validation, thus improving operational efficiency by reducing manual errors.

Bilakanti (2025) explores the transformative potential of Generative AI in optimizing claim processing across various channels, such as email and call centers. Traditional claim processing methods often involve extensive manual labor, leading to inefficiencies and delays. By utilizing advanced AI models like Natural Language Processing (NPL) and

Generative Adversarial Networks (GANs), the study demonstrates significant improvements in data extraction accuracy, fraud detection and decision-making efficiency. The findings highlight that automating these processes not only reduces operational costs but also enhances customer satisfaction through faster claim settlements. This research underscores the necessity of integrating AI technologies to modernize insurance practices and improve overall service quality.

The integration of Artificial Intelligence (AI) and mobile technology in insurance claims management has led to significant improvements in efficiency and customer satisfaction. The implementation of AI-driven systems has reduced claims processing times from 45 minutes to 18 minutes and increased fraud detection accuracy from 65% to 89%. Additionally, customer satisfaction scores have risen from 58% to 84% (Kandregula, 2025). The proposed framework utilizes Optical Character Recognition (OCR), computer vision, and Natural Language Processing (NLP) to automate the claims process, allowing policyholders to submit claims via mobile devices using various data formats, including images and voice commands. These advancements not only enhance operational efficiency but also address traditional challenges in the claims process, paving the way for more agile and customer-centric insurance services.

Deep Learning Models: In insurance sector automation of claim processing has been significantly improved through the implementation of advanced deep learning models, especially Convolutional Neutral Networks (CNNs). According to Khan et al. (2023), this system drastically minimizes processing times. This has traditionally been a bottleneck in claims evaluation. A Specialized data set comprising 5,121 images of various vehicle damages such as cracks, scratches and flat tires was fastidiously developed to train the model, underscoring the critical role of high quality data in optimizing processing efficiency. The study evaluated several deep learning architectures and identified Inception V3 as the most effective, achieving an impressive accuracy rate of 97%. This finding brings out the importance of model selection in enhancing both speed and accuracy in claims processing (Khan et al., 2023).

By integrating the deep learning model in to the insurance work flow, the proposed system simplifies and accelerates the claims evaluation process, reduces the reliance on human intervention, which often contributes to delays in traditional systems (Khan et al., 2023). Deep learning models can drastically minimize processing times by automating the assessment of claims depending on the images of damaged vehicles as Khan et al (2023)

explored the use of Convolutional Neutral Networks (CNNs). This approach is not only speeds up the evaluation process but also reduces reliance on human intervention; which is often a bottleneck in traditional systems.

The study by Han (2024) addresses a critical need in the car insurance industry, accurate prediction of claims. As insurers face increasing competition and rising costs, understanding the factors that influence claim amounts becomes essential for optimizing premium pricing and enhancing profitability . By employing machine learning techniques, the research not only improves forecasting accuracy but also identifies key variables such as new car sales and whether conditions that play significant roles in determining claims. This approach offers valuable insights for insurers, enabling them to develop more effective claims management strategies and ultimately improve customer satisfaction.

The study explores the impact of Guidewire Claim Center on insurance claims processing, revealing a 50% reduction in settlement times and a rise in fraud detection accuracy from 65% to 89% (Shreedharan, 2025). By integrating AI technologies like Optical Character Recognition (OCR) and Natural Language Processing (NLP), insurers significantly enhance operational efficiency and customer satisfaction while addressing challenges such as integration and regulatory compliance.

Data Analytics: By analyzing historical data insurers can make informed decision that enhance efficiency and minimizing processing times by using data analytics in optimizing resource allocation and identifying trends in claims processing (Nguyen and Lee, 2021). Through techniques such as predictive analysis, insurers can hypothesize future claims patterns adjust their resource accordingly, ensuring that claims handlers are available when demand is highest. By examining the life cycle of the previous claims insurers enables to identify common causes of delays they can pinpoint specific stages that frequently experience holdups, such as documentation or approval processes. Advanced analytics can facilitate the detection of fraudulent patterns by analyzing anomalies in claims data. In summary data analytics in insurance claims processing is valuable for enhancing efficiency and fraud detection. It enables better resource allocation and pattern identification.

2.5.1. The Role of simulation modeling in optimizing claims processing

Simulation modeling offers a powerful tool for analyzing the existing process, identifying areas of inefficiency, and testing potential optimization strategies without the cost or risk associated with real world changes (Brown and Taylor, 2021). Therefore, this thesis aims to

investigate the cause of delays in Tsehay Insurance motor insurance claim processing and propose optimization strategies through simulation modeling, with the goal of reducing cycle time, enhancing customer satisfaction, and overall operational efficiency.

Existing literature indicates that effective claims processing is paramount for customer satisfaction in the insurance sector (Beck et al., 2017; Johnson & Lee, 2019). Factors such as technology integration (RPA and AI), staff training, and communication are frequently cited as determinants of processing efficiency (Smith, 2020). Simulation modeling has emerged as a valuable tool for visualizing and optimizing operational processes, enabling companies to test various scenarios and improve workflow (Davis & Thomas, 2021). It is a powerful tool for predicting motor insurance claim processing cycle time by replicating the existing claims process in a controlled environment. This approach allows insurers to visualize different scenarios and assess the impact of various operational changes (Jones, 2021). By incorporating key variables simulation modeling can forecast the effect of increased automation or staff training on cycle times enabling data-driven decision making (Burri et al., 2021). In addition to this, simulation modeling can help to identify bottlenecks and inefficiencies, providing insights into where improvements can be done (Ngyen and Lee, 2021). In summary, effective claims processing driven by technology, trained staff and clear communication is crucial for customer satisfaction in insurance. Simulation modeling offers a valuable tool for visualizing, optimizing workflows and predicting the impact of changes like automation on cycle times, ultimately improving efficiency and identify bottlenecks.

2.5.2. Potential improvements through the implementation of Simulation Modeling

By implementing the simulation modeling the insurance company can improve the processing cycle time by allowing insurers to test various operational strategies before actual implementation. Research by Zhang et al (2023) indicates that implementing simulation models can lead to reductions in cycle times by 20-30% through optimized workflow designs. Furthermore, Lee and Kim (2021) demonstrate that simulation modeling can help predict future processing times based on historical data, thus facilitating proactive resource allocation.

By addressing bottlenecks, the simulation can help streamline workflows and enhance overall efficiency (Patel & Kahn, 2021). Furthermore simulations can reveal the best practice for technology integration and staff allocation, potentially reducing the average

processing time (Keller & Flores, 2022). By conducting what-if analysis the company enables to optimize resource allocation and improve turndown times (Jones, 2021) this analysis can lead to more efficient claims process, resulting in faster resolution times for customers).

Simulation modeling is a basic tool that used to replicate the claims workflow and predicting cycle times. This approach allows to the company to create a virtual representation of their process, enabling the analysis of different scenarios and the assessment of several operational changes (Jones, 2021). By testing several operational strategies by using simulation modeling tools, insurers can identify the most effective approaches for enhancing efficiency and reducing delays (Keller & Flores, 2022).

2.5.3 Why Choosing Simulation Modeling Approach

It is a powerful tool due to its ability to provide a holistic view of the entire claims process. It allows for the visualization of different scenarios, enabling insurers to assess the impact of several changes before actual implementation. By identifying inefficiencies and bottlenecks simulation modeling empowers decision–makers to optimize workflows effectively in addition to this enhance customer satisfaction and operational efficiency for continuous improvement in claims processing. A research indicates that simulation modeling provides a comprehensive perspective on claims processes, highlighting its effectiveness in visualizing workflow and identifying interdependencies (Smith et al, 2022).

Complexity of insurance Processes: claim processing system involves several steps including data entry, verification, assessment, and payment processing. The simulation modeling effectively replicates this process in a controlled environment, enables the researcher to visualize the entire system and understand how changes in one part affect the overall workflow. Research indicates that the complexity of insurance claims, which involves multiple steps, can be effectively managed through simulation. This method allows researchers to replicate and analyze processes in a controlled setting (Johnson & Lee, 2023). Research from 2025 indicates that simulation is essential for managing the complexity of insurance claims, allowing for detailed replication and analysis of multi-step process in a controlled environment (Martinez & Zhao, 2025). The complexity of insurance claims processing, involving multiple steps, can be effectively managed through simulation modeling, allowing for replication and analysis in a controlled environment. However,

existing research primarily focuses on the potential of simulation, lacking detailed analysis of specific simulation techniques or real-world case studies demonstrating significant improvements in efficiency.

Scenario Testing Optimization: Simulation modeling is offers a unique advantage in optimizing motor insurance claims processing by using "what-if "analysis testing various scenario without disrupting real-world operations. This capability is crucial for optimizing claims processing (Davis, 2023).

Identification of Bottlenecks: one of the advantages of the simulation is its ability to identify bottlenecks and inefficiencies with in the claims processing system. By modeling the workflow, stakeholders can identify where delays occur and understand the underlying causes. Studies have shown that simulation modeling is instrumental in pinpointing inefficiencies with claims workflows. By visualizing processes, stakeholders can identify specific delays and their root causes (Thompson, 2023).

Data –Driven Decision Making: simulation modeling cerates accurate representation of the claims process, the insights gained from the simulation modeling are grounded in reality, making them more actionable for decision-makers. Recent literature underscores the significance of these models in improving operational strategies (Garcia et al, 2022).

Cost-Effectiveness: Recent findings reveals cost benefit of simulation modeling, allowing organizations to test various improvement strategies without incurring the cost associated with real-world trial and error (Khan & Taylor, 2024).

Enhanced Communication and Collaboration: simulation modeling can serve as a valuable communication tool among stake holders, collaboration including management, IT personnel and claim officers. Visual representation of workflows can facilitate discussions about process improvements and foster collaboration on solutions (Nguyen & Patel, 2025).

2.5.4. Comparative Analysis of simulation modeling

Researcher uses simulation modeling approach to optimize motor insurance claims processing has several strengths compared with other tools in literature review as shown below:-

Scenario testing: simulation modeling allows insurers to mimic virtual claims processes, to enabling test various operational changes and assess their impacts before implementation. Especially this capability is important for identifying bottlenecks and inefficiencies in the workflow, it is not easily known through ML and RPA alone. Simulation modeling is offers a unique advantage in optimizing motor insurance claims processing by using "what-if "analysis testing various scenario without disrupting real-world operations. This capability is crucial for optimizing claims processing (Davis, 2023).

Comprehensive Analysis: simulation modeling provides a holistic view of the entire claims process it can incorporating various factors such as resource allocation technology integration to evaluate the impact on processing time while ML and RPA is focuses on automating specific tasks. Simulation modeling technique is particularly useful for identifying processes bottlenecks and evaluating the effect of resource allocation (Rogers, 2020)

Data Driven Insights: Both SM and ML depend on data , however SM can utilize big range of data inputs to simulate different scenarios this allows to how changes in one part of the process affects the overall cycle time. Simulation modeling cerates accurate representation of the claims process, the insights gained from the simulation modeling are grounded in reality, making them more actionable for decision-makers (Garcia et al, 2022).

Flexibility: simulation modeling can be used to reflect changes in the claims process such as shifts in customer behavior this significant is takes more advantage over the other tools.

Table 2. 1 Comparison of various tools based on the literature Review

Tool	Description	Advantages	Limitations
Machine Learning (ML)	Uses algorithms to analyze data and automate decision-making processes.	Reduces manual errors; enhances speed and accuracy of claims.	Requires large datasets; complexity in model training.
Robotic Process Automation (RPA)	Automates repetitive tasks to improve efficiency.	Streamlines routine processes; minimizes human intervention.	Limited to predefined tasks; may require significant setup.
Document Verification Tools	Automated systems to verify documentation accuracy and completeness.	Increases accuracy; reduces time spent on manual checks.	May miss context-based errors; dependent on data quality.
Predictive Analytics	Analyzes historical data to forecast future claims and trends.	Informs resource allocation; identifies potential risks.	Primarily focuses on trends, not real-time processes.
Claims Management Software	Centralized platforms for managing claims from initiation to settlement.	Enhances workflow organization; provides real-time tracking.	Can be costly; requires training for effective use.
Customer Relationship Management (CRM) Systems	Manages customer interactions and data throughout the claims process.	Improves customer communication; supports relationship management.	May require integration with other systems; can be complex.
Artificial Intelligence (AI)	Enhances various aspects of claims processing through automation and analysis.	Speeds up processing; improves fraud detection; boosts customer satisfaction.	Requires high-quality data; complex implementation; integration challenges.
Simulation Modeling	Replicates the claims process to analyze various scenarios and outcomes.	Provides comprehensive process visualization; identifies bottlenecks; facilitates "what-if" analyses.	Can be complex to develop; requires quality data for accuracy.

Simulation modeling distinguishes itself from other tools employed in claims processing, such as Machine Learning (ML), Robotic Process Automation (RPA), Document Verification Tools, Predictive Analytics, Claims Management Software, Customer Relationship Management (CRM) systems and Artificial Intelligence (AI), through its capacity for comprehensive process visualization and "what-if" analyses. While ML excels at data analysis and automating decision-making, and RPA streamlines repetitive tasks, simulation modeling provides a holistic view of the entire claims process, enabling the identification of bottlenecks and inefficiencies that might not be apparent through other

methods. Document verification tools and predictive analytics offer increased accuracy and informed resource allocation, respectively, but lack the comprehensive scope of simulation modeling. Although claims management software enhances workflow organization and CRM systems improve customer communication, these tools do not provide the same level of process visualization and scenario analysis as simulation modeling. Simulation modeling allows insurers to test various scenarios in claims processing, enabling them to forecast outcomes and assess the impact of changes in procedures or technology (Patel & Kahn, 2021). AI enhances claims processing through automation and analysis, yet its implementation can be complex and may present integration challenges. Simulation modeling, conversely, facilitates a comprehensive understanding of process dynamics and interdependencies, making it a valuable tool for optimizing claims processing strategies. Simulation modeling is essential for managing the complexity of insurance claims, allowing for detailed replication and analysis of multi-step process in a controlled environment (Martinez & Zhao, 2025).

In essence, simulation modeling offers a versatile approach to claims management by replicating the claims process to analyze various scenarios and outcomes. This allows for testing different strategies in a low-cost, risk-free environment, leading to better decision-making and improved accuracy. However, it is important to acknowledge that developing simulation models can be complex and requires quality data for accuracy. Despite this, the benefits of simulation modeling, including comprehensive process visualization, bottleneck identification, and "what-if" analyses, make it a valuable tool for optimizing insurance claims processing. Studies have shown that simulation modeling is instrumental in pinpointing inefficiencies with claims workflows. By visualizing processes, stakeholders can identify specific delays and their root causes (Thompson, 2023).

2.6 Critical Factors and Variables that affect Processing Time

Various variables influence the processing cycle time of motor insurance claims. According to Davydenko and Karakanova (2021), key factors include the complexity of claims, the volume of claims received, and the efficiency of communication between stakeholders. In addition, the role of technology, such as automated systems and data management tools, has been highlighted by Chen et al. (2020), indicating that effective integration of technology can significantly minimizes processing times. Other studies emphasizes the impact of human factors, including staff training and experience, which are crucial for effective claims

handling(Smith & Brown, 2022). In summary, motor insurance claim processing time hinges on claim complexity, volume, and communication effectiveness. While technology integration and well-trained, experienced staff are crucial for minimizing processing times and offer advantages like reduced costs and improved customer satisfaction, current literature lacks specific detail on technology implementation and quantification of impact for each factor. Further research is needed to address these gaps and provide more actionable insights for optimizing claims processing.

Data quality: The completeness and the accuracy of the data can lead to delays. Missing or `incomplete information and errors in submitted data requires additional time for verification. Data quality is a significant variable, incomplete or inaccurate submission can lead to delays (Patel and Kahn, 2021).

Staff training: Well-trained staff and experienced personnel can process claims quickly. Investing training for claims personnel is crucial for maintaining high service standards. Regular training sessions on emerging technologies and best practices can empower staff to utilize new tools effectively and mange claims more efficiently (Keller & Flores.2022). A well-informed team is better equipped to handle complex claims and maintain customer satisfaction. Staff training plays a critical role; well trained personnel can navigate the claims process more effectively, directly impacting processing time (Thompson, 2019).

Operational workflow design: The structure and stages of the claims process affects how swiftly claims move through different stages to minimize bottlenecks and slowdown the overall processing. It has a crucial role as inefficiencies and bottlenecks in the process can prolong the processing time (Rogers, 2020). Operational efficiencies play a critical role in prolonging the claims processing cycle. Gaps in business management practices, such as inadequate technological integration and poor communication channels, negatively impact efficiency (EAST AFRICAN FINANCE JOURNAL, 2024), Operation inefficiencies, inadequate documentation, and concerns regarding fraud further intensify the delays. Implementing strategies suggest that an integrated approach, which includes the modernization of claims processing system to ensure adhesion to established timelines and standards, can significantly improve the claims settlement process (EAFJ, 2024). Efficient operational workflow design is vital for swift claim processing, yet inefficiencies and poor communication prolong the cycle. Current literature highlights the importance of modernization but lacks specific details on how to best integrate technology and improve

communication. Further research should focus on actionable strategies for overcoming these operational gaps.

Customer communication: Confusing instructions with customers can lead to misunderstanding and results for delays in processing time of claims, so clarity of communication has a crucial role in quick processing time. Effective and timely communication reduces follows-ups and minimizes processing delays (Garcia, 2022).

Claim submission Method and Customer Factors: The methods of claims submission could be online or offline this will be affect the processing speed of the claims the online submission generally being faster. More complex systems requires more time for investigation and resolution and also quick customers respond requesting for additional information can impact on processing time.

Fraud detection Measures: Advanced fraud detection tools may wither speed up or slow down the process, depending on the implementation so additional checks for fraud can extend processing times. As literature review shows that various potential improvements for simulation modeling in motor insurance claims processing is a key enhancement of integrating of real-time data, which is important for increasing the accuracy and relevance of simulation modeling (Patel & Kahn, 2021).

Inadequate data management: Errors or missing information in the initial claims submission often lead to prolonged processing times. Uneven distribution of workload among claims handlers can create bottlenecks. Complexity of cases involves multi-party claims or disputes, requiring additional time for resolution.

2.7 Motor Insurance Claims Procedure

Claim Notification: The initial steps in the claims process it begins when the policy holder notifies the accident to the insurance company by submitting a notification form that explains the loss, what accident is occurred by including the date, time, situation and the brief description of what happened. It must be recognized early with in the specified days to the insurance company and made through an agent, mobile calling or directly to the insurance company. Failure to give the notification with in the specified days is a violating of the company policy, which might give the right to the insurer to turndown liability.

Verification: It is the process of checking all the submitted documents for the accuracy and completeness that they meet the requirements of the claims. Reported loss of the policyholder's item is covered at the time of loss by the insurer that received notification and then presents the causes of the damage. This step ensures that the claim is legitimate, checking policy coverage and confirming that all required information is submitted.

Site survey: It is the process of assessing the loss that damaged at the time of incident after inspection; surveyors give a professional proof of loss and extent of loss to the claims officers. The claim officer and managers discuss about the parts to be repaired, changed or replaced based on the surveyors advice and payment to the policyholder. If the policy holder is not agreed with it will go to independent surveyors at the time of loss inspection it is used to help the insurers to protect if there is any fraudulent act.

Approval process: It is the formal review and authorization of the claims process of ensuring that all the criteria are met before preceding the payment. If the claim is approved the resolution process begins the insurer calculates the payout amount and communicates this to the policyholders, allowing for any necessary negotiations.

Claim payment: The payment step occurs after the claim has been approved and determined the amount of loss based on the evaluation of damages and liabilities and agreed upon, the ensured is entitled to receive payment. This step is critical as it represents the resolution of the claim and the fulfillment of the insurer's obligation to compensate the policyholder for their losses. Insights into where improvements can be done (Ngyen and Lee, 2021).

2.8 Impact of Optimized processing Cycle time on operational efficiency and Resource Utilization

Optimized processing cycle times have a profound impact on operational efficiency and resource utilization. According to Burri et al. (2020), shorter cycle times lead to decreased operational costs, as resources are used more effectively**.** Enhanced efficiency not only improves the speed of service delivery but also increases customer satisfaction, ultimately resulting in higher retention rates. Furthermore, studies indicate that companies with optimized processing times can better manage workforce allocation, leading to improved employee productivity (Garcia, 2022).

Optimized processing time has an impact on operational efficiency and customer satisfaction in the insurance industry. As research's indicates that the faster claim resolution is a critical

determinant of customer satisfaction and loyalty (Deloitte, 2022). When the processing times are minimized the customer frustration is less and enhancing their overall experience with the insurer (Garcia, 2022). In addition to this improved operational efficiency is resulting from optimized cycle times can reduce the cost of the company, as resources are utilized effectively (Burri et al., 2020). Besides profitability increase the company competitively in the market. Optimized processing times can streamline workflows and reduce bottlenecks, which not only improves service delivery but also lowers operational costs. Optimized processing times contribute to increased profitability, enhancing a company's competitive edge in the market. As noted by Chen and Liu (2020), organizations that leverage technologies like robotic Process Automation (RPA) achieve remarkable improvements in processing times, further solidifying their market position. In summary the interplay between operational efficiency, customer satisfaction and optimized processing times creates a positive feedback loop that benefits both clients and insurers.

Impact of Optimized processing Cycle time:

Reduced operational cost: Faster processing reduces the time resources both human and technological are tied to each claim. This allows for better allocation of resources across various tasks.

Improved Service Delivery: optimized processing insures quicker claim resolutions, which is a critical determinant of customer satisfaction and loyalty**.**

Enhance Workforce Management: Efficient processing allows for better workload distribution, preventing employee burnout and improving overall productivity.

Increased Profitability: Streamlined workflows and reduced bottlenecks lower operational costs and improve service delivery, enhancing the company's competitive edge.

Potential Drawbacks:

Initial Investment: Implementing new technologies or process may require significant upfront investment.

Integration Challenges; Integrating new systems with legacy system can be complex and may cause disruptions.

Employee Resistance: Employees may resist changes to established workflows requiring effective change management strategies.

Over-reliance on Technology: Over-dependence on automation without adequate human oversight can lead to errors or a decline in customer service quality.

2.9 Strategies derived from simulation Models to Enhance Claims Processing Workflow

The implementation of simulation models can lead to several effective strategies to enhance the claims processing workflow. Research by Patel and Kumar (2022) suggests that simulation can identify optimal staffing levels and training needs, allowing for better resource management. Moreover, simulation can help in redesign workflows to eliminate unnecessary steps and reduce delays (Davydenko & Karakhanova, 2021). By analyzing deferent processing scenarios, insurers can implement targeted improvements.

The implementation of simulation models can lead to several effective strategies for enhancing the claims processing workflow the following are the derived strategies:

Optimal Staffing Levels: Simulation models can identify the ideal number of staff required at various times, ensuring that workloads are balanced and that there are neither too many nor too few employees handling claims. This helps in resource management and reduces burnout among employees.

Training Needs Assessment: By analyzing simulation results, organizations can pinpoint specific training requirements for staff. This ensures that employees are equipped with the necessary skills to handle claims efficiently, which can improve overall processing times.

Workflow Redesign: Simulation allows for the examination of current workflows, helping to identify unnecessary steps that contribute to delays. By streamlining these workflows, companies can reduce processing times and enhance efficiency.

Scenario Analysis: Different processing scenarios can be tested through simulation to understand the impact of various changes, such as implementing new technologies or adjusting procedures. This enables insurers to make data-driven decisions about which improvements to implement.

Identification of Bottlenecks: Simulation can reveal specific stages in the claims process where bottlenecks frequently occur. Addressing these bottlenecks can significantly enhance the speed and efficiency of claims processing.

Continuous Improvement: Ongoing simulation allows for the continuous monitoring of the claims process, enabling insurers to adapt to changing conditions and continuously refine their strategies for optimal performance.

In summary, simulation models provide a powerful tool for enhancing claims processing workflows by identifying optimal staffing levels, assessing training needs, redesigning workflows, conducting scenario analyses, identifying bottlenecks, and facilitating continuous improvement. By leveraging these strategies, insurers can streamline their operations, reduce processing times, and ultimately improve customer satisfaction.

2.10. Research Gap

Despite advancements in motor insurance claims processing, significant research gaps persist, particularly concerning the reduction of processing times through targeted interventions. Limited exploration of simulation modeling in this context few studies has investigated its practical implications specifically for motor insurance claims. Existing research tends to focus on broader claims management issues, often overlooking the unique challenges associated with motor insurance claims, such as:

Complexity of Damage Assessment: Variability in damage evaluation can lead to inconsistencies in processing times.

Customer Communication Needs: Rapid responses to customer inquiries are crucial for satisfaction but hindered by inefficient workflows.

Furthermore, the need for empirical validation of theoretical model is emphasized by Foster (2022), highlighting the necessity for actionable insights into various optimization strategies. Key variables that warrant attention include:

Processing Time: The duration taken to complete claims from submission to resolution.

Bottleneck in the Claims Process: Specific stages where delays commonly occur.

Customer Satisfaction Metrics: Indicates that reflect the quality of service and overall customer experience.

Workflow Representation: A clear depiction of the claims process to identify inefficiencies.

Scenario Variability: The impact of different interventions on the claim process.

Addressing these variables through simulation modeling can help fill existing gaps, enhancing the understanding of motor insurance claims processing and ultimately leading to improved operational efficiencies and customer satisfaction. Key variables that warranting attention include processing time, specific bottlenecks in the claims process, effective intervention strategies, customer satisfaction metrics, workflow representation, scenario variability, and cost implications. Addressing these variables through simulation modeling can help fill existing gaps, enhancing the understanding of motor insurance claims processing and ultimately leading to improved operational efficiencies and customer satisfaction.

Overall, there is a lack of detailed exploration into how processing times can be effectively reduced through targeted interventions, highlighting the need for strategies that enhances processing efficiency and improve customer satisfaction in the motor insurance industry. Despite the existing literature, the application of simulation modeling remains underexplored, limiting our understanding of its practical implications. The researcher approaches simulation modeling to optimize claims processing by representing existing workflows, identifying bottlenecks, and testing different scenarios to enhance efficiency and reduce processing time.

2.11. Conceptual Hypothesis

The conceptual framework presented in this review outlines the relationships among essential variables that influence processing time in motor insurance claims, specifically focusing on simulation modeling, resource allocation and workflow efficiency.

H1: Simulation modeling can effectively identify the key factors influencing the processing cycle time for motor insurance claims, which is crucial for targeted improvements.

H2: The application of simulation modeling will reveal bottlenecks in the claims processing workflow, leading to reduced cycle times and enhanced overall efficiency.

H3: Simulation modeling can optimize resource allocation within the claims processing system to enhance efficiency and reduce cycle times, ensuring better service delivery.

H4: Insights gained from simulation modeling will demonstrate the relationship between process variations and processing cycle times in motor insurance claims, allowing for more informed decision-making.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.0 Introduction

The overall methodology used in the research begins by outlining approach and design, followed by the variables, data sources and data collection methods. It also includes data analysis methods and ethical considerations.

3.1 Study Area

This study was conducted at Tsehay insurance company, located in Addis Ababa Ethiopia. As one of the prominent insurance provider it is known for its diverse range of services, including motor insurance. The company operates in a competitive market where efficiency in processing claims is critical for customer satisfaction and retention. The study will focus on the internal processes of the claims department to analyze and optimize the processing cycle time.

3.2 Study Approach

This study adopted a simulation modeling approach to analyze and optimize the processing cycle time for motor insurance claims. Simulation modeling is a powerful quantitative research method that allows for the examination of complex systems by replicating their process digitally. This method provides insights into the dynamics of the claims processing workflow, enabling the identification of bottlenecks and inefficiencies **(Pattel & Kahn, 2021).** By employing simulation, this research aims to develop strategies that can enhance operational efficiency and improve the overall customer experience.

3.3 Study Design

Following a comprehensive literature review and problem definition, the study will identify specific gaps related to processing cycle times in motor insurance claims. The research utilizes a mixed-methods approach, integrating both quantitative and qualitative data to analyze and enhance the motor insurance claim processing cycle time at Tsehay Insurance S.C. By combining simulation modeling with statistical analysis, the study investigates the existing bottlenecks and explores actionable improvements based on empirical data. The simulation model will be designed using Discrete-event simulation (DES) techniques, which

allow for the modeling of complex processes with variable duration and interdependencies **(Kumar & Singh, 2023).** The simulation will consider multiple scenarios to evaluate the impact of different process improvements on claims process.

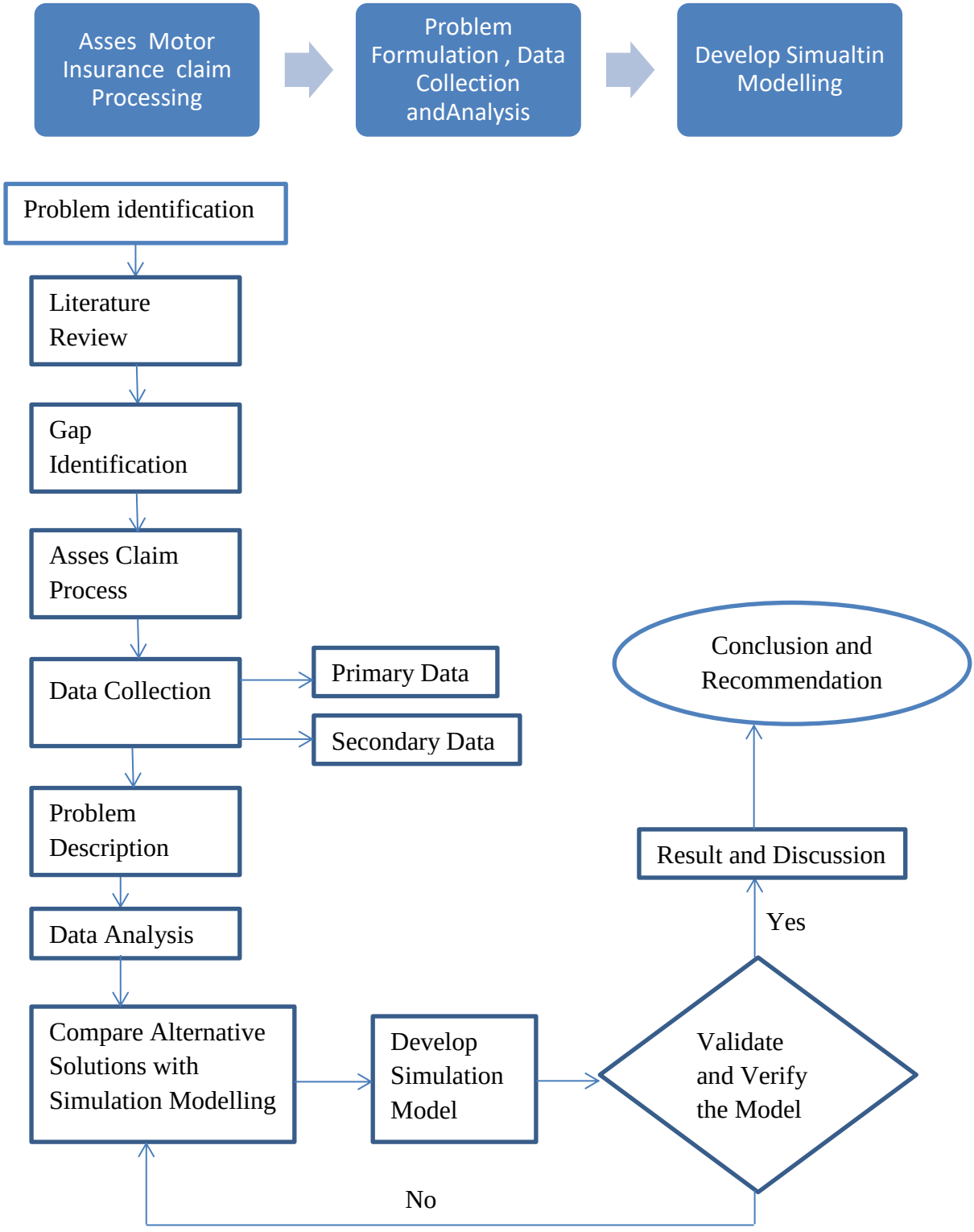


Figure 3. 1. ***Research Framework***

3.4 Target Population

The target population of this research consists of 38 employees of Tsehay Insurance Company who are directly involved in motor insurance claim processing. This group includes managers, supervisors, claim officers and surveyors. These individuals were selected because they are involved in the claim process from notification to claim resolution, significantly impacting customer satisfaction, processing time and the operational efficiencies of the company.

By focusing on these selected groups, the study ensures that the collected data reflects the perspectives and expertise of those directly engaged in the process being investigated. The selection of these employees aligns with the objectives of the study, as their positions provide valuable insights to the challenges and potential improvements of the claim process.

3.5. Data Collection Instrument

Both primary and secondary data were utilized to ensure a comprehensive analysis

3.5.1. Primary Data

Primary data were collected through structured interviews and questionaries' with claims officers, managers, and relevant staff at Tsehay Insurance Company. This data includes information on processing times, workload, resource allocation, and common challenges faced during claims processing **(Brown & Taylor, 2021)**. The combination of structured interviews and questionaries' allowed for both qualitative insights and quantitative data, informing the analysis of current inefficiencies and potential enhancements.

The structured interviews facilitated in-depth discussions, allowing participants to share their experiences and insights regarding claims processing. During these interviews, they provided specific information about the time taken for various stages of the process; it included initial review, documentation verification, claim assessment, and payment processing. This data was critical for identifying delays and understanding the overall cycle time for claim. The targeted respondents were identified, and questions were crafted to be clear and concise, incorporating both closed-ended and open-ended formats. A pitot test was conducted to refine the questions based on feedback, ensuring they effectively captured the necessary data.

3.5.2 Secondary Data

The secondary data were gathered from company records, industry reports and existing literature on claims processing to provide a contextual framework and support primary findings **(Garret, 2023).**

3.6 Data Utilization for Simulation Modeling

Simulation modeling utilizes a foundational data consisting of 168 claims records, focusing on key variables that affect motor insurance claim processing. The research employs a Discrete-event simulation (DES) model to simulate the claims processing workflow at Tsehay Insurance Company.

The DES model will represent the claims process as a series of discrete events, such as claim submissions, approvals and settlements, allowing for a detail tracking of individual claims through different stages. This model will enable an analysis of current efficiency and help identify bottlenecks in the claim process.

The model consists of several key components claims will be represented as entities moving through various stages of the claim process and also the employees will act as resources interacting with these claims. The stages of claim handling, as gathered from employee feedback will include claim registration, document verification, approval, damage assessment and payment processing. Claims will enter the system based on the arrival rates, and each claim will pass through the defined stages.

3.7 Ensuring Reliability and Validity

3.7.1 Reliability Measures

Consistent Protocols: Standardize interviews and survey protocols were used to ensure that each respondent was asked the same questions in the same manner, minimizing variability in responses.

Multiple Data Sources: Data were triangulated by comparing insights from interviews, focus groups and secondary data sources. This cross-verification helped confirm findings and enhance reliability.

3.7.2 Validity Measures

Content validity: The questionnaire ensured comprehensive coverage of all relevant aspects of the claims processing workflow by including input from industry experts during the design phase.

Construct Validity: The questionnaire was pre-tested to confirm that it effectively measured the intended constructs, such as customer satisfaction, efficiency, and operational challenges.

Feedback Mechanism: An open-ended question was incorporated to allow respondents to elaborate on their experiences and perspectives, ensuring a deeper understanding of the context.

3.8. Data Analysis Tools

In this research, several advanced data analysis tools are employed to optimize the motor insurance claims processing workflow. These tools Simulation Modeling, Pareto Analysis, and Value Stream Mapping (VSM) offer unique methodologies for identifying inefficiencies and enhancing operational performance.
The researcher utilizes the following tools for data analysis:

Simulation modeling: is a technique used to create a digital representation of a real world process, allowing organizations to analyze and optimize complex systems. It identifies bottlenecks and assesses the impact of changes in variables, enabling the simulation of multiple scenarios to evaluate various performance metrics, and optimize resource allocation to enhance efficiency.

This tool is especially effective in motor insurance claim processing, where discrete events, such as claim submission, damage assessment approval and payment, occur **(Jones, 2021).** In this research Discrete Event Simulation (DES) is used to represent and analyze systems where changes occur at distinct points in time, such as claim submission, approval and payment, providing valuable insights to enhance valuable claims workflow process.

Pareto Analysis: The Pareto principle (80/20 rule) suggests that 80% of problems come from 20% of causes. Identifying the key challenges in the claims processing workflow will help focus improvement efforts.

Value Stream Mapping (VSM): VSM helps visualize the flow of information and materials through the claims process, aiding in the identification of waste and inefficiencies. Ultimately, this method aims to enhance operational efficiency and customer satisfaction.

3.9. Ethical consideration

This study adhered to ethical guidelines to insure transparency throughout the research process. Ethical considerations included obtaining informed consent from interview participants, ensuring the confidentiality of sensitive data, and accurately reporting findings. The research was conducted with the utmost respect for respondents, ensuring that no harm come to them in any way. Maintaining data integrity was vital, as it ensured the accuracy and honesty of data collection and reporting. The study also adhered to academic integrity by avoiding any form of plagiarism, properly acknowledging all sources and contributions from previous research.

CHAPTER FOUR:

RESULTS AND DISCUSSION

4.1 Introduction

This section presents the findings based on the collected data from Tsehay Insurance Company and responses from questionnaires. It addresses the research questions and analyzes the characteristics of the respondent's response rates, and result of descriptive statistics in Tsehay Insurance Motor claim processing.

4.2 Respondent characteristics

The research collected responses from 38 individuals involved in the claims process, including claims officers, supervisors, managers, and surveyors. The demographic breakdown is shown below in Table 4.1

Table 4. 1: - Frequency distribution table for Demographic Information

Demographic category	Option	Count	Percentage (%)
Gender	Male	29	76.32%
	Female	9	23.68%
Age group	18-24	2	5.26%
	25-34	25	65.79%
	35-44	9	23.68%
	45-54	2	5.26%
	55 and older	0	0.00%
Roles in claim process	Manager	8	21.05%
	Claims Officer	18	47.37%
	Manager	8	21.05%
	Underwriting	2	5.26%
	Claims supervisor	2	5.26%
	Surveyor	7	18.42%
	Other	1	2.63%
Experience in Insurance	Less than 1 year	1	2.63%
	1-3 years	7	18.42%
	3-5 years	9	23.68%
	More than 5 years	21	55.26%

The largest age group is 25-34 (65.79%); indicating a predominantly younger workforce. claim officers represents the largest role, suggesting a focus on operational rather than managerial roles. Most respondents have more than 5 years' of experience, indicating a knowledgeable workforce. This demographic distribution emphasizes the importance of engaging with a predominantly young and experienced team to leverage their insights for improving claims processing.

4.2.1 Main challenges Identified

The data in Table 4.2 supports these findings, showing that the most significant challenge, inconsistent workflow, and communication gaps the company can potentially resolve a significant portion of inefficiencies in the claims processing workflow. Comparative analysis with existing literature highlights similar challenges faced by other insurers, such as those reported by **Baldwin and Smith (2020),** which noted that operational inefficiencies often stem from poor communication and inadequate resource allocation.

The analysis reveals several significant challenges faced in claims processing workflow at Tsehay Insurance Company, including:

Inconsistent Workflow (36.84%): This was identified as the leading challenge, indicating operational inefficiencies. Respondents noted that variations in process lead to delays and confusion, impacting overall efficiency.

Communication Gaps (23.68%): Poor communication among stakeholders can lead to misunderstanding and delays in the claims process. This challenge emphasizes the need for clearer communication channels and protocols to streamline information flow.

Insufficient Resources (18.42%): A lack of adequate resources such as staffing, technology, and tools were reported as a barrier to efficient claims processing. Respondents indicated that limited resources hinder their ability to manage workloads effectively.

Lack of Automation (18.42%): The absence of automated system for routine tasks contributes to longer processing times and potential errors. Respondents expressed a strong demand for technological integration to enhance efficiency.

Others (2.63%): A minor percentage of respondents identified additional challenges underscoring the complexity of the claims process.

From the respondent's response, the most significant challenge is inconsistent workflow, followed by communication gaps.

Table 4. 2: - Challenges face during the claims process

Challenges face	Frequency	Percentage (%)
Communication gaps	9	23.68%
Insufficient resource	7	18.42%
Inconsistent workflow	14	36.84%
Lack of automation	7	18.42%
Other	1	2.63%

4.2.2 Suggested Improvements for Claim Processing

The results from the survey reveal that a significant portion of respondents believe advanced technology is essential for improving the claims process, with 54.55% highlighting this as a primary area for enhancement.

More Automation (9.09%)

Automation in claims processing can significantly reduce processing times and human error. By integrating automated systems for tasks such as document submission and initial assessment, insurers can streamline workflows and allow adjusters to focus on more complex issues.

Decentralized Claim Handling (9.09%)

Decentralized claims handling empowers local teams or automated systems to manage claims without needing approval from a central office. This can enhance responsiveness and flexibility, enabling quicker resolutions.

Employee Training (21.21%)

Training staff on the latest technologies and processes is vital. Well-trained employees can navigate advanced systems more efficiently, improving the overall claims experience for customers. Literature emphasizes the importance of ongoing training in adapting to technological advancements **(Bai et al., 2021).**

Integration with Garages (6.06%)

Integrating claims processes with repair garages allows for better communication and coordination. This integration can lead to quicker repairs and improved customer satisfaction. A study by the Insurance Information Institute has shown that partnerships with trusted service providers can enhance the claims experience.

Advanced Technology Usage (54.55%)

This encompasses the adoption of artificial intelligence (AI), machine learning, and data analytics in the claims process. Technologies like AI can analyze claims data, identify patterns, and predict outcomes, thereby expediting decision-making. Studies show that organizations adopting AI in claims processing saw reductions in cycle times and costs by up to 30% **(McKinsey & Company, 2020).**

Table 4. 3: - Suggested Improvements

Suggested improvements	Frequency	Percentage (%)
More automation	3	9.09%
Decentralized claim handling	3	9.09%
Employee training	7	21.21%
Integration with garages	2	6.06%
Advanced technology usage	18	54.55%

4.2.3 Time Consuming Steps in the Claims Process

The survey results indicate that the approval process is the most significant bottleneck in the claims journey, cited by 55% of respondents.

Approval Process (55%)

The complexity of the approval process often leads to delays. In many organizations, this step requires multiple layers of verification and authorization, which can slow down the overall claims timeline. Research highlights that streamlining approval workflows can lead to a 40% reduction in time taken for claims processing **(Accenture, 2021).**

Document Verification (21%)

This step involves checking the authenticity and completeness of submitted documents, which can be time-consuming, particularly if there's a lack of automation. Studies suggest that implementing digital document verification tools can significantly reduce the time associated with this step **(Forrester, 2021).**

Damage Assessment (21%)

Assessing damage is critical for determining the value of a claim; however, it can be delayed due to scheduling inspections or gathering necessary information. Advanced technologies such as drones or AI-powered imaging systems can expedite this process, as demonstrated in pilot programs across various insurance companies **(Deloitte, 2022).**

Payment (3%)

While payment is the final step, it is less frequently cited as a bottleneck, likely because it occurs after the approval and assessment stages. However, improving payment processing systems through automation can enhance overall customer satisfaction by ensuring timely payments once claims are approved.

Respondents indicated that the Approval Process is the most time-consuming step, identified by 55% of respondents. Addressing this bottleneck is critical for enhancing overall efficiency.

Table 4. 4: -Most time consuming steps

Steps	Number of Respondents	Percentage (%)
Approval process	21	55%
Document verification	8	21%
Damage assessment	8	21%
Payment	1	3%

4.2.4 Delays Encountered

In analyzing the data presented in Table 4.5 about delays encountered by respondents, we observe that a majority of participants (55%) reported experiencing delays "sometimes." This indicates that while delays are not a constant issue for everyone, they are prevalent enough to affect more than half of the respondents at least occasionally.

Frequency Distribution: The frequency distribution showcases how often respondents encounter delays.

Sometimes (55%): This majority suggests that delays are a typical experience but not necessarily a routine one. It indicates variability; some days may be better than others.

Always (18%): A noteworthy portion consistently faces delays, which could point towards systemic issues, inefficiencies, or high-demand situations that hinder timely responses or completions.

Often (16%): This group experiences delays frequently, suggesting they may encounter repetitive issues that need addressing.

Rarely (11%): A smaller segment experiences delays infrequently, which could imply effective management or lesser engagement with activities prone to delays.

In summary, the data presents a complex picture of delays encountered by respondents, with significant implications for improvement. Understanding the nature and frequency of these delays can lead to targeted actions that enhance efficiency and user satisfaction. Addressing the issues of those who encounter delays "always" and "often" could be particularly critical in reducing the overall percentage of respondents facing delays.

Table 4. 5: - Delays encountered

Frequency	Number of Respondents	Percentage (%)
Sometimes	21	55%
Always	7	18%
Often	6	16%
Rarely	4	11%

4.2.5 Demands for Automation

The most respondents (68%) expressed there is a strong demand for increased automation in the claims process. This reflects that a strong recognition of the need for technological enhancements to improve efficiency and reduce processing times.

Table 4. 6: Automation demand

Automation Demand	Number of Respondents	Percentage (%)
Yes	26	68%
No	12	32%

In general the key challenges in the company include inconsistent workflows and communication gaps. Respondents suggest that advanced technology will address time-

consuming steps, such as the approval process, to minimize the processing times and enhance efficiency.

4.3 Data Overview

The research utilized a data set consisting of 168 claims records, focusing on key variables affecting motor insurance claims processing, the analysis of processing times of claim stages (initial review, documentation verification, claim assessment, and payment processing) shows significant difference between total time required and available working minutes, indicating bottlenecks that need to be address.

Table 4. 7:-Claims Data Overview

Claim number 168	**Total time (days)**	**Initial review(days)**	**Documentation verification(days)**	**Claim assessment (days)**	**Payment processing(days)**
Total	28,217	4,092	8,326	8,434	7,138

The data indicates that the total time taken for claims processing is alarmingly high, with 28, 217 days recorded across all claims. Breaking this down, the initial review stage alone accounts for 4,092 days, while documentation verification adds a notable 8,326 days. The claim assessment stage takes 8,434 days, and payment processing contributes 7,138 days. These figures underscore the need for a thorough examination of each stage to identify and mitigate the causes of delays, thereby streamlining the claims process and improving overall customer satisfaction. Addressing these bottlenecks will not only enhance operational efficiency but also align the claims processing time more closely with industry standards and customer expectations.

Initial Review

It is the first process in the motor insurance claim processing and the average processing time is 24.38 days and converting it in to hours for simulation modeling.

Average time: 24.38 days

Converted the average time of the initial review to hours

24.38days*24hours=**585.12hr**

2. Documentation Verification

Average Time: 49.61 days

Converted to hours

49.61days*24hours=**1,190.64hr**

3. Claim Assessment

Average Time: 50.19days

Converted to hours

50.19*24hours=**1,204.56hr**

4. Payment Processing

Average time: 42.47 days

Converted to hours

42.47days*24hours**=1019.28hours**

Allocate Resources

Total employee: 28

Claim officers: 18

Supervisors: 2 and

Surveyors: 7

Input processing times for each step in hours as shown below:

Initial Review: **585.12hours**

Documentation Verification: **1190.64hours**

Claim Assessment: **1204.56hours**

Payment processing: **1019.28 hours**

Utilization Calculations

Working days

Assuming no holidays every month the working day is 22

Daily working hours

8hours/day

Total working hours per month

22days*8hours/day=**176hours/month**

Total available time for three months

The three month period is typically chosen to provide a sufficient time frame for analyzing claims processing patterns. It allows for observing variations in workload, seasonal trends, and operational efficiency over a realistic duration**.**

For 3 months

176hours/month*3months**=528hours**

Total working minutes per month

176hours*60=**10,560 minutes**

Total working minutes for all employees

28employees*10,560minutes**=295,680minutes**

Utilization for each process/stages

Initial Review

8workinghours/day*60minutes=480minutes

4092claims*480minutes=**1,964,160minutes**

Calculating working minutes

90days* $\frac{6working\ days}{7days}$ **=** ≈ 77.14working days

Total working minutes

= 77.14days*8hour*60minutes =32,027.2minutes

Documentation Verification

4092claims*1190.64hours=4,872,098.88 minutes

Total working minutes

= 77.14days*8hour*60minutes =32,027.2minutes

Claim Assessment

4092claims*1204.56hours = 4,929,059.52 minutes

Total working minutes

= 77.14days*8hour*60minutes =32,027.2minutes

Payment Processing

4092claims*1019.28 hours = 4,170,893.76minutes

Total working minutes

= 77.14days*8hour*60minutes =32,027.2minutes

Average processing time per claim

Total processing time sum the average times for all stages to calculate the total processing time per claim

Total processing = Initial review + Documentation verification + Claim assessment + Payment

= 585.12hours+ 1190.64hours+ 1204.56hours + 1019.28 hours

= **3,999.6hours**

Estimate the impact of proposed changes like Impact of Automation

If the automation is introduced, estimate how much time each step could be minimized and calculate the new total processing time.

If automation reduces the processing time for each process by 30%

New time = old time * (1-0.30)

For Initial Review: 585.12hours

New time = 585.12hours (1-0.30)

New time = **409.6hours**

Documentation Verification: 1190.64hours

New time=**1190.64hours** (1-0.30)

New time = 833hours

Claim Assessment: 1204.56hours

New time=1204.56hours (1-0.30)

New time = 843.2hours

Payment processing: **1019.28 hours**

New time=1019.28 hours (1-0.30)

New time = 713.5 hours

Average processing time per stage

For each stage calculate the Average processing time per claim

Average processing time per claim (stage) $= \frac{\text{Total time for stage}}{\text{Number of claims}}$

Average processing time (Initial review) = $\frac{1{,}964{,}160\text{minutes}}{4{,}092\text{ claims}}$ **= 480 minutes**

Average time (Initial review) = **480 minutes**

Average time (Documentation Verification) = = $\frac{4{,}872{,}098.88\text{ minutes}}{4{,}092\text{ claims}}$

Average time (Documentation Verification) = **1,190 minutes**

Average time (Claim Assessment) = $\frac{4{,}929{,}059.52\text{ minutes}}{4{,}092\text{ claims}}$

Average time (Claim Assessment) = **1,204 minutes**

Average time (Payment) = $\frac{4{,}170{,}893.76\text{minutes}}{4{,}092\text{ claims}}$

Average time (Payment) = **1,019 minute**s

Table 4. 8:-Summary of Total Utilization for Each Step

Steps	**Total Time (Minutes)**	**Total Working(Minutes)**
Initial Review	1,964,160	32,027
Documentation Verification	4,872,098.88	32,027
Claim Assessment	4,929,059.52	32,027
Payment	4,170,893.76	32,027

The above calculations provide a comprehensive view of the resource utilization across each step of the claims processing workflow. The total time required for each step far exceeds the available working minutes, this indicating potential bottlenecks and areas where efficiency improvements could be beneficial.

Table 4. 9: **Claims processing workflow metrics**

Stage	Total Time (Minutes)	Average Time (Minutes)	Utilization (Minutes)	Automated Time (Minutes)
Initial Review	35,107.20	480	32,027	24,576
Documentation Verification	71,438.40	1,190	32,027	49,980
Claim Assessment	72,273.36	1,204	32,027	50,592
Payment Processing	61,164.48	1,019	32,027	42,810

The graph shows that significant differences in the motor insurance claims processing stages, highlighting that Documentation verification and claim assessment require the most total time, with values of 71,438.4 and 72, 273, 36 minutes respectively. In contrast the fixed utilization of 32,027 minutes. Per stage indicates that the workload considerably exceeds available resources, indicating potential bottlenecks. Furthermore, the lower automated time values suggest that implementing automation could streamline these stages, enhancing overall efficiency in the claims process.

Output Metrics: key performance indicators (KPIs) that the researcher want to analyze, such as :- total processing time for each claim, utilization rates of resource, average delay times ,frequency of bottlenecks and overall efficiency of the claims process.

4.4 Pareto Analysis

The Pareto principle (80/20 rule) suggests that 80% of problems come from 20% of causes. Identifying the key challenges in the claims processing workflow will help focus improvement efforts.

The researcher identifies several challenges such as, inconsistent workflow, communication gaps and insufficient resources.

Quantify the Impact: Assign a frequency (percentage) to each challenge based on the survey data.

Inconsistent Workflow: 36.84%

Communication Gaps: 23.68%

Insufficient Resource: 18.42%

Lack of Automation: 18.42%

Other: 2.63%

Table 4. 10 Cumulative frequencies for challenges

Challenge	Frequency (%)	Cumulative Frequency (%)
Inconsistent Workflow	36.84	36.84
Communication Gaps	23.68	60.52
Insufficient Resources	18.42	78.94
Lack of Automation	18.42	97.36
Other	2.63	100

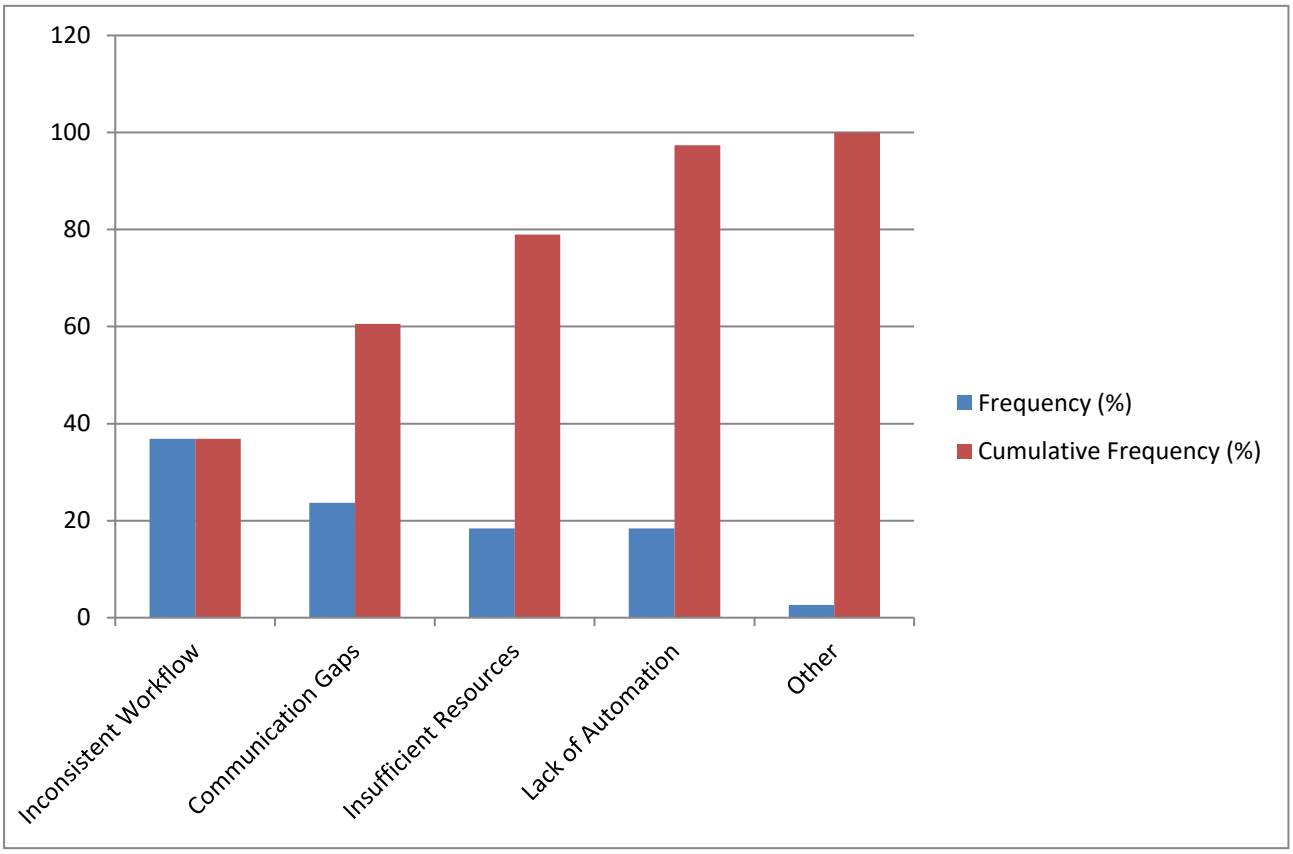


Figure 4. 1 Pareto Chart of factors contributing to claims processing delays

Analyze the chart

The Pareto Analysis graph illustrates the challenges faced in the claims processing workflow, emphasizing the frequency of each issue and their cumulative impact. The blue bars represent the frequency percentages of various challenges, with "Inconsistent Workflow" at 36.84% and "Communication Gaps" at 23.68%. Together, these two challenges account for approximately 60% of the total problems identified. This indicates that addressing them could lead to significant improvements in the overall efficiency of the

claims process. The cumulative frequency, represented by the red line, shows that after these two challenges, "Insufficient Resources" and "Lack of Automation" contribute lesser percentages, at 18.42% each, while "Other" accounts for only 2.63%. By prioritizing the resolution of "Inconsistent Workflow" and "Communication Gaps," organizations can target the most impactful areas for improvement, potentially alleviating a substantial portion of inefficiencies and enhancing the claims processing experience.

Focus on the top Challenges: the first two bars Inconsistent Workflow and Communication Gaps accounts for approximately 60% of the problems. By addressing this two primary challenges, the researcher potentially resolve a significant portion of the inefficiencies in the claims processing workflow.

Inconsistent workflow:

Implement Standard Operating Procedure (SOPs): document clear procedure for each claims process.

Conduct Regular Training: ensure all employees are trained on SOPs and updates.

Perform Process Audits: regularly review workflows to identify and correct deviations.

Establish Performance Metrics: monitor key metrics to ensure adherence to processes.

Communication Gaps

Create Feedback Channels: enable anonymous feedback to identify communication gaps.

Define Reporting Structures: Clarify communication lines for updates and issue reporting.

4.5 Value Stream Mapping (VSM)

Value Stream Mapping (VSM) is a lean-management tool used to analyze the flow of materials and information currently required to bring a product or service to a consumer. In the context of the claims process, VSM helps organizations visualize and understand the complexities involved, ultimately aiming to identify areas for improvement that can enhance operational efficiency and increase customer satisfaction.

Mapping the Current State

To effectively map the current state of the claims process, we need to identify each step involved and the time taken for each:

Claim Registration: This is the initial step where the customer submits the claim. It typically involves capturing essential information and documentation from the claimant.

Document Verification: In this step, submitted documents are validated for authenticity and completeness to ensure they meet the requirements for further processing.

Damage Assessment: This involves evaluating the claim's validity, which may require inspections or assessments to determine the extent of the damage and the appropriate compensation.

Payment Processing: After the assessment, this step involves the calculation of the final payout and disbursement of payment to the claimant.

Time Taken for Each Step:

Initial Review: 24.38 days

Documentation Verification: 49.61 days

Claim Assessment: 50.19 days

Payment Processing: 42.47 days

Identifying Waste

In analyzing the current state of the claims process, it’s crucial to identify waste, which can manifest in various forms:

Delays: The longest processes (Documentation Verification and Claim Assessment) are notable sources of delay. Long waiting times may lead to dissatisfaction among customers and affect the overall service experience.

Bottlenecks: The Claim Assessment step is a significant bottleneck, with an extended duration of 50.19 days, leading to backlogs that can stall the entire claims process. This not only affects internal workflows but also impacts customer perception of service efficiency.

Redundancies: There may be redundant tasks within the Documentation Verification stage, where multiple teams perform similar checks, leading to inefficiencies and wasted resources.

Proposed Improvements

To address the identified waste and enhance the claims process, several strategic improvements can be implemented:

Automation: Implementing automated systems for Documentation Verification and Claim Assessment can greatly reduce the time taken and minimize human error. Automation tools can expedite the data entry and verification processes, ensuring faster turnaround times.

Improved Communication Tools: Utilizing integrated digital platforms can enhance communication among various teams involved in the claims process. Tools such as collaborative software or chat applications can ensure that updates and queries are addressed promptly, reducing delays caused by miscommunication.

Standardized Procedures: Establishing clear and standardized protocols for each step in the claims process can reduce redundancies and streamline operations. By creating a uniform process, staff can follow established guidelines with minimal deviation, which can enhance efficiency and consistency.

VSM helps visualize the flow of information and materials through the claims process, helping to identify waste and inefficiencies ultimately aiming to enhance operational efficiency and customer satisfaction.

Map the Current State

Identify each step in the claim process:

Claim registration, Document Verification, Damage Assessment and Payment Processing.

Time taken for each step

Initial Review: 24.38 days

Documentation Verification: 49.61 days

Claim Assessment: 50.19 days

Payment Processing: 42.47 days

Identify Waste

Delays: the longest steps are Documentation Verification and Claim Assessment indicating significant delays.

Bottlenecks: Claim Assessment is identified as a bottleneck due to its lengthy duration (50.19 days). This can cause a backlog in subsequent steps.

Redundancies: Potential duplication of efforts in documentation could be leading to inefficiencies.

Proposed Improvements

Automation: implement automated systems for Documentation Verification and Claim Assessment to minimize errors and processing time.

Improved Communication Tools: Use digital platforms to enhance collaboration among teams, allowing for quicker responses and updates.

Standardize Procedures: establish clear protocols to streamline each step, reducing redundancies.

4.6 Estimate Potential Reduction in Time

The lead time analysis indicates a significant improvement in processing times across various stages. The Initial Review has been reduced from 24.38 days to 17.07 days, achieving a 30% reduction. Similarly, Documentation Verification decreased from 49.61 days to 34.73 days, also reflecting a 30% reduction. Claim Assessment saw a reduction from 50.19 days to 35.13 days, while Payment Processing was shortened from 42.47 days to 29.73 days, both marking a 30% improvement. In total, the current state lead time was 166.65 days, which is now reduced to 116.66 days in the future state. This analysis shows a total lead time reduction of 49.99 days, highlighting the effectiveness of the improvements implemented.

Calculate Lead Time

Current State Lead Time:

Total=24.38+49.61+50.19+42.47=**166.65 days**

Future State Lead Time:

Total = 17.07+34.73+35.13+29.73=**116.66 days**

Analyze the VSM

Identify Key Improvements:

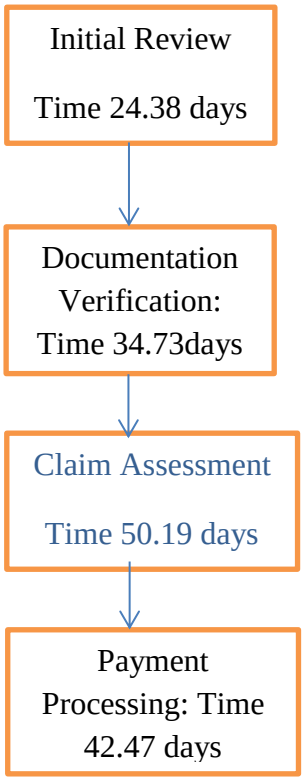
Focus on approval process: streamline this step through automation and standardized procedures.

Reduce Document Verification Time: Implement automated verification systems to minimize processing delays.

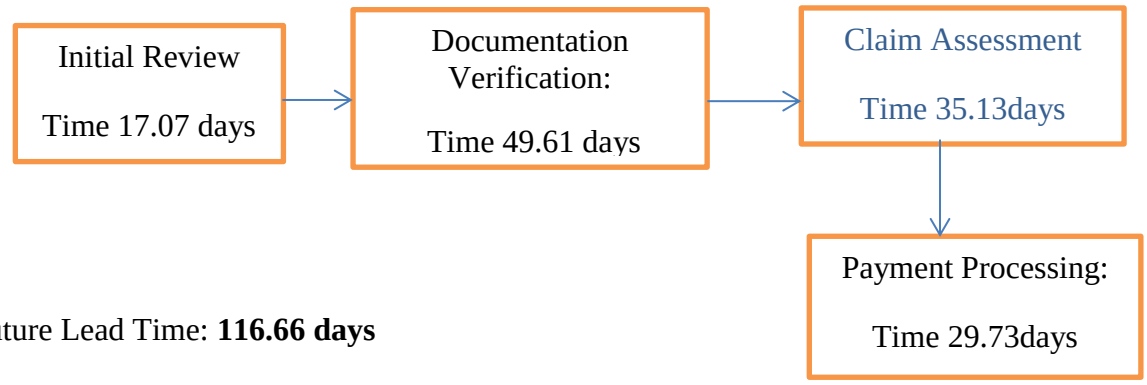
Enhance communication: Foster better inter-departmental collaboration to expedite the overall process.

By using Value Stream Mapping (VSM), the claim process can be significantly improved, reducing the lead time from 166.65 days to 116.66 days. This analysis not only highlights areas of waste but also provides actionable strategies for enhancing efficiency and customer satisfaction in the claims processing workflow.

Current State Layout



Current Lead Time: **166.65 days**
Future State Layout



Future Lead Time: **116.66 days**

Figure: 4.2 Value Stream Mapping Layouts

4.7 Simulation modeling for motor insurance claim processing

By creating a virtual representation of the claims workflow, the researcher can identify bottlenecks, assess the impact of various interventions, and evaluate potential improvements without the risks and costs associated with implementing real-world changes.

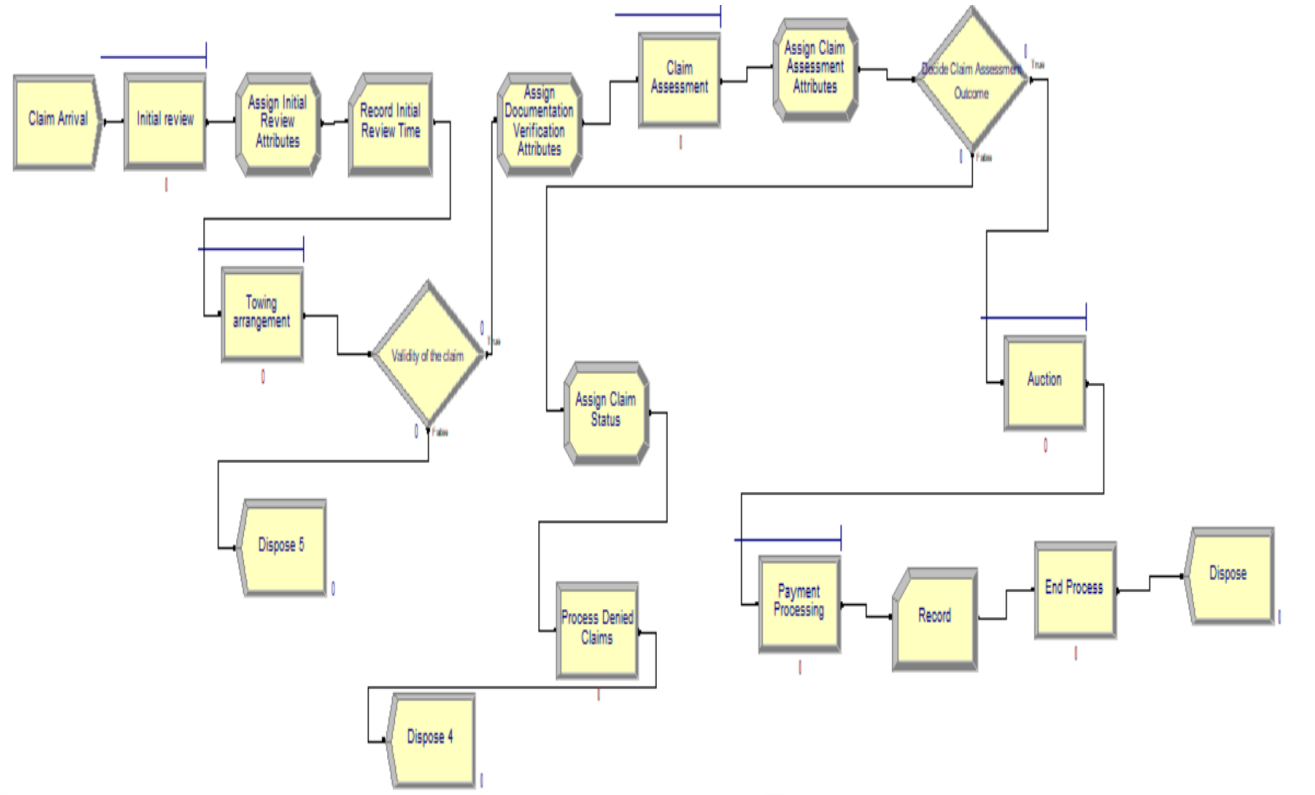


Figure 4. 2 Arena simulation modeling for motor insurance claim processing

Chi-Square Test

This test compares the observed frequency of elements (or patterns) in the sequence to the expected frequency, to determine if they follow the expected distribution. This is performed by dividing the data range into 10 intervals and counts the observed frequencies in each. Calculate the expected frequencies assuming a uniform distribution using:

$$X_0^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

Let's assume we divide the range of inter arrival times into 10 equal intervals.

Minimum: 2.40 hours

Maximum: 3.30 hours

Interval Width: $R_i = \frac{3.30-2.40}{10} = 0.09$

Calculate Observed Frequencies (O_i)

Based on the generated inter arrival times, we count how many fall into each interval.

Calculate class width

Find the range from your collected data(R)

R= Maximum value – Minimum value

Determine the number of classes by using Stuges Rule

K= 1+3.322*$\log_{10}(n)$

Where: - k is number of classes or bins

n is the number of collected data

Calculate class width

Dividing the range by the number of class

Class width = $\frac{Range}{K}$

Collected Data:168 inter arrival times.

Maximum Value: 3.30

Minimum Value: 2.40

Calculate the Range (R)

R=3.30−2.40=0.90

Determine the Number of Classes (K)

K=1+3.322·log10 (168) ≈1+3.322*2.226=8.41≈9 classes

Calculate Class Width

Class Width = $\frac{0.90}{9}$ = ≈ 0.10

Adjust Degrees of Freedom

Degrees of Freedom = K−1=9−1=8

Table 4.11 Observed frequency table

Interval (Hours)	Observed Frequency ($\mathbf{O_i}$)
[2.40 - 2.49)	12
[2.50 - 2.59)	15
[2.60 - 2.69)	20
[2.70 - 2.79)	25
[2.80 - 2.89)	30
[2.90 - 2.99)	25
[3.00 - 3.09)	20
[3.10 - 3.19)	12

[3.20 - 3.29)	8
[3.30 - 3.39)	6
Sum	168

Table 4.12 Random Number Test Using Chi-Square Test Method

Interval	**Observed Frequency** (O_i)	**Expected frequencies** $(E_i = \frac{N}{n})$	$(O_i - E_i)$	$(O_i - E_i)^2$	$\frac{(O_i - E_i)^2}{E_i}$
[2.50 - 2.59)	17	16.8	0.2	0.04	0.002
[2.60 - 2.69)	17	16.8	0.2	0.04	0.002
[2.70 - 2.79)	18	16.8	1.2	1.44	0.086
[2.80 - 2.89)	18	16.8	1.2	1.44	0.086
[2.90 - 2.99)	17	16.8	0.2	0.04	0.002
[3.00 - 3.09)	15	16.8	-1.8	3.24	0.193
[3.10 - 3.19)	10	16.8	-6.8	46.24	2.754
[3.20 - 3.29)	7	16.8	-9.8	96.04	5.714
[3.30 - 3.39)	6	16.8	-10.8	116.64	6.947
Sum	**168**	**168**	**0**	**10.64**	**15.04**

Since the calculated Chi-Square statistic value (15.04) is less than the critical value (16.5), the test accepts the null hypothesis at the 0.05 significance level. This means there is no significant difference between the observed and expected frequencies, and the data follows the expected distribution.

Number of Replication

$$n=\left(\frac{Z^2.\sigma^2}{E^2}\right)$$

Parameters

n = number of replications

Z= Z-score (1.96 for 95% confidence)

σ = estimated standard derivation of the performance measure

E= desired margin of error

Steps to use the formula

1. Determine Z:

   For a 95% confidence level, use Z= 1.96

2. Estimate σ:

Obtain the standard deviation from historical data processing times

3. Decide E:

Set the margin of error to be accept (± 5 days)

4. Insert the values into the formula to calculate n
5. Round up

Always round up to the nearest whole number for the number of replications.

σ = 20 days

E= 5 days

Using the formula

$n=(\frac{Z^2.\sigma^2}{E^2})$

$n=(\frac{1.96^2.20^2}{5^2}) \approx 62.6$

Round up to **63** replications

Table 4. 11 Types of Distribution identified by input analyzer

Operations	Distribution Type	Mean	Lambda	Range
Initial Review	Exponential	25.5	0.0392	126
Documentation Verification	Exponential	57.3	0.0174	305
Claim Assessment	Exponential	47.8	0.0209	427
Payment Processing	Exponential	22.3	0.0448	121

4.8 Verification and Validation of Simulation Modeling

4.8.1 Verification of simulation models

Verification is about ensuring that the simulation model is correctly implemented according to its conceptual design. This involves checking for coding errors, ensuring the logic and calculations are accurate, and that the model behaves as intended under various scenarios.

It's a critical step to ensure that the model accurately represents the assumptions and specifications defined during the model-building phase without any computational errors

4.8.2 Validation of Simulation Modelling

Hypothesis Test

Null Hypothesis (Ho): The observed data follows a distribution similar to the simulation output.

Alternative Hypothesis (H1): The observed data do not follow a distribution similar to the simulation output.

Significance level

α: 0.05

Sample statistics

Sample Size (N): 168

Samples Mean ($\bar{x}$): 153.38

Standard Deviation(s): 2.0787

Test static calculation

Population Mean (μ):153

Test Statistics (t): $\frac{\bar{x}-\mu}{s/\sqrt{N}}$

$\frac{153\bar{.}38-153}{2.0787/\sqrt{168}}$ = 0.38/0.262 ≈ 1.45

Degrees of freedom (df):

df = N-1 = 168-1 = 167

Critical Value

Using a t- distribution table for α = 0.05 and df= 167

Critical Value ≈ 1.914

Decision

Calculated t-value

|t|=|1.45|=1.45

Comparison

Since |t| (1.45) < Critical Value (1.974), the researcher fails to rejects the null hypothesis

Based on the analysis, there is not enough evidence to conclude that the observed data do not follow a distribution similar to the simulation output at a 0.05 significance level.

Calculate the P-value

Degree of freedom (df) = N-1

df= 168-1 = 167

By using the t-distribution table:

|t|= 1.45 in the distribution table for a degree of freedom 167

For df = 167

The critical t-value for α=0.05 is approximately 1.975

Since |t|= 1.45 is less than 1.975, we know the p-value is greater than 0.05.

From standard t- distribution table, we look for approximate value:

For |t| = 1.40, the p-value is around 0.16.

For |t| =1.45 the p-value is slightly lower than 0.15 but above 0.10

The p-value for the t-test with |t|=1.45 and df =167 is approximately between 0.10 and 0.15

Based on the t-test conducted, the calculated t-value is |t|= 1.45 with df = of 167. The corresponding p-value is approximate between 0.10 and 0.15, since this p-value is greater than the significance level α = 0.05, we fail to reject the null hypothesis.

4.8.3 Long-Run Performance Measure of Queueing Systems

Arrival Rate

The arrival rate (λ) describes how claims enter the queue. For this case, the arrival rates is calculated as the number of arrivals within a specific time frame divided by total time period (λ = 168/24 hours = 7 arrivals per hour).

Service Rate

The service rate (μ) is the average number of claims that can be served per unit of time. The service rate is calculated as the number of server (c) divided by the average service time (S = 38/8 =4.75 claims per hours)

Server Utilization

Server utilization (ρ) is the proportion of time a server actually spends with the customer or fraction of time the server is busy. This is calculated as:

$\rho = \frac{\lambda}{\mu} = \frac{7\ claims/hours}{4.75\ \text{claims/hours}} \approx 1.47 = 147\ \%$

Probability of zero units (P_0)

This is the probability that there are zero customers in the system or probability that queuing system is empty, meaning no one is waiting and all servers are idle. It's calculated as:

$\boldsymbol{P_0}$ = 1- $\frac{\lambda}{\mu}$ = 1- $\frac{7}{4.75}$ = 1 – 1.473 = 0.599 = -0.473 it is not valid, as it indicates the system cannot handle the load).

Average Number of Customers in the System (L)

The average number of claims in the system is the average number of claims that are waiting in the queue (L_q) and those currently being served (L_s). It's calculated as:

$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} = \frac{7^2}{4.75(4.75-7)} = 4.6\ claims$

$L_s = \frac{\lambda}{\mu-\lambda} = \frac{7}{4.75-7} = 3.1\ claims$

Then

L = Queue Length (L_q) + System Length (L_s)

L = 4.6 + 3.1 = 7.7 claims

Average Time a Customer Spends in the System (W)

The average time a customer spends in the system is the average time for which a customer has to wait in the queue to get service (W_q) and a negative experience and the average total time spent by a customer in the service (W_s). It's calculated as:

$W_q = \frac{\lambda}{\mu(\mu-\lambda)} = \frac{7^2}{4.75(4.75-7)}$ = 4.6 hours

$W_s = \frac{1}{\mu-\lambda} = \frac{7}{4.75-7}$ = 3.1 hours

Then

W = Waiting time in the queue (W_q) + Total time in the system (W_s)

W = 4.6 + 3.1 = 7.7 hours

4.8.4 Scenario Test

Baseline scenario

The objective of this scenario is to establish a reference point for the current efficiency of motor insurance claim processing. Historical data reveals that the average processing times are 24.38 days for the initial Review, 49.61 days for documentation verification, 50.19 days for claim assessment, and 42.47 days for payment processing. Consequently, the total baseline processing time is 166.65 days.

Total Baseline Processing Time:

Total = 24.38+49.61+50.19+42.47 = **166.65 days**

Automation Scenario

This scenario assesses the impact of implementing automation in claim processing. It is assumed that there will be a 30% reduction in processing times across all stages. The new processing times are calculated as follows: initial review takes 17.07 days, documentation verification takes 34.73 days, claim assessment takes 35.13 days, and payment processing takes 29.73 days. This leads to a new total processing time of 116.66 days, representing a reduction of approximately 49.99 days from the baseline, or a 30% improvement.

New Documentation Verification Time: 49.61*(1-0.30)

49.61*0.70 = 34.73 days

New Initial Review Time: 24.38*(1-0.30)

24.38*0.70 = 17.07 days

New Claim Assessment: 50.19*0.70 = 35.13 days

New payment Processing Time: 42.47*0.70 = 29.73 days

Total New Processing Time:

Total = 34.73+17.07+35.13+29.73 = 116.66 days

Comparison:

Reduction from baseline (166.65 days)

=166.65-116.66 = **49.99 days** (approx. 30% improvement)

Enhanced Training Scenario

The objective here is to evaluate the effect of improved staff training on processing efficiency. It is assumed that better training will result in a 20% reduction in processing times. The new times are 19.50 days for initial review, 39.69 days for documentation verification, 40.15 days for claim assessment, and 33.98 days for payment processing. The total new processing time is 133.32 days, reflecting a reduction of 33.33 days from the baseline, which is about a 20% improvement.

Total New Processing Time:

Total = 19.50+39.69+40.15+33.98= 133.32 days

Comparison:

Reduction = 166.65-133.32= 33.33days (approx. 20% improvement)

Resource Allocation Scenario

This scenario tests the impact of increasing the number of claims officers during peak periods by 25%. It is assumed that this increase will lead to a 15% reduction in processing times. The new processing times are 20.71 days for initial review, 42.17 days for documentation verification, 42.66 days for claim assessment, and 36.10 days for payment processing. The total new processing time is 141.64 days, resulting in a reduction of 25.01 days from the baseline, approximately a 15% improvement.

Total New Processing Time:

Total = 20.71+42.17+42.66+36.10= **141.64** days

Comparison:

Reduction = 166.65-141.64= 25.01days (approx. 15% improvement)

Improved communication Scenario

The objective is to assess the effect of enhanced communication tools on claims processing. It is assumed that these tools will result in a 25% reduction in processing times. The new times are 18.29 days for initial review, 37.21 days for documentation verification, 37.64 days for claim assessment, and 31.85 days for payment processing. The total new processing time is 124.99 days, indicating a reduction of 41.66 days from the baseline, or around a 25% improvement.

Total New Processing Time:

18.29 +37.21++ 37.64+ 31.85 = **124.99days**

Comparison:

Reduction = 166.65-127.99= 41.66 days (approx. 25% improvements)

Bottleneck Mitigation Scenario

This scenario focuses on identifying and addressing bottlenecks in the processing workflow, particularly in the damage assessment process, where processing time is reduced by 40%. The new processing time for damage assessment is 30.11 days, while the other stages retain their baseline times. The total new processing time is 146.57 days, resulting in a reduction of 20.08 days from the baseline, which is approximately a 12% improvement.

New processing Time for Damage Assessment:

50.19*0.60= 30.11 days (approx. 40% reduction)

Total New processing Time:

Using baseline for other stages:

Total= 24.38+49.61+30.11+42.47= **146.57 days**

Comparison:

Reduction= 166.65-146.57= **20.08days** (approx. 12% improvements).

Table 4. 12 Summary of Scenarios testing

Scenario	Metric	Expected Improvement (%)	Actual Improvement (%)	Total Processing Time (Days)	Bottleneck Identified
Baseline	Total Processing Time	-	-	166.65	Initial Review
Automation	Total Processing Time	30%	30.87%	116.66	Documentation Verification
Enhanced Training	Total Processing Time	20%	24.80%	133.32	Claim Assessment
Resource Allocation	Total Processing Time	15%	16.99%	141.64	Document Verification
Improved Communication	Total Processing Time	25%	25%	124.99	All stages improved
Bottleneck Mitigation	Total Processing Time	40%	12%	146.57	Damage Assessment

CHAPTER FIVE

5. CONCLUSION, AND RECOMMENDATION

.

5.1 Conclusion

The findings of this study underscore the critical need for Tsehay Insurance S.C. to optimize its claims processing workflow in order to enhance operational efficiency and elevate customer satisfaction. The findings reveal specific bottlenecks that hinder the current system, emphasizing the need for targeted interventions. To address these challenges, the implementation of automation guided by insights gained from simulation modeling is crucial for streamlining processes, reducing turnaround times, and minimizing errors. This study also highlights the complementary role of simulation modeling techniques.

Tsehay Insurance can identify inefficiencies and test potential solutions in a risk-free environment. This dual approach leveraging both automation for immediate improvements and simulation modeling for long-term strategic planning will ultimately lead to a more responsive and customer-centric claims experience. As the industry increasingly embraces digital transformation, adopting a systematic approach that integrates both automation and simulation will be essential for maintaining competitiveness and meeting evolving customer expectations.

Moreover, this thesis presents a comprehensive framework for utilizing simulation modeling as a continuous improvement tool in claims management. By applying simulation techniques, Tsehay Insurance can not only identify inefficiencies but also test potential solutions in a risk-free environment, enabling informed decision-making.

5.2 Recommendation

To enhance the efficiency of claims processing at Tsehay Insurance S.C., various key recommendations are proposed. Leveraging simulation modeling should be prioritized as it enables the company to assess various scenarios, guiding decision-making and optimizing resource allocation. Additionally, developing Standard Operating Procedures (SOPs) is essential to establish clear procedures for each stage of the claims process, which will help reduce inconsistencies and improve overall efficiency. Enhancing communication among

stakeholders is also important, implementing effective communication strategies can minimize misunderstandings and "speed up," the claims process.

Furthermore, investing in automation technologies like Robotic Process Automation (RPA) can significantly minimize routine task processing times. Providing continuous training for claims personnel on new technologies and best practices will ensure a knowledgeable and efficient workforce. Regular process audits are crucial for identifying bottlenecks and areas for improvement, fostering a culture of continuous enhancement.

Finally utilizing “feedback mechanisms." to gather customer insights will help identify pain points in the claims process and align operations with policy holder expectations. By implementing these recommendations, Tsehay Insurance S.C. can significantly enhance its claims processing efficiency, leading to improved customer satisfaction and strong competitive position in the market.

Reference

Kalogeraki, M., & Antoniou, F. (2024). Claim management and dispute resolution in the construction industry: Current research trends using novel technologies. *Buildings*, 14, 967. https://doi.org/10.3390/buildings14040967

Poufinas, T., Gogas, P., Papadimitriou, T., & Zaganidis, E. (2023). Machine learning in forecasting motor insurance claims. *Risks*, 11(9), 164. https://doi.org/10.3390/risks11090164

Smith, A & Jones, R. (2022). Impact of claims processing on customer satisfaction: A study of motor insurance. Journal of Insurance Research, 45(3), 221-234.

Han, Y. (2024). Research on car insurance compensation based on machine learning. In *2024 5th International Conference on Computer Science and Management Technology (ICCSMT 2024)* (pp. 1-5). Jinan University-University of Birmingham Joint Institute. https://doi.org/10.1145/3708036.3708152

Adams, R., & Green, T. (2022). Simulation Modeling in Motor Insurance: Bridging Theory and Practice. Journal of Insurance Studies, 12(4), 301-315

Bilakanti, G. (2025). Enhancing claim processing efficiency with generative AI. *International Journal of Leading Research Publication (IJLRP)*, 3(1), 1-5. https://doi.org/10.5281/zenodo.15196823

Keller, J., & Flores, A. (2022). Enhancing Staff Competence in Claims Processing through Continuous Education. Insurance Training Journal, 10(2), 45-58.

Nguyen, H., & Patel, R. (2023). Customer Feedback Mechanisms in Insurance: A Study on Claims Processing Improvements. International Journal of Insurance Management, 14(1), 67-80.

Pingili, R. (2025). AI-driven intelligent document processing for healthcare and insurance. *International Journal of Science and Research Archive*, 14(01), 1063-1077. https://doi.org/10.30574/ijsra.2025.14.1.0194

Brati, E., Braimllari, A., & Gjeçi, A. (2025). Machine Learning Applications for Predicting High-Cost Claims Using Insurance Data. Data, 10(6), 90. https://doi.org/10.3390/data10060090

Walters, F., & Chen, L. (2023). The Impact of Lean Practices on Insurance Claims Efficiency. Operations Research in Insurance, 11(1), 88-102.

Garcia, T. (2023). Effective Communication Strategies for Enhancing Customer Experience in Insurance Claims. Journal of Customer Service in Insurance, 8(3), 112-124.

Nellutla, A. (2025). Enhancing health insurance claim processing through artificial intelligence and data analytics. International Journal of Novel Research and Development. https://doi.org/10.XXXX/ijnrd.2501264

Brown, C., & Lee, S. (2023). Advances in Simulation Technology for Claims Management. Journal of Operational Insurance Research, 15(3), 200-215.

Thompson, R. (2023). Innovations in Claims Processing: Integrating Technology for Better Outcomes. Insurance Technology Review, 9(2), 77-90.

NPingili, R. (2024). The basics of robotic process automation in insurance claims. *International Journal for Multidisciplinary Research (IJFMR)*, 6(6), November-December. https://www.ijfmr.com/IJFMR240630854

Kumar, P., & Singh, V. (2023). Evaluating the Impact of Automation on Claims Processing Times. Insurance Analytics Journal, 5(1), 33-47.

Hankede, M. (2024). Assessing the factors causing delay by insurance companies to pay claims to customers: A case of selected insurance companies, and pensions and insurance authority (PIA). East African Finance Journal, 3(2), 234-261. https://doi.org/10.59413/eafj/v3.i2.8

Adams, R., & Green, T. (2022). Simulation modeling in motor insurance: Bridging theory and practice. Journal of Insurance Studies, 12(4), 301–315.

Baldwin, J., & Smith, L. (2020). Delays in claims processing: Impact on customer satisfaction and profitability. Journal of Insurance Research, 33(2), 88–102.

Brown, A., & Taylor, B. (2021). Data-driven decision making in claims processing. Journal of Insurance Operations, 17(4), 115–130.

Yavari. M, & Zaker, H. (2019). An integrated two-layer network model designing a resilient green-closed loop supply chain Journal of cleaner production, 230, 198-218 https://doi.org/101016/j.jclepro.2019.04.130

Brown, A., & Lee, C. (2022). Operational costs in claims management: An analysis. Insurance Management Journal, 29(1), 45–60.

Chen, Y., & Liu, H. (2020). The role of automated systems in claims processing. International Journal of Insurance Technology, 10(3), 220–235.

Jilcha, K. (2019). Research design and methodology. Cyberspace. IntechOpen. https://doi.org/10.5772/intechopen.85731

Ellison, T. (2023). Customer retention strategies in the insurance industry. Insurance Marketing Journal, 45(4), 150–160.

Khan, S. S., Rupak, A. U. H., & Rahman, M. S. (2024). Optimizing vehicle insurance processing through advanced deep learning models. Proceedings of the IEEE International Conference on Computing, Communication, and Network Technologies (ICCCNT). https://doi.org/10.1109/ICCCNT61001.2024.10724385

Foster, R. (2021). Empirical research in insurance claims processing: A need for insights. Journal of Claims Management, 23(2), 98–110.

Garcia, M. (2022). Effective communication in claims processing: Enhancing customer satisfaction. Journal of Customer Experience, 19(5), 220–235.

Kandregula, P. K. (2025). Harnessing artificial intelligence to enhance the mobile insurance claims management process. *International Journal of Science and Research Archive*, 15(02), 712-722. https://doi.org/10.30574/ijsra.2025.15.2.1459

Garrett, J. (2023). The importance of speed in claims settlement. Insurance Review, 38(1), 50–62.

Harris, P. (2020). Continuous improvement methodologies in insurance: Lean and Six Sigma applications. International Journal of Insurance Operations, 15(4), 310–325.

Brati, E., Braimllari, A., & Gjeçi, A. (2025). Machine Learning Applications for Predicting High-Cost Claims Using Insurance Data. Data, 10(6), 90. https://doi.org/10.3390/data10060090

Jones, T. (2021). Simulation modeling in insurance: A comprehensive overview. Operations Research in Insurance, 12(3), 128–145.

Kumar, R., & Singh, A. (2023). Simulation modeling for claims management. Journal of Risk Management, 22(4), 200–215.

Miller, S., & Davis, R. (2018). Understanding processing time in insurance claims. Insurance Studies Quarterly, 7(3), 60–75.

Fernando, N., Hillary, R., Kumarage, A., Abeywardhana, L., & Thiyaganathan, V. (2022). Automated vehicle insurance claims processing using computer vision, natural language processing. In Proceedings of the 2022 International Conference on ICT for Emerging Regions (ICTer). https://doi.org/10.1109/ICTer58063.2022.10024089

Nguyen, T., & Lee, J. (2021). Leveraging data analytics in insurance: Trends and resource allocation. Journal of Insurance Analytics, 10(2), 85–100.

Patel, K., & Kahn, M. (2021). Forecasting outcomes in claims processing through simulation. Journal of Operational Research, 34(1), 150–165.

Rogers, L. (2020). Bottleneck identification in insurance processes: A simulation approach. Simulation and Modeling in Insurance, 11(2), 220–235.

Shaik, M. (2019). Intelligent automation for insurance claims processing. International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences, 7(4), 1-9. https://doi.org/10.5281/zenodo.14352226

Pramudya, A. A., Wibowo, A., Santosa, W., & Permana, F. J. (2025). A claim-based risk mapping of construction all-risk insurance in Indonesia. *Construction Economics and Building*, 25(1), 122-142. https://doi.org/10.5130/AJCEB.v25i1.9035

Thompson, G. (2019). The impact of staff training on claims processing efficiency. Insurance Training Review, 12(4), 200–215.

Tsehay Insurance S.C. annual report 2024 & 2025E.C.

Appendix-I Questionaries' respondent

Respondent ID	Gender	Age Group	Role	Experience	Most Time-Consuming Step	Delays Encountered	Main Challenges	Current Efficiency	Automation	Improvements Suggested
1	Male	18-24	Claims Officer	less than 1 year	Document verification	Sometimes	Communication gaps	Neutral	Yes	Implement more automation. and training on the system
2	Male	35-44	Claim supervisor	>5 years	Approval process	Sometimes	Insufficient resources	Efficient	Yes	Decentralized claim handling and employee trained personnel
3	Male	25-34	Claims Officer	1-3 years	Approval process	Sometimes	Inefficient workflows	Efficient	Yes	automation system that works mathematical calculations and communication
4	Male	35-44	Manager	>5 years	Approval process	Sometimes	Inefficient workflows	Neutral	Yes	Integration of garages with spare part sales to minimize proforma collecting time
5	Male	35-44	Manager	>5 years	Damage assessment	Sometimes	Communication gaps	very Efficient	Yes	Reducing the time of documentation
6	Female	25-34	Claims Officer	3-5 years	Document verification	Sometimes	Documentation	Efficient	Yes	Simple problem solving techniques that reduces the load and communication
7	Female	35-44	Claims Officer	>5 years	Approval process	Always	Communication gaps	Neutral	Yes	Give customer service training and additional technologies
8	Male	25-34	Claims Officer	1-3 years	Approval process	Often	Insufficient resources	Neutral	No	Integrating technology, efficient workflow and staff training
9	Female	25-34	Claim registration	3-5 years	Damage assessment	Always	Insufficient resources	Efficient	Yes	Notification and data collection early
10	Female	25-34	Underwriting	3-5 years	Document verification	Sometimes	Communication gaps	Efficient	Yes	
11	Male	25-34	Claims Officer	3-5 years	Approval process	Sometimes	Lack of automation	Efficient	Yes	
12	Female	25-34	Claims Officer	3-5 years	Approval process	Sometimes	Lack of automation	very Efficient	Yes	Using system
13	Female	35-44	Claims Officer	>5 years	Approval process	Sometimes	Lack of automation	Neutral	No	
14	Female	25-34	Claims Officer	3-5 years	Approval process	Rarely	Inconsistent workflow	Efficient	Yes	Improve the workflow, approval platform and integrated system
15	Male	25-34	Claims Officer	>5 years	Document verification	Rarely	Lack of automation	very Efficient	Yes	use technology
16	Female	25-34	Claims Officer	>5 years	Document verification	Rarely	Inconsistent workflow	Efficient	Yes	
17	Male	45-54	Manager	>5 years	Approval process	Sometimes	Communication gaps	Efficient	Yes	Integrated with spare part sales
18	Male	45-54	Underwriting	>5 years	Document verification	Always	Inconsistent workflow and lack of spare parts	Efficient	Yes	Decentralized claim handling and create awareness for insurers about claim processing

19	Male	25-34	Claims Officer	>5 years	Damage assessment	Sometimes	Lack of automation	Efficient	Yes	Proforma collection and post risk survey
20	Male	25-34	Claims Officer	1-3 years	Damage assessment	Sometimes	Inconsistent workflow	Neutral	Yes	Provide best workflow
21	Male	25-34	Manager	>5 years	Approval process	Often	Lack of automation	Neutral	No	Use updated technology to reduce claim processing time and give training for employers
22	Male	25-34	Claims Officer	3-5 years	Document verification	Always	Inconsistent workflow	Efficient	No	Give customer service training and additional technologies
23	Male	25-34	Claims Officer	1-3 years	Approval process	Sometimes	Inconsistent workflow	Efficient	Yes	Coordination with engineering departments and additional resource constraints
24	Male	25-34	Claims Officer	1-3 years	Damage assessment	Sometimes	Inconsistent workflow	Efficient	Yes	
25	Male	35-44	Claim supervisor	>5 years	Approval process	Sometimes	Inconsistent workflow	Neutral	Yes	use time reducing techniques
26	Male	18-24	Claims Officer	1-3 years	Approval process	Sometimes	Inconsistent workflow and lack of automation	Efficient	No	Create awareness for customers and provide training for employers
27	Male	25-34	Surveyor	3-5 years	Approval process	Sometimes	Insufficient resources	Neutral	No	Hiring well trained personnel and implementing automation
28	Male	25-34	Surveyor	>5 years	Damage assessment	Sometimes	Insufficient resources	Efficient	No	Use digital system and best workflow
29	Male	35-44	Surveyor	>5 years	Approval process	Often	Inconsistent workflow and lack of automation	Neutral	No	Utilize automated tools or system
30	Male	25-34	Senior Engineer	>5 years	Approval process	Often	Inconsistent workflow	Efficient	No	Using system for best work flow and give training for employers
31	Male	25-34	Surveyor	3-5 years	Document verification	Always	Communication gaps	Inefficient	No	Improving workflow process and communication
32	Male	25-34	Surveyor	>5 years	Approval process and payment	Often	Communication gaps and market inflation on currency	Neutral	No	using software's that can connect purchasing and payment issues
33	Male	25-34	Manager	>5 years	Approval process	Sometimes	Insufficient resources	Efficient	Yes	
34	Male	25-34	Surveyor	>5 years	Approval process	Often	Inconsistent workflow	Efficient	Yes	Creating compliance handling department, opening front desk information support for claim and hiring experienced officer
35	Male	25-34	Manager	>5 years	Payment	Always	Communication gaps	very Efficient	Yes	using system to reduce processing time
36	Female	25-34	Claims Officer	1-3 years	Damage assessment	Rarely	Communication gaps	Efficient	Yes	Provide training for officers and use automated system that

										connects departments
37	Male	35-44	Manager	>5 years	Approval process	Always	Insufficient resources and Lack of automation	Neutral	Yes	Implement continuous staff training; create well and easy workflow mechanism and implement the standard across the claim system. Create integration between underwriting engineering and finance department and implementing the time standards for each workflow.
38	Male	35-44	Manager	>5 years	Damage assessment	Sometimes	Lack of automation	Neutral	No	Implementing the software to help the approval workflow to reduce the processing time

APPENDIX-II: Collected data

Claim No	Total Time (Days)	Initial Review (Days)	Documentation Verification (Days)	Claim Assessment (Days)	Payment Processing (Days)
1	50	7	18	14	11
2	244	12	97	103	32
3	66	1	24	29	12
4	246	48	74	109	15
5	192	27	92	45	28
6	244	36	105	85	18
7	261	39	110	88	24
8	364	54	135	98	77
9	363	53	134	97	79
10	111	17	44	26	24
11	853	127	229	431	66
12	125	19	45	35	26
13	348	52	112	82	99
14	766	15	308	312	121
15	205	31	72	44	58
16	228	34	81	48	65
17	43	6	10	15	12

18	64	10	18	16	20
19	13	2	3	4	4
20	28	4	10	6	8
21	535	80	210	120	125
22	364	54	135	98	77
23	361	53	134	97	77
24	56	8	18	12	18
25	234	35	84	49	66
26	111	17	44	26	24
27	362	54	134	97	77
28	19	3	4	6	6
29	52	8	12	9	12
30	208	31	72	44	61
31	41	6	10	15	10
32	205	31	72	44	58
33	240	36	86	51	67
34	46	7	11	14	14
35	233	35	83	49	66
36	41	6	10	15	10
37	213	32	77	46	58
38	47	7	11	14	15
39	33	5	8	10	10
40	31	5	8	10	8
41	53	8	12	16	17
42	123	18	48	29	28
43	55	8	12	16	19
44	89	13	22	24	30
45	55	8	12	16	19
46	51	8	11	13	19
47	73	11	17	19	26
48	78	12	18	20	28
49	41	6	10	14	11
50	77	12	18	20	27
51	254	38	91	57	68
52	364	54	135	98	77
53	370	55	138	101	76
54	19	3	4	6	6
55	438	66	102	62	74
56	42	6	10	12	14
57	19	3	4	6	6
58	47	7	11	14	15
59	44	7	10	13	14

60	222	33	84	48	57
61	376	56	101	62	57
62	65	10	16	13	26
63	169	25	49	29	66
64	158	24	39	27	68
65	167	25	41	28	73
66	160	24	40	26	70
67	28	4	7	8	9
68	22	3	6	5	8
69	30	5	8	7	10
70	51	8	12	16	15
71	144	22	36	26	60
72	47	7	11	14	15
73	50	8	12	16	14
74	89	13	22	24	30
75	56	8	12	16	20
76	205	31	72	44	58
77	77	11	18	20	28
78	75	11	17	19	28
79	17	3	4	5	5
80	61	9	15	18	19
81	204	30	69	41	64
82	38	6	10	8	14
83	230	34	78	46	72
84	781	117	215	306	143
85	62	10	15	11	26
86	33	5	8	7	13
87	94	14	22	24	34
88	317	48	90	75	104
89	109	16	30	25	38
90	227	34	72	43	78
91	77	11	18	20	28
92	344	52	112	107	73
93	85	12	20	19	34
94	385	58	112	97	118
95	47	7	11	14	15
96	167	25	49	29	64
97	370	55	138	101	76
98	143	21	40	25	57
99	90	13	22	18	37
100	348	52	112	79	105
101	32	3	10	8	11

102	37	5	9	6	17
103	33	2	10	11	9
104	14	2	3	3	6
105	151	23	45	27	56
106	72	11	18	14	29
107	112	17	28	19	48
108	243	36	61	40	106
109	494	74	136	196	88
110	48	7	11	10	20
111	12	2	3	2	5
112	272	41	86	51	94
113	102	15	25	18	44
114	38	6	10	8	14
115	265	40	78	50	97
116	340	51	64	172	53
117	17	2	5	7	3
118	23	4	6	5	8
119	43	6	10	12	15
120	815	123	215	309	168
121	55	8	12	16	19
122	543	81	120	231	111
123	120	18	44	26	32
124	120	18	44	26	32
125	42	6	10	8	18
126	81	12	20	13	36
127	26	4	7	5	10
128	370	55	101	138	76
129	147	22	36	24	65
130	53	8	12	11	22
131	72	9	18	21	24
132	72	11	16	18	27
133	62	9	16	12	25
134		7	11	10	21
135	173	26	43	29	75
136	5	1	1	1	2
137	110	17	29	33	31
138	63	9	15	11	28
139	36	5	8	7	16
140	902	135	274	384	109
141	42	6	10	13	15
142	610	92	140	295	83
143	136	20	34	24	58

144	162	24	39	28	71
145	40	6	10	8	16
146	39	6	9	8	16
147	36	5	8	7	16
148	25	4	6	5	10
149	48	9	12	10	17
150	173	26	43	39	65
151	19	3	5	4	7
152	615	92	145	296	82
153	214	32	38	78	66
154	163	25	39	27	72
155	37	6	9	8	14
156	21	3	5	4	9
157	41	6	10	8	17
158	185	28	57	42	58
159	110	17	18	26	49
160	149	22	27	39	61
161	21	3	5	4	9
162	210	31	46	61	72
163	429	64	97	206	62
164	206	31	66	42	67
165	39	6	9	8	16
166	330	50	75	107	98
167	568	85	119	276	88
168	327	49	81	134	93
Total	**28,217.00**	**4,092.00**	**8,326.00**	**8,434.00**	**7,138.00**

APPENDIX-II: Inter-arrival time of the claims

2.50, 3.10, 2.80, 3.20, 2.60, 3.00, 2.90, 2.70, 3.30, 2.40,
2.60, 3.10, 2.80, 3.20, 2.70, 3.00, 2.80, 3.10, 2.60, 2.90,
2.80, 3.00, 2.70, 3.20, 2.80, 3.10, 2.60, 2.90, 3.00, 2.70,
3.20, 2.80, 3.10, 2.60, 2.90, 3.00, 2.70, 3.20, 2.80, 3.10,
2.60, 2.90, 3.00, 2.70, 3.20, 2.80, 3.10, 2.60, 2.90, 3.00,
2.70, 3.20, 2.80, 3.10, 2.60, 2.90, 3.00, 2.70, 3.20, 2.80,
3.10, 2.60, 2.90, 3.00, 2.70, 3.20, 2.80, 3.10, 2.60, 2.90,
3.00, 2.70, 3.20, 2.80, 3.10, 2.60, 2.90, 3.00, 2.70, 3.20,
2.80, 3.10, 2.60, 2.90, 3.00, 2.70, 3.20, 2.80, 3.10, 2.60,
2.90, 3.00, 2.70, 3.20, 2.80, 3.10, 2.60, 2.90, 3.00, 2.70,
3.20, 2.80, 3.10, 2.60, 2.90, 3.00, 2.70, 3.20, 2.80, 3.10,
2.60, 2.90, 3.00, 2.70, 3.20, 2.80, 3.10, 2.60, 2.90, 3.00,
2.70, 3.20, 2.80, 3.10, 2.60, 2.90, 3.00, 2.70, 3.20, 2.80,
3.10, 2.60, 2.90, 3.00, 2.70, 3.20, 2.80, 3.10, 2.60, 2.90,
3.00, 2.70, 3.20, 2.80, 3.10, 2.60, 2.90, 3.00, 2.70, 3.20,

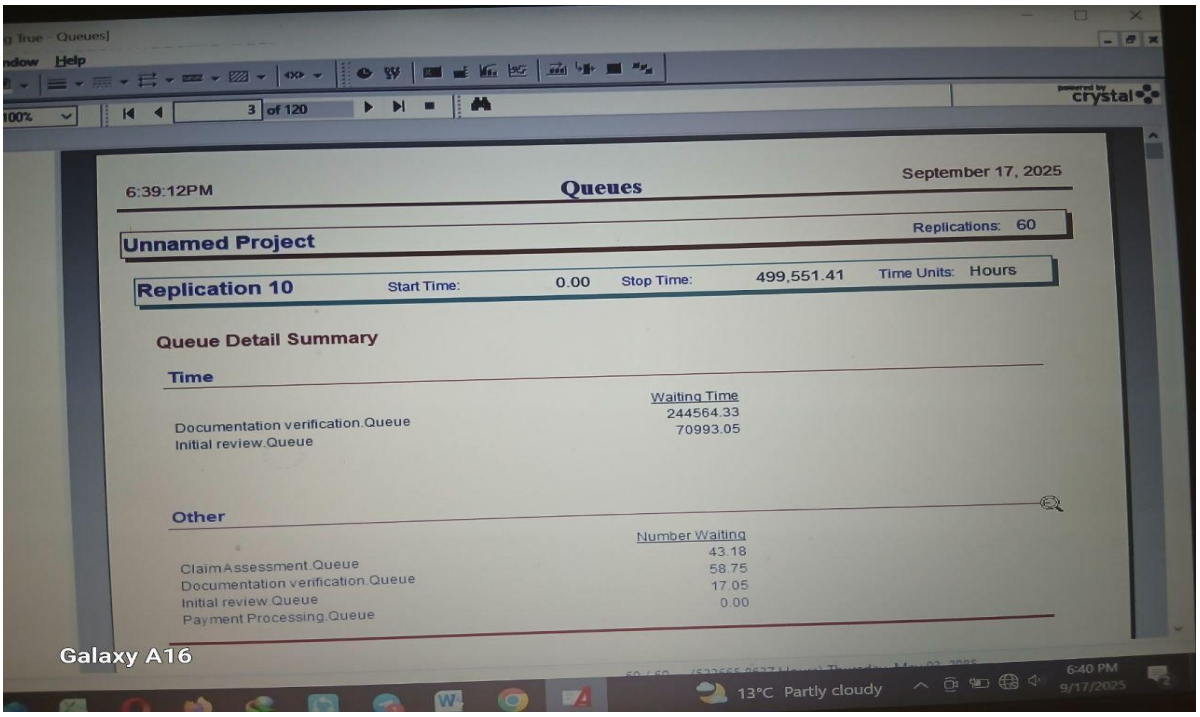
2.80, 3.10, 2.60, 2.90, 3.00, 2.70, 3.20, 2.80, 3.10, 2.60,
2.90, 3.00, 2.70, 3.20, 2.80, 3.10, 2.60, 2.90, 3.00, 2.70]

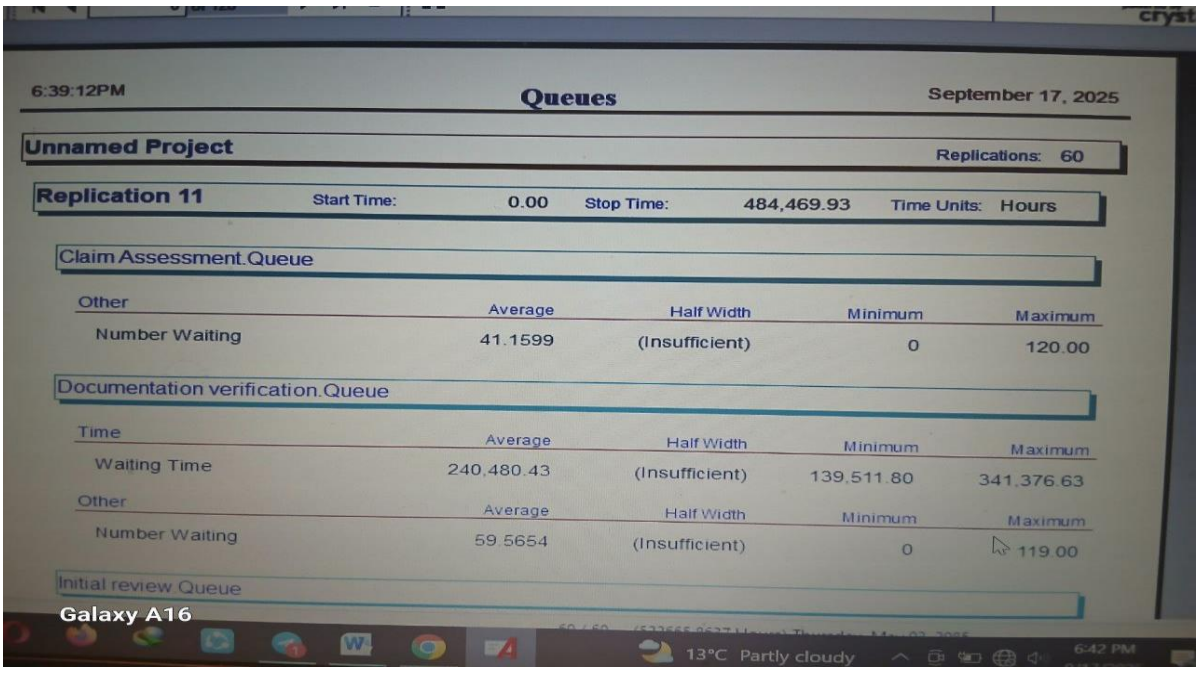
Appendix III: Literature Review Summary

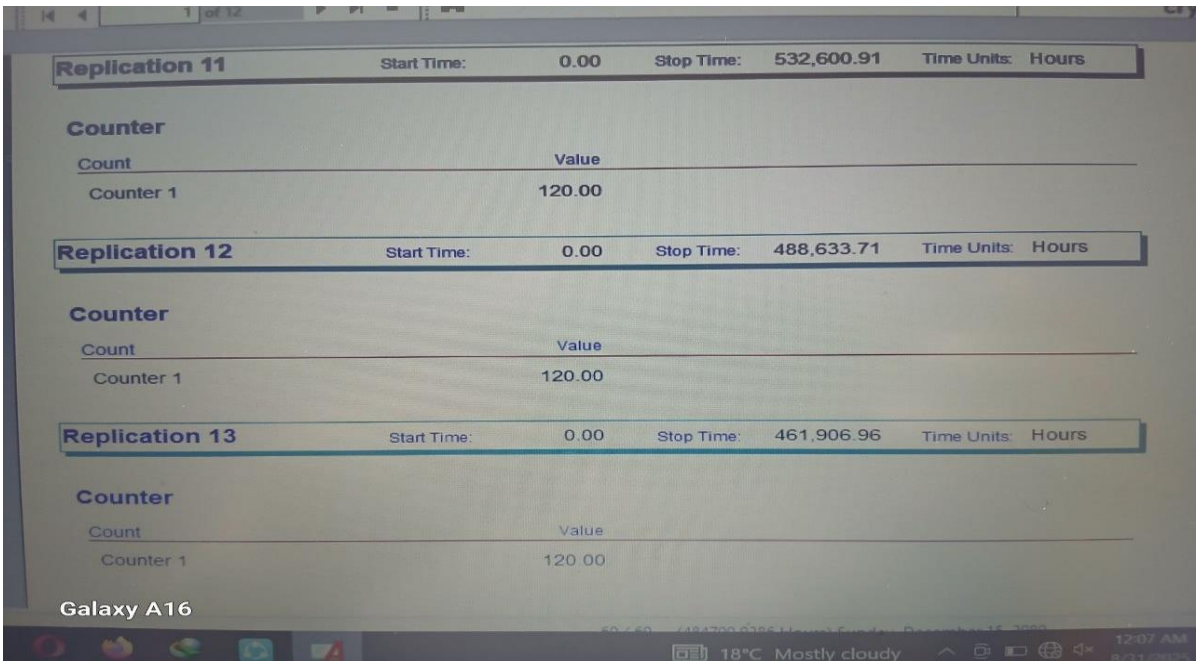
Title	Authors	Year	Method	Problem	Solution
Optimization of Motor Insurance Claims Processing	Baldwin & Smith	2020	Literature Review	Delays in claims processing lead to customer dissatisfaction and impact company reputation.	Identifying bottlenecks and implementing solutions to improve processing time.
Deep Learning Models for Claims Processing	Khan et al.	2023	Experimental Study	Traditional claims evaluation is slow and error-prone.	Implement CNNs to automate claims evaluation, reducing processing times.
Operational Efficiencies in Claims Processing	EAST AFRICAN FINANCE JOURNAL (EAFJ)	2024	Case Study	Gaps in management practices negatively impact efficiency.	Modernize claims systems and integrate technology for improved timelines.
Machine Learning in Insurance Claims	Burri et al.	2020	Empirical Research	Inefficiencies in claims processing and fraud detection.	Utilize ML algorithms to accelerate claims processing and improve accuracy.
Simulation Modeling for Claims Optimization	Patel & Kahn	2021	Simulation Modeling	Complex processes hinder optimization in claims processing.	Use simulation modeling to identify bottlenecks and optimize workflows.
Critical Factors Influencing Claims Processing Time	Chen & Liu	2020	Survey Analysis	Lack of technology integration and staff training.	Adoption of automated systems (e.g., RPA and AI) to reduce errors and expedite claims processing.
Lean Principles in Claims Processing	Womack & Jones	2016	Qualitative Analysis	Inefficiencies due to non-value-added activities.	Apply lean principles to streamline operations and enhance service quality.
Customer Communication in Claims Processing	Garcia	2022	Survey and Interviews	Poor communication leads to delays.	Implement proactive communication strategies to reduce follow-ups and enhance customer satisfaction.

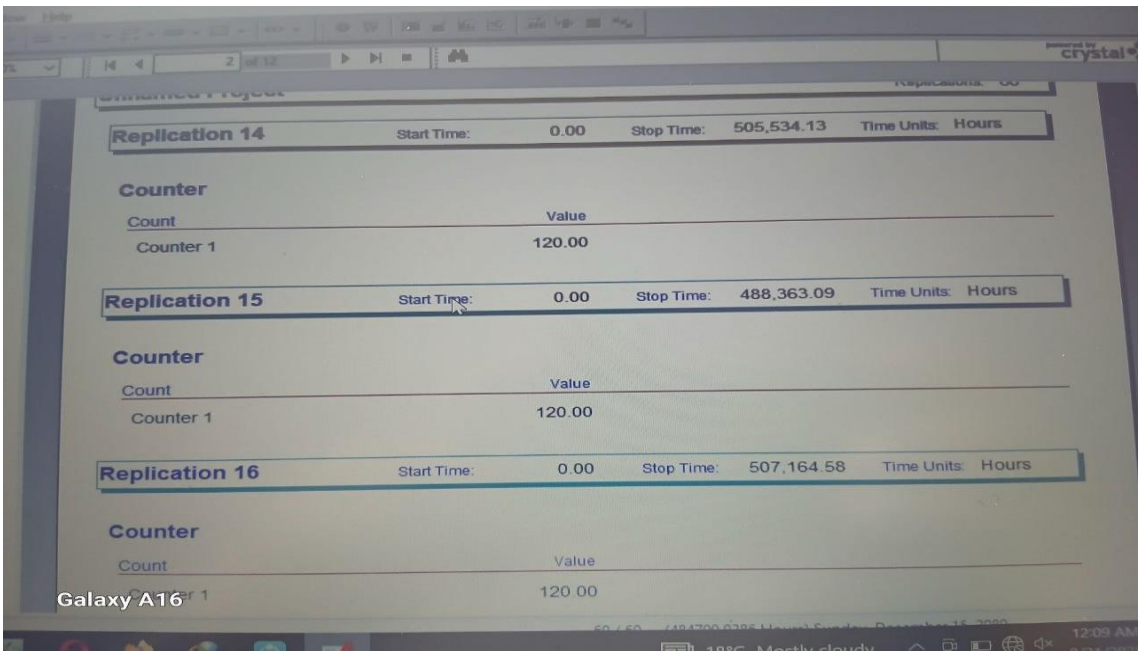
Role of Machine Learning in Claims Processing	Berri et al.	2020	Literature Review	Automation challenges in claims validation and fraud detection.	Leverage ML algorithms for quicker decision-making and accuracy in claims costs.
Simulation Modeling in Insurance	Kinyua Weru and Waititu	2020	Empirical Study	Need for better insights into claims processing inefficiencies.	Apply EVT to model extreme occurrences and understand large claims behavior.
Staff Training and Claims Processing Efficiency	Thompson	2019	Literature Review / Empirical Study	Ineffective staff training affecting processing time and efficiency.	Emphasizing well-trained personnel to enhance claims process navigation.
Enhancing Customer Feedback Mechanisms	Nguyen & Patel	2023	Survey Analysis	Lack of customer feedback hinders process improvement.	Incorporate feedback mechanisms to identify areas for enhancement.
Identifying Bottlenecks in Claims Processing	Rogers	2020	Case Study	Bottlenecks hinder the efficiency of claims processing.	Utilize simulation to identify and address bottlenecks in workflows.
Process Optimization in Claims Processing using Lean and Six Sigma	Harris	2020	Process Improvement / Literature Review	Operational inefficiencies and waste in the claims process.	Implementing Lean and Six Sigma methodologies to eliminate waste and improve claims flow.
Research Gap in Simulation Modeling for Motor Insurance	Adams & Green	2022	Literature Review / Conceptual Study	Few studies on simulation modeling in motor insurance claims processing.	Conducting empirical research and providing practical insights into simulation modeling for motor insurance.
Optimizing Claims Processing through Automation	Walters	2019	Case Study / Literature Review	Routine tasks (data entry, validation) slow down claims processing.	Automating routine tasks to reduce time and increase accuracy in claims handling.
Simulation Modeling in Claims Processing	Jones	2021	Simulation Modeling	Lack of understanding of complex claims processes and challenges in identifying areas for improvement.	Using simulation modeling to analyze processes, assess outcomes, and identify improvement areas.

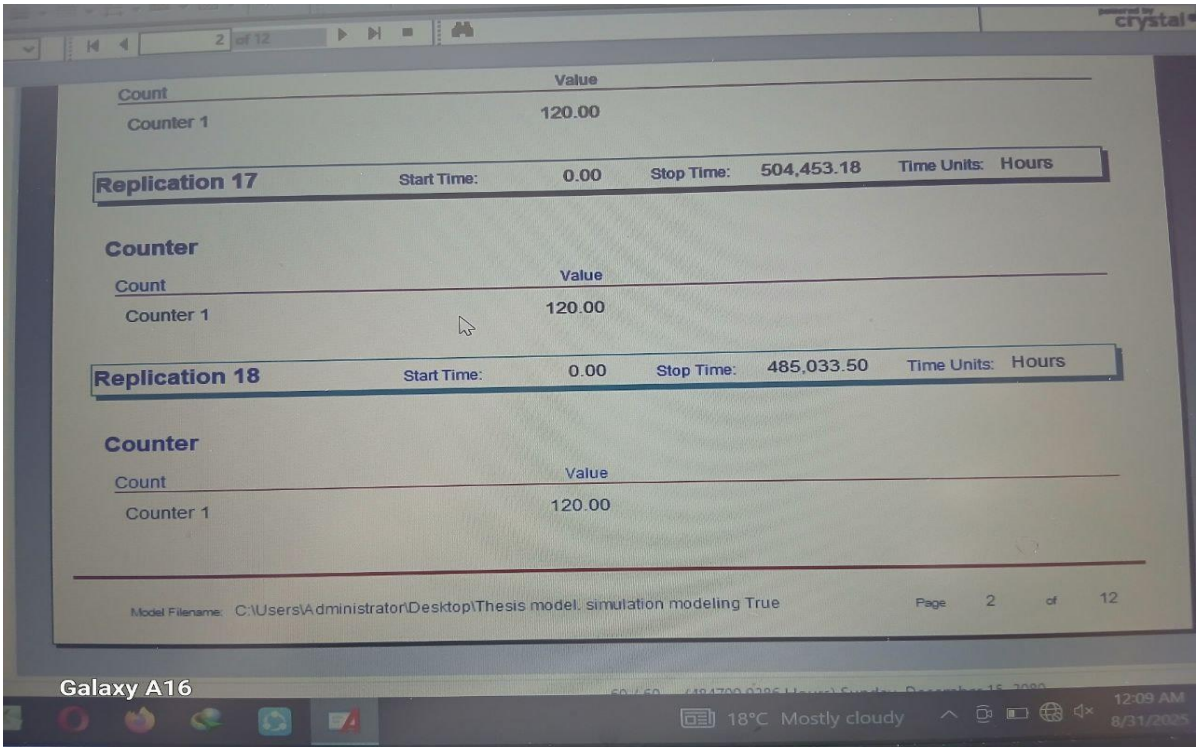
Appendix- -IV: Appendex V: Simulation modeling replication results

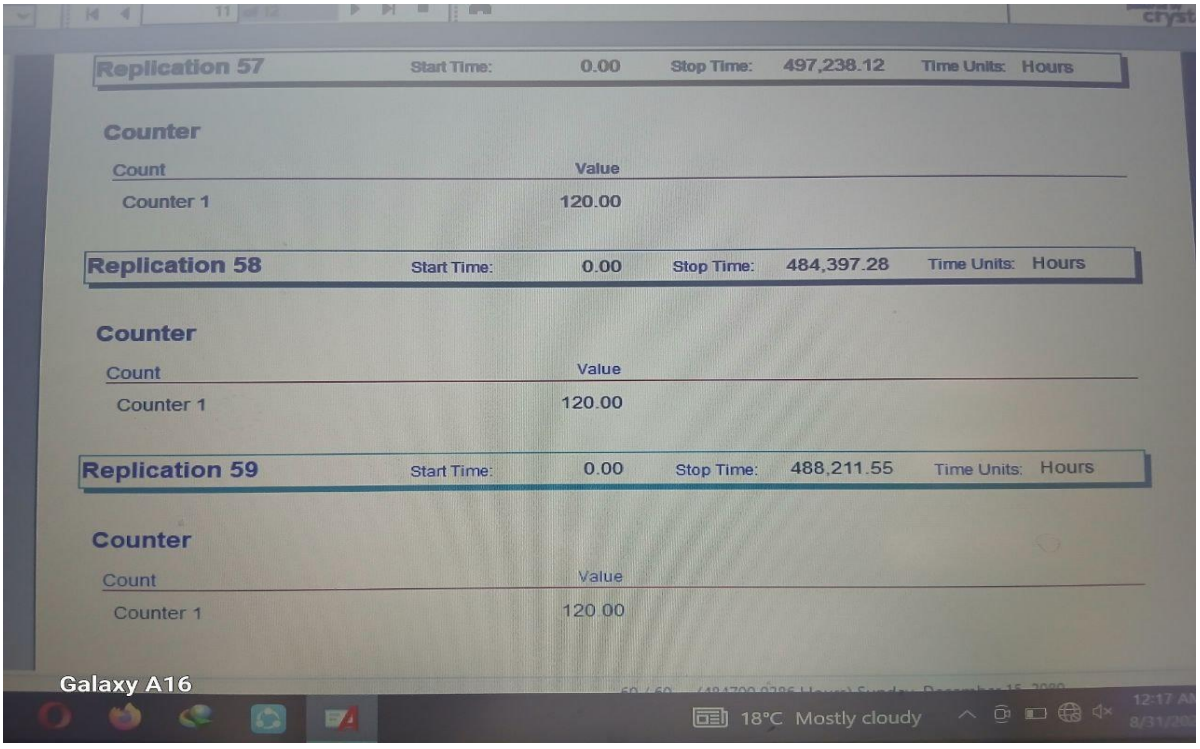





Replication 11 Start Time: 0.00 Stop Time: 532,600.91 Time Units: Hours
Counter
Count Value
Counter 1 120.00
Replication 12 Start Time: 0.00 Stop Time: 488,633.71 Time Units: Hours
Counter
Count Value
Counter 1 120.00
Replication 13 Start Time: 0.00 Stop Time: 461,906.96 Time Units: Hours
Counter
Count Value
Counter 1 120.00
Galaxy A16


Replication 14 Start Time: 0.00 Stop Time: 505,534.13 Time Units: Hours
Counter
Count Value
Counter 1 120.00
Replication 15 Start Time: 0.00 Stop Time: 488,363.09 Time Units: Hours
Counter
Count Value
Counter 1 120.00
Replication 16 Start Time: 0.00 Stop Time: 507,164.58 Time Units: Hours
Counter
Count Value
120.00
Galaxy A16


Count
Value
Counter 1
120.00
Replication 17
Start Time: 0.00
Stop Time: 504,453.18
Time Units: Hours
Counter
Count
Value
Counter 1
120.00
Replication 18
Start Time: 0.00
Stop Time: 485,033.50
Time Units: Hours
Counter
Count
Value
Counter 1
120.00
Model Filename: C:\Users\Administrator\Desktop\Thesis model. simulation modeling True
Page 2 of 12
Galaxy A16
18°C Mostly cloudy


Replication 57
Start Time: 0.00
Stop Time: 497,238.12
Time Units: Hours
Counter
Count
Value
Counter 1
120.00
Replication 58
Start Time: 0.00
Stop Time: 484,397.28
Time Units: Hours
Counter
Count
Value
Counter 1
120.00
Replication 59
Start Time: 0.00
Stop Time: 488,211.55
Time Units: Hours
Counter
Count
Value
Counter 1
120.00
Galaxy A16
18°C Mostly cloudy

Replication	Output	Replication	Output
1	482,407.86	31	479,152.77
2	486,234.57	32	493,514.15
3	455,659.89	33	476,474.84
4	484,283.79	34	507,743.04
5	466,407.80	35	495,562.73
6	460,263.89	36	506,672.52
7	534,249.12	37	495,167.93
8	490,963.26	38	515.576.80
9	495,214.00	39	499,049.26
10	497,475.18	40	519,709.82
11	532.600.91	41	495,759.99
12	488,633.71	42	512,974.86
13	461,906.96	43	488,138.83
14	505,534.13	44	519,688.12
15	488,363.09	45	539,830.93
16	507,164.58	46	482,647.26
17	504,453.18	47	455,148.51
18	485,033.50	48	477,237.09
19	503,927.14	49	484,628.48
20	514,623.70	50	496,747.81
21	522,328.76	51	488,977.93
22	490,400.50	52	505,747.50
23	499,399.05	53	509,640.88
24	539,371.04	54	511,338.97
25	451,759.87	55	524,000.76
26	509,747.80	56	495,439.91
27	474,530.04	57	497,238.12
28	460,364.90	58	484,397.28
29	496,656.68	59	488,211.55
30	516,144.44	60	484,700.93

Appendix VI: Data collection request form

College of Technology and Built Environment

School of Mechanical and Industrial Engineering

Date: 21/05/25

DATA COLLECTION REQUEST FORM

To: Tsehay Insurance S.C.

Mr./Mrs. Natenael Kassahun Assfaw

is a BSc/MSc/PhD student in our School at Addis Ababa Institute of technology, Addis Ababa University. At this moment he/she is doing his/her thesis/project/term paper entitled

"Enhancing Efficiency in Motor insurance claims processing Through a comprehensive study of simulation Modeling approaches"

In order to successfully complete his/her paper, the student wants to obtain information from your factory/industry/organization.

The school strongly appreciates for any sort of assistance you provide to our student related to his/her thesis/project/term paper. In addition, we would like to inform you that the data is required and will be used only for educational purpose.

Thank you in advance for your kind cooperation.

School of Mechanical & Industrial Engineering

Dr. Abdulkadir Aman
Interim Head of the School of Mechanical and Industrial Engineering
College of Technology and Built Environment
Addis Ababa University

Kidane C. (PhD-Student)

+251-11-1-232414 smie.aait@aau.edu.et aau.edu.et

SEEK WISDOM, ELEVATE YOUR INTELLECT, AND SERVE HUMANITY