Event-based Smart Contracts for Automated Claims Processing and Payouts in Smart Insurance

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***Abstract*—The combination of blockchain technology and smart contracts has become a viable way to expedite claims processing and payouts in the quickly changing insurance industry. Enhancing efficiency, transparency, and reliability for the industry may be achieved by automating certain procedures and initiating them on predetermined triggers, smart contracts that is event-based. Conventional insurance procedures can be laborious, slow, and prone to human mistake, which can cause inefficiencies and delays in the resolution of claims. This research proposes a simplified system that automates the whole claims process from submission to reimbursement by utilizing blockchain technology and smart contracts. The suggested method does away with the requirement for human claim filing by having policyholders' claims automatically triggered by predetermined occurrences. These occurrences might be anything from medical emergencies to natural calamities, enabling prompt and precise claim start. The whole claims process is managed by smart contracts that are programmed with precise triggers and conditions, guaranteeing transaction immutability, security, and transparency. Moreover, reimbursements are carried out automatically after the triggering event has been verified, disregarding conventional bureaucratic processes and drastically cutting down on processing times. This strategy decreases the possibility of fraud and disagreement while also improving operational efficiency by combining self-executing contracts with decentralized ledger technology. Insurance companies and policyholders will both eventually profit from an accelerated, transparent, and reliable claims processing procedure thanks to the use of event-based smart contracts. A Python-implemented system achieving 97.6% accuracy using the proposed method, demonstrates its efficacy and reliability for the given task.**

Keywords*—Blockchain technology; smart contracts; event-based triggers; automated claims processing; transparency and trustworthiness

I. INTRODUCTION

Private insurance businesses act as a central organization to give advantages to policyholders. They offer worth by using historic information and mathematical procedures to determine whether premiums are going to be adequate for covering predicted claims. Furthermore, authorities can control these companies in order to ensure enough funding. Insurance firms are currently losing a significant amount of money as a result of claims leakage. Illegal claims are a massive and expensive issue for insurance firms, possibly resulting in trillions of dollars in unwarranted spending every year [2]. Traditional policy approaches for detecting fraud are complex and time-consuming. They mostly rely on expert inspection, adjusters as well, and specialized investigative services. Manual inspection faces extra costs and yields erroneous findings. Furthermore, delayed decisions may result in additional losses for the insurance firms. The insurance business administers auto-insurance processing of claims using information gathered from several domains, including police, county administration, insurance representatives, and medical professionals [3]. These businesses work together to communicate multi-source data, which is crucial enabling insurance firms to correctly assess customer claims. Yet, the majority of existing claim processing procedures are laborious and time-consuming because to a lack of automated methods to perform information collection/analysis, along with technology to make reliable decisions [4]. To enhance the effectiveness and adaptability of insurance claim the process, it is necessary to integrate automated processes and trust administration mechanisms at an application level [5].The excessive number of false claims given out by motor insurance firms has resulted in price hikes of several hundred dollars to counteract the false payouts, reducing insurance company profitability as well as the level of operations [6]. As a result, there exists an urgent need to provide quick and effective solutions for identifying fraud, risk assessment, and

safe storage of information that strike a perfect equilibrium among customer private information safeguarding, loss prevention savings, and expenditure on false alarm identification (Cousaert, Vadgama, and Xu 2022). Recommend creating a successful framework for insurance companies to address such difficulties [7].

Intelligent contracts may streamline numerous common operations in the P&C insurance industry, including policy issuance and claim management. For example, parameterized insurance policies can initiate payments whenever predetermined conditions are satisfied, such as in the case of a natural disaster [8]. It may also assess all payment choices to determine which one is optimal. This technology eliminates the requirement for middlemen and increases effectiveness, giving policyholders access actual time replies which are not impeded by delays in insurance claims [9]. This study examines the notion of automation claims handling and payouts driven by event-driven intelligent contracts in the insurance business. The technological infrastructure necessary to construct a system like this, includes the selection of blockchain platform, programming languages, and architectural considerations for smart contract implementation [10]. Research demonstrate the flow of data and actions across the system, emphasizing the seamless integration of event-driven triggers for automating the claims handling workflow [11]. Its technological infrastructure necessary to construct any of these systems, in addition to the selection regarding the blockchain platform, programming languages, and architectural considerations for smart contracts .Demonstrate the flow of data and operations across the system, emphasizing the effortless incorporation of based on events triggering for automating the claims handling process [12].

The Current solutions based on blockchain employ intelligent agreements to enhance the transfer of assets, restrict fraud, and decrease administrative expenses. However, they do not address collaborative insurance, allowing individuals who have comparable characteristics to safeguard each other in an increased favorable, reasonable, and open way [13].To illustrate whether event-based intelligent agreements might transform the claims handling procedure by thoroughly examining its technological foundations and operational ramifications, benefiting insurance companies, policyholders, and various other stakeholders equally. With adopting this novel strategy, insurance firms may achieve unprecedented levels of efficiency, openness, and satisfaction with customers, bringing in an entirely novel phase of insurance claim administration [14].

Key contributions are as follows:

- By automating claims processing through event-based smart contracts, the system eliminates manual submission processes, reducing administrative burdens and streamlining operations.
- Blockchain technology ensures transparency and immutability of transactions, providing a clear audit trail for all stakeholders involved.
- Predefined events trigger claims automatically, enabling quick initiation upon the occurrence of insured events such as natural disasters or medical emergencies. This swift response enhances customer satisfaction and reduces delays in claim settlements.
- The inherent security features of blockchain technology, combined with self-executing smart contracts [1] minimize the potential for fraudulent activities in the claims process.
- Automated payouts upon verification of triggering events bypass traditional bureaucratic procedures, significantly reducing processing times.
- By streamlining processes and reducing manual intervention, insurers can realize cost savings and operational efficiencies.

The remaining section of this work is structured as follows: Section II covers similar work and a full evaluation of it. Section III offers details on the problem statement. Section IV provides a detailed discussion of the suggested method. Section V presents and examines the results of the tests, as well as a comprehensive comparison of the proposed technique to current standard procedures. Section VI, the last section, represents where the paper is finished.

II. Related Works

The existing health insurance claims procedure has issues with inefficiency and complexity. Whenever a patient files a health insurance claim, he or she must first visit the medical facility to obtain a diagnostic certification and being received, and finally submit the required application documentation to the insurer. The person will not get compensation until the company completes its verification procedure via the patient's clinic. Research can use the technology of blockchain to better the existing situation. Blockchain innovation may successfully open up avenues for communication between insurance companies and healthcare providers, increase industrial integrating, and improve healthcare firms' capacity to access data. This study uses blockchain and smart contract technology to boost the progress of Internet healthcare. First, blockchain and smart contracts technology may effectively handle the problem of web-based verification. In addition, it contributes to better monitoring. Finally, it helps to solve risk management issues. Finally, it promotes efficient anti-money laundering. The suggested approach meets a number of safety criteria: mutual verification of identities and the non-rep among all of both roles, along with additional significant the blockchain relies safety concerns. In the case of a conflict provide an arbitration system to distribute duties. The effective deployment of the blockchain system in the insurance sector necessitate the development of strong publicly accessible infrastructure (PKI), partnerships between healthcare providers for offering electronic health records (EMR), as well as money alliances for expressing consumer financial data, that could create practical and legal obstacles in some countries [15].

The insurance sector, firms have implemented substantial and fundamental modifications to update their basic processes, making operations simpler and quicker for customers and enterprises. To service more clients while enhancing the total

client experience across all contact points, organizations are seeking to shift out of standalone transactional systems and towards contextually engagement systems. Several insurance companies currently use some form of automation, including scanning, uploading papers for the process, or automating bank transfer activities. However, occasionally this might result in inadequate results or delayed procedures. Robotic Process Automation (RPA) is the employing of computer programs robots to execute business operations that would normally be performed by humans. RPA can help companies accomplish their business goals while utilizing existing technology and increasing the returns on prior and ongoing transformational expenditures. Insurers may utilize RPA to analyze large amounts of complicated data at greater rates and in less time. RPA is poised to assist claiming businesses develop and improve their results in the age of technology by increasing automated processes, efficiency, and concentration for claim experts. Companies with superior outsourced capabilities have widened their concentration on automating to save labor expenses and streamline procedures. The following has generated an emerging RPA industry that is expected to expand significantly. RPA's drawbacks includes being unable to perform activities that need complicated making choices or mental skills, as well as its dependence on organized information and repeated procedures, that might not apply to all circumstances or sectors [16].

Dhieb et al. [17] propose safe and automatic healthcare system architecture that eliminates human intervention, protects insurance operations, notifies and educates concerning dangerous consumers, identifies forged claims, and decreases the financial loss for the insurance industry. Subsequently introducing the blockchain relies system for enabling secure transactions as well as information offering between various agents who communicate inside the insurance company network, that research suggest employing the xtreme gradient boosting (XGBoost) artificial intelligence method for the formerly mentioned insurance companies and comparing its efficacy to that of other cutting-edge algorithms. The findings show that when implemented to an automobile insurance dataset, Boost outperforms other present-day learning methods. When it comes to identifying false claims, it outperforms the decision tree algorithms by 7% on average. The findings show that whenever deployed to an automobile insurance dataset, XGboost outperforms alternative present-day learning methods. Whenever it comes to identifying false claims, it outperforms the decision tree models by 7% on average. In addition, present an online educational approach to autonomously cope with real-time modifications to the insurance network, as well as demonstrate that it beats other online cutting-edge method. At last use the hyper ledger networks fabric composer and the built neural network modules to construct and replicate the machine learning algorithms and bit coin architecture. Throughout the coming years, company are going to concentrate on improving the proposed framework and introducing artificial intelligence (AI) products targeted to various insurance services.

The insurance sector relies largely on a number of activities carried out by different organizations, including insurers, insured’s, and third-party service providers. The growing competitive climate is driving insurance businesses to adopt innovative technology to solve a variety of issues, including an absence of confidence, openness, and economic uncertainty. For this purpose, blockchain is being employed as a new technology for accessible and safe information preservation and transfer. Loukil et al. [18] propose CioSy, an integrated a blockchain-based healthcare platform that monitors and processes insurance activities. To the greatest extent of understanding, current processes do not take cooperative insurance into account while aiming for a computerized, clear, and tamper-proof solution. CioSy intends to use smart contracts to automate the processing of insurance policies, claims, and payments. For validation reasons, an experimental prototype is created on the Ethereum blockchain. The findings from experiments suggest that the suggested strategy is viable and cost-effective. In the future, research hopes to give a formal privacy demonstration for the suggested paradigm. In addition, intend to investigate the feasibility of deploying the funds gathered by an insurance pooling utilizing blockchain-based technology with the goal to encourage bankers and insurance organizations to join a proposed collaboration healthcare system.

Traditional claims handling procedures are inadequate for the current world, which has an expanding fleet of cars and an equal amount of incidents. Fernando et al. [19]suggest a fresh proposal for automating the financial services industry's laborious operations. Its provided approach is made up of three primary elements: re-identifying the car's model and year, identifying the harmed automotive part, kind, and extent, and computing a precise repair cost utilizing damages part recognition. Simplify the recording process by detecting important fields from the user's voice input. This guarantees that all parties participating in the procedure benefit from the proposed system. The presented solutions were developed utilizing Artificial Intelligence approaches, namely CNN models and natural language processing techniques. The initiative's planned developments for the future include improving the ASR to detect more fields linked to completing out the initial claim seeking form as well as including additional regional dialects. The given technique is capable of recognizing one type of harm in a picture. This may be enhanced to identify multiple kinds of harm in a picture as technology for computer vision evolves. These improvements will improve the overall efficiency of the system in the years to come.

Machine learning or data mining algorithms may be utilized for forecasting future management and are thus considered strong tools. Data mining has recently become increasingly significant for obtaining essential data in the healthcare industry. Health insurance costs are critical in the development of healthcare institutions. In order to offer improved healthcare services, it is critical to anticipate the cost of medical insurance that constitutes one of the opportunities for improving healthcare facilities. Dutta et al. [20] addresses projecting the cost of medical coverage, which must be provided by the individual receiving medical care. To accomplish the best predictions examination, several data mining regression techniques are used, including decision trees, random forests, polynomial regression, and regression

using linear models. A contrast was made among the actual and expected expenditures for the predictions premiums, and a graph was created on this foundation to help us identify the optimum method of regression for insurance policy prediction. One constraint is the possible complexity and technical needs of adopting sophisticated neural network algorithms such as Bi-LSTM, that might necessitate extensive knowledge and computing power. Another drawback is the absence of insurance-related information, which restricts the research to a small dataset and could restrict the ability to generalize of the findings. Every method is evaluated to determine the most appropriate solution.

While several studies have highlighted the potential of emerging technologies such as blockchain, robotic process automation (RPA), machine learning, and data mining in revolutionizing the health insurance claims process, there remain significant limitations across these works. Firstly, while blockchain offers secure data sharing, its implementation may face challenges related to infrastructure development and legal obstacles. Additionally, the reliance on structured data and repetitive processes in RPA may limit its applicability in complex decision-making scenarios. Moreover, the effectiveness of machine learning algorithms like XGBoost and data mining techniques in predicting insurance costs is constrained by the availability of comprehensive datasets and computational resources. Furthermore, the complexity of advanced neural network algorithms may hinder their adoption, while the lack of insurance-specific information can restrict the generalizability of findings. These limitations underscore the need for further research to address technical, data-related, and practical challenges in leveraging emerging technologies for enhancing the efficiency and effectiveness of health insurance processes.

The existing health insurance claims procedure is plagued by inefficiency and complexity, requiring patients to visit medical facilities to obtain diagnostic certification and then submit documentation to insurers, resulting in delayed compensation. To address these issues, the current research proposes utilizing blockchain and smart contract technology. This technology facilitates communication between insurance companies and healthcare providers, enhances industrial integration, and improves healthcare firms' access to data. The proposed approach aims to boost the progress of Internet healthcare by effectively handling web-based verification, improving monitoring, and addressing risk management issues. Dhieb et al. proposed a safe and automatic healthcare system architecture that eliminates human intervention, protects insurance operations, identifies forged claims, and decreases financial loss. They suggest employing the XGBoost artificial intelligence method for insurance companies, which outperforms other algorithms in identifying false claims. Similarly, Loukil et al. proposed CioSy, a blockchain-based healthcare platform that automates insurance policies, claims, and payments through smart contracts. Fernando et al. suggest automating financial services operations, including car damage assessment for insurance claims, using Artificial Intelligence approaches. Dutta et al. on predicting medical insurance costs, utilizing various data mining regression techniques. These earlier studies provide a comprehensive framework for the current research on Event-Based Smart Contracts for Automated Claims Processing and Payouts in Smart Insurance. The proposed system will leverage blockchain technology and smart contracts to automate and streamline the insurance claim process, enhancing efficiency, transparency, and security. By integrating findings from previous research, the proposed system will significantly contribute to solving the inefficiencies and complexities of the existing health insurance claims procedure.

III. Problem Statement

The current insurance claims procedure is plagued by inefficiencies and complexities, requiring physically visit facilities for certification before submitting paperwork to insurance firms. This cumbersome process leads to delays in compensation and poses challenges in data verification and risk management [18]. However, emerging technologies like blockchain and Robotic Process Automation (RPA) offer promising solutions to streamline these operations. Blockchain can facilitate secure communication between insurance companies and healthcare providers, while RPA can automate repetitive tasks, improving efficiency and accuracy. Additionally, the integration of artificial intelligence (AI) algorithms, such as XGBoost, enhances fraud detection and claim processing speed. Despite these advancements, there remain challenges in implementing these technologies, including the need for robust infrastructure and data privacy considerations [16]. Hence, there is a pressing need for innovative solutions like CioSy, a blockchain-based healthcare platform, which automates insurance processes through smart contracts, ensuring transparency and reliability. Furthermore, leveraging AI techniques like convolutional neural networks (CNN) and natural language processing (NLP) can further enhance claims handling by automating tasks like damage assessment and form completion. Ultimately, adopting these technologies can revolutionize the insurance sector, making processes more efficient, transparent, and customer-centric .The Novel method Automated Claims Processing and Payouts Triggered by Event-Based Smart Contracts is proposed.

IV. Proposed Method Automated Claims Processing and Payouts Triggered by Event-based Smart Contracts

The suggested event-driven architecture insurance claim procedure follows a certain set of phases in its approach. First, pertinent data on insurance plans, applicants, and triggering events are gathered through data collection and preprocessing. After that, this data is examined and plotted to reveal trends and patterns that might guide the creation of smart contracts. Subsequently, blockchain technology is utilized for safe transactions and smart contract implementation in the automatic medical insurance claims processing system. Automate the claims procedure and ensure speed and transparency, smart contracts are configured with certain triggers and criteria. When certain events occur, such as natural catastrophes or medical emergencies, smart contracts automatically start the claims procedure. This entails confirming the legitimacy of the claim and streamlining the reimbursement procedure without requiring human

involvement. Utilizing blockchain technology, this technique places a strong emphasis on guaranteeing the confidentiality and integrity of the claims process. In addition, the system is routinely optimized and monitored to preserve its efficacy and efficiency in managing insurance claims.

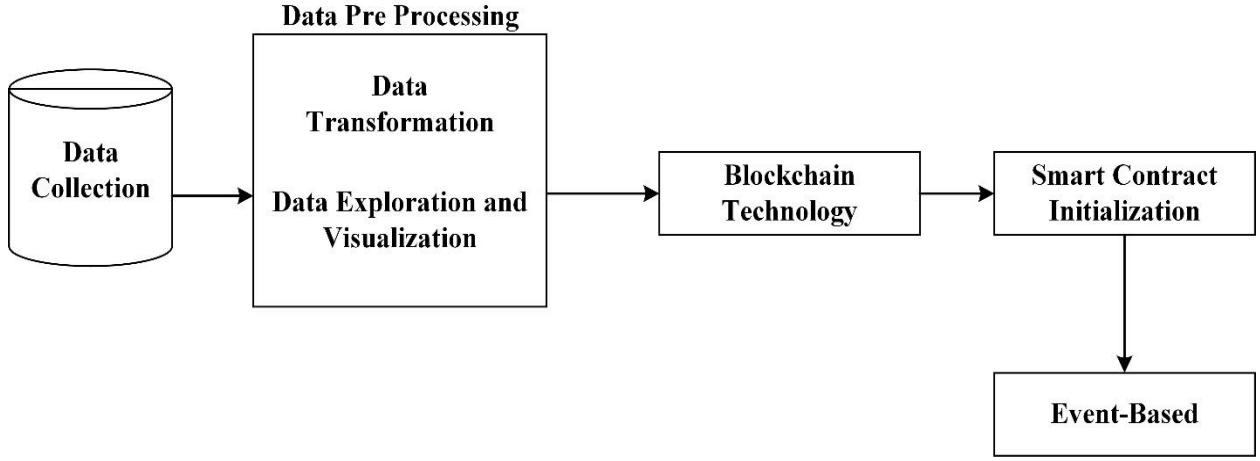

Fig. 1. Automated claims processing and payouts triggered by event-based smart contracts.

Fig. 1 displays a flowchart of a data-driven workflow using blockchain technology. The procedure includes five steps data gathering, data pre-processing, blockchain technology, smart contract activation, and event-based process.

A. Data Collection

The "Health Insurance Dataset - EDA" available on Kaggle offers a comprehensive exploration of health insurance data, comprising information on 1338 US health insurance customers. The dataset includes features such as age, gender, body mass index (BMI), number of children, smoking status, region, and insurance charges. It serves to facilitate analysis on factors affecting insurance charges, prediction of new charges, and comparison of plans across different regions. Key inquiries encompass the impact of age, smoking status, and number of children on insurance charges, identification of regions with the highest or lowest average charges, and examination of BMI distribution across regions. This dataset is valuable for understanding insurance pricing and trends [21].

B. Data Pre Processing

Data preprocessing involves cleaning and transforming raw data to enhance its quality and usability for analysis, typically including tasks such as handling missing values, outlier detection, normalization, and feature scaling. This step is crucial for ensuring accurate and reliable results in data analysis and modeling.

1) Data transformation: In the data transformation stage, several techniques are applied to prepare the data for modeling. Categorical variables are encoded into numerical representations, typically using methods like one-hot encoding to create binary columns for each category or label encoding to assign unique numerical values to categories. Numerical functions can be scaled to make sure consistent degrees across variables, assisting algorithms touchy to function magnitudes. Feature engineering consists of crafting new capabilities from present ones, leveraging domain information or statistical insights to enhance model performance. This may consist of growing interaction terms, polynomial features, or transform variables to better capturing relationships or styles within the information. These transformation steps collectively intention to enhance the suitability and predictive strength of the dataset for subsequent modeling duties [22].

2) Data exploration and visualization: Explore the distribution of each feature and the relationship between feature variable and the targeted variable. Visualize the information using plots along with histograms, box plots, scatter plots, and so forth. to benefit insights into the records and become aware of patterns.

C. Automatic Medical Insurance Claims Service System through Blockchain Technology

The remedy offered by this study was to implement an autonomous insurance claim servicing system using the blockchain. The surroundings are used to exchange data between healthcare providers, insurance providers, and individuals. The environment's functions include the blockchain computing center (BCC), the appropriate government agencies (CA), the healthcare facility (MI), the insurance provider (IC), the finance company (BK), the patient (PT), & the center for arbitration (AI). Medicinal institutions can create a healthcare alliance chain under the supervision of the medicinal board CA1. Assurance and banks can join a financial alliances chain that is overseen by the banking regulator, CA2. Participants of the exact same alliance are able to exchange entire material.

Step 1: All CA, MI, IC, BK, and PT must verify with BCC in order to get both public and private ECDSA signing keys, as well as pubic and secret PKI key pairs. BCC also saves every patient's healthcare blockchain information. Furthermore, various kinds of CA will establish partnerships among the people they represent, and the partnership's membership' data will be exchanged.

Step 2: The patient, PT, buys health assurance through the health care firm IC. The IC will first check the PT's identification and then execute an insurance agreement with them. The PT must furnish the IC with the details of its BK account and paperwork will then sent to the BCC via the CA. Whenever the PT returns hospital in MI not too distant upcoming, and the examination result satisfies the alleged contented indicated in the health insurance agreement, the IC will move forward by the healthcare claims.

Step 3: Whenever a patient PT visits a healthcare facility MI and notifies the MI that they he or she has acquired health coverage, the MI will first authenticate the PT's identification, review the PT's electronic health record EMR, and then issue an authorization, with the information being communicated to the Scc via CA.

Step 4: The medical facility MI then notifies the assurance firm IC to process claims from insurance companies, and the IC acquires the PT medically-related diagnostic material given by MI.

Step 5: The insurance provider IC instructs the financial institution BK to pay the patient PT, and the record is transferred to the BCC via the CA.

Step 6: A claimed disagreement, the patient PT may file a complaint with the arbitration agency AI. AI will receive the communication contents from both side besides arrive at logical decisions.

D. Smart Contract Initialization

Blockchain technology was used in the suggested design. Certain essential data is kept and confirmed on the blockchain throughout the verification and permission procedure. The smart contract is a code that defines the block chain's most essential data. Everyone created essential data, which is stored on the blockchain in the suggested smart contract. Every smart contract has the following fundamental fields: id (identity), information about the transaction, certification, and timestamp. The smart contracts include the individual's bank account, whereas the smart contract includes the insurance company's bank account. The field's insurance contract is included with the smart contract. A smart contract supports digitized medical records. Finally, the purchase ID is shown in the smart contract. The blockchain technology center also provides both private and public key sets for every position during the authentication step.

1) Registration phase: The network's role X may include the Competent of authorities (CA), the healthcare facility (MI), the insurance provider (IC), the financial company (BK), and the individual in need (PT), who sign up blockchain center (BCC) also receive an individual's public/private key combination and a digital proof to verify their identities via a safe channel. Fig. 2 depicts the diagram for the enrollment process. Registration phase flow is explained in Fig. 2.

2) Authentication process: During the start of the interaction, system roles A and B must authenticate their respective identities using the ECDSA technique. System roles A and B may comprise appropriate government agencies (CA), healthcare providers (MI), insurance firms (IC), banking (BK), and individuals (PT).

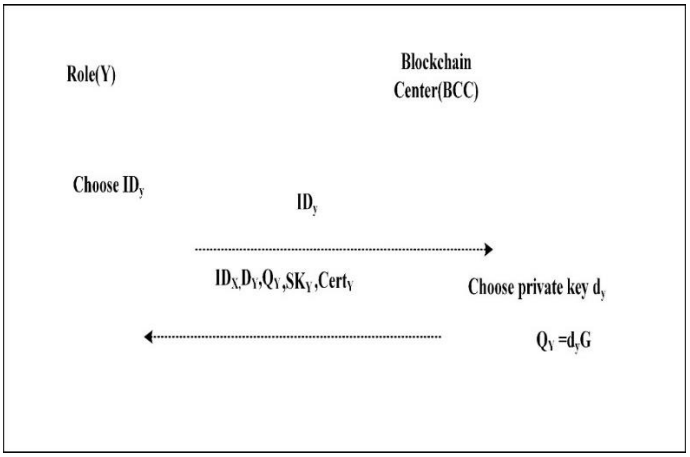

Fig. 2. Registration phase.

3) Communications procedure: The recommended solution makes use of the hyper ledger's block chain design, which increases the CA's role, allows for more versatility in accessing monitoring, and reduces the stress on BCC. After authenticating interactions across all roles, the details will then be provided to the various CAs, which will then send the blockchain information BCC. MI and IC both operate to own CA, which might allow documents flow throughout CA membership as well as cross-CA management of entry while retaining safety & efficacy. The accessible party (AP) might be a hospital (MI), an insurance company (IC), a financial institution (BK), or a client. A schematic representation of the CA communications method is proposed [15]. Blockchain-Based Medical Insurance System is shown in Fig. 3.

E. Event-Driven Architecture Insurance Claim Process

The Claim entity depicts an insurance claim which consumers can file or that current insurance companies may employ to assess how to pay out. The claim form includes a Loss Amount and a connection to the Insurance Policy organization. After an Event has been established, the processing Event method the request may be utilized to determine if it needs to be payed out. The Root Cause Mapping object, typically is a Boolean, is used within the process Event () method to determine if a payout is necessary for a fundamental issue and insurance policy combination. The Root Cause Mapping is defined in the privileges portion of the agreement.

1) Identity NFT: The identification NFT will serve as verification of identification for claim management. Whenever the program is first set up, the NFT is going to be coined (generated) for claims managers using the mailing addresses supplied in the initial setup script. Anyone is unable to establish an event if they have an Identification NFT.

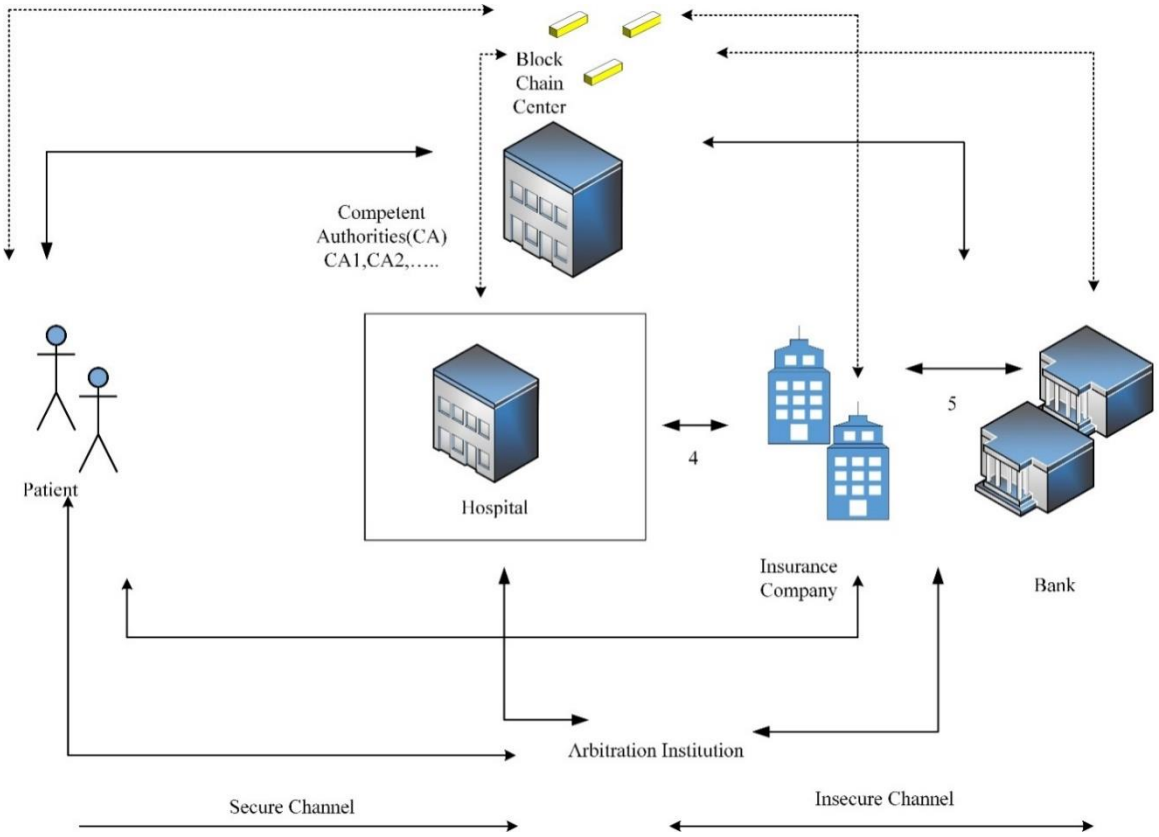

Fig. 3. Blockchain-based medical insurance system.

When the entitlements director organizes an event, their uniqueness is verified by the identification NFT contract. If it is valid, an event is produced in the Event Contract, which is then passed on to the claim contract for processing. All pending claims for the covered protocols are going to be adjusted using Root Cause Mapping. If the amalgamation of the root problem and regulation proves accurate, a payment should be provided. In the initial release of the program, just the claim's current state will be changed.

Any individual may file a right depending on their assurance coverage. The Entitlements agreement will compare information on the insurance against current claims. If previous demands exact similar policy and root cause were previously approved or postponed then the latest one will be assigned the identical status. In subsequent versions of the app, any blockchain-based insurance company may utilize this capability to poll whether or not a entitlement deserves to be paid out, allowing them to streamline this process.

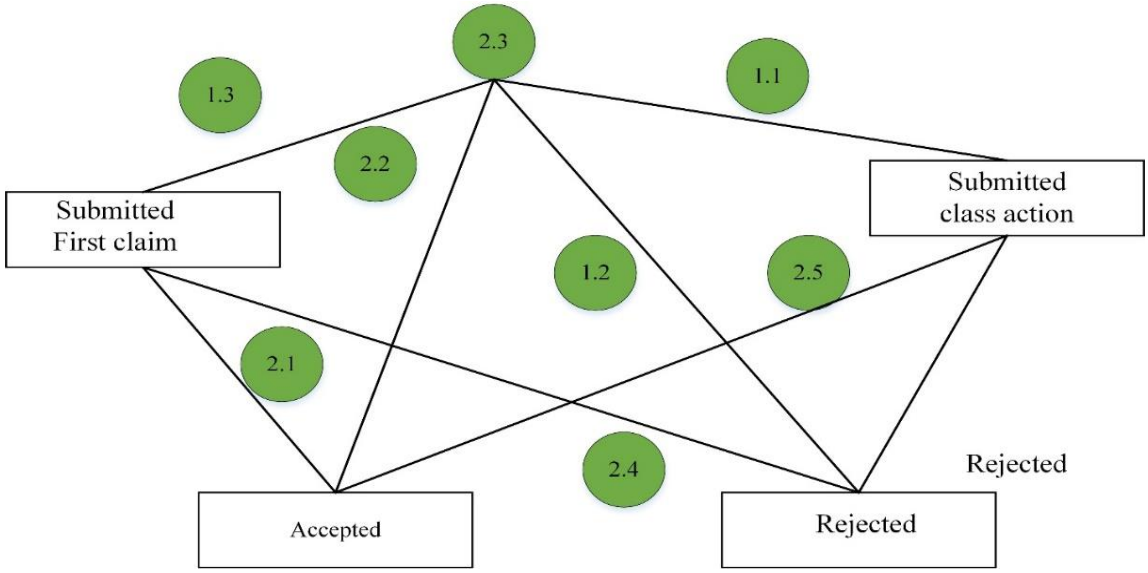

Fig. 4. State diagram of claims object.

The claim is the primary entity in the realm structure. The entitlement made in the framework can be in one of four "states" depending on the user's selections. Phase transitions 1.1 to 1.4 are for newly formed claims. Whenever the request is the initial one for a benefit, it will be marked given the status "submitted - first claim" (1.1). If more than one claim is currently lodged for the asset, it will be marked as "accepted - class action" (1.4). If a entitlements administrator has already accepted or rejected a claim having an identifiable cause, then subsequent claims will be immediately approved (1.2) or denied (1.3). Steps 2.1–2.4 apply to claims that were previously filed at the time the claims administrator reports an event. In that point, all filed claims are going to be immediately approved (2.1 and 2.3) or denied (2.2 or 2.4) [23]. Fig. 4 shows state diagram of claims object.

V. Result and Discussions

The integration of blockchain technology and smart contracts presents a transformative solution for the insurance industry, revolutionizing claims processing and payouts. By automating the entire process based on predefined events, such as natural disasters or medical emergencies, the proposed system eliminates manual claims submission, enhances efficiency, and ensures transparency and security. With payouts executed automatically upon event verification, bureaucratic hurdles are bypassed, leading to expedited processing times and reduced fraud risks. This innovative approach not only streamlines operations but also fosters trust and reliability, ultimately delivering significant benefits to insurers and policyholders alike in a future characterized by expedited, transparent, and trustworthy claims processing.

Event-driven architecture for insurance claim processes is given in Fig. 5 driving events such as policy updates, patient updates, and claim submissions trigger a series of actions. A graph depicting the number of driving events per second illustrates the system's real-time processing capabilities, enabling insurers to handle fluctuating workloads efficiently. This visualization aids in understanding system performance and scalability, ensuring timely and accurate processing of insurance claims.

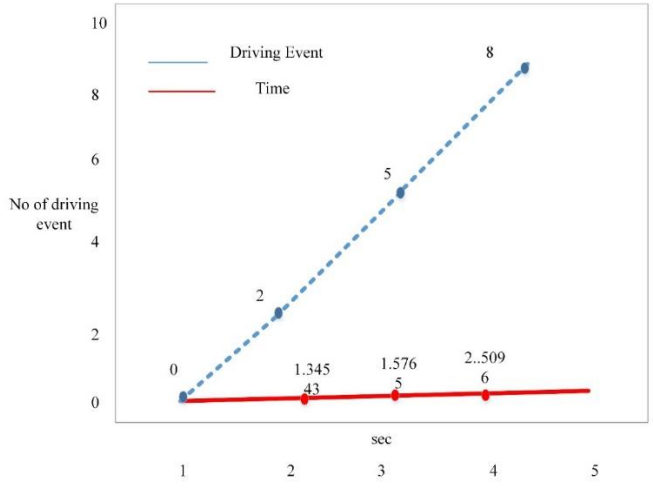

Fig. 5. Event-driven architecture for insurance claim processes.

Fig. 6 depicts a partial dependence plot illustrating how an old claim affects insurance outcomes. It visualizes the relationship between the age of a claim and its impact on insurance variables, such as claim probability or payout amount. This graph, insurers can understand how the age of a claim influences risk assessment and decision-making in insurance processes. It helps identify patterns and trends, enabling more informed underwriting and claims management strategies. This graphical representation facilitates data-driven insights for optimizing insurance operations and managing risk effectively.

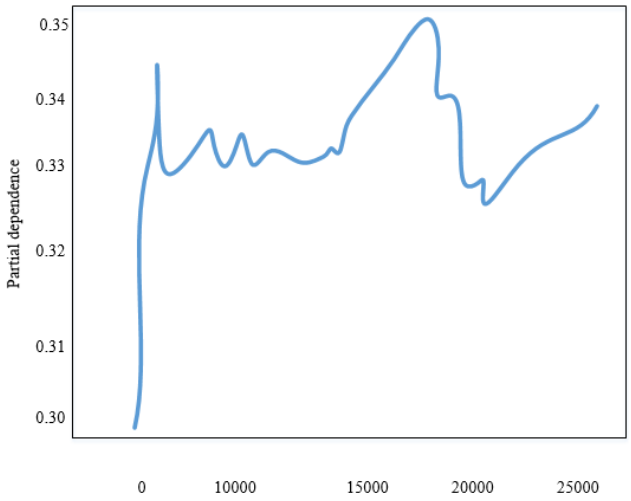

Fig. 6. Automatic insurance claim prediction.

Fig. 7 shows the amounts of paid and denied claims for different categories of old claims the amount of paid claims is higher than denied ones, with the 3rd claim having the highest amount of paid claims. The bar chart helps to visualize the distribution and comparison of paid and denied claims for different categories of old claims.

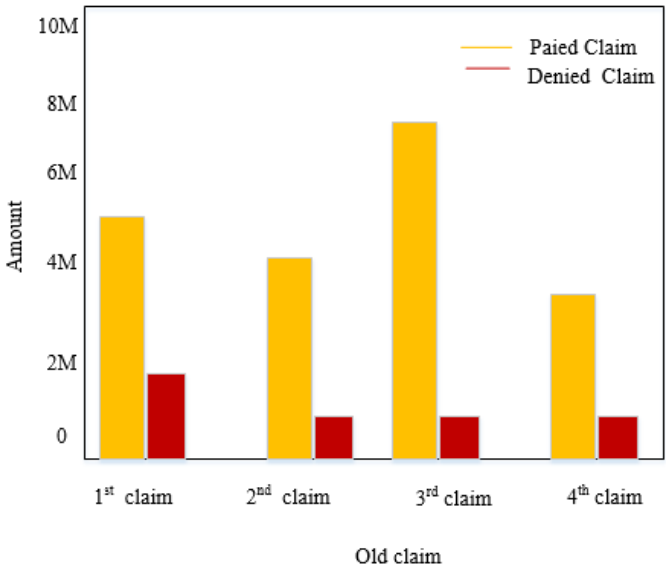

Fig. 7. The amounts of paid and denied claims.

Table I presents performance metrics for different methods the proposed method achieves high accuracy (94.44%) and outperforms others in precision (98.1%), recall (98.98%), and F1-score (98.54%) in Fig. 8. This indicates its effectiveness in correctly identifying positive instances while minimizing false positives and negatives, demonstrating its potential superiority in the classification task.

TABLE I. PERFORMANCE METRICS

Methods	Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)
RNN	90.54	90.4	92.00	92.44
Auto encoder	92.77	91.88	91.76	91.56
VAE	95.5	93.57	94.01	94.45
Proposed method	97.6	98.1	98.98	98.54

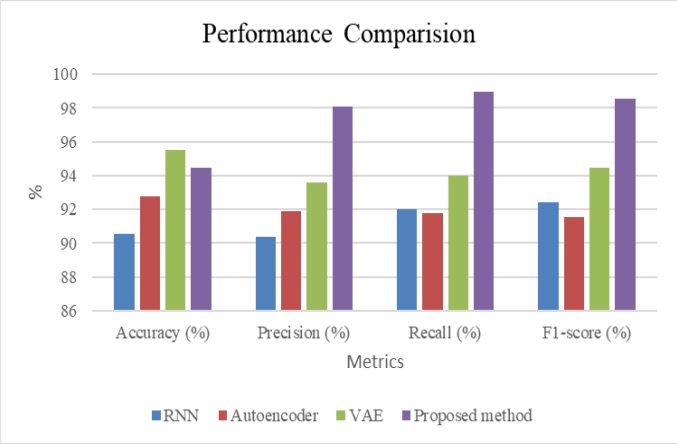

Fig. 8. Performance comparison.

Table II shows that he proposed method achieves an accuracy of 97.6% using the "Health Insurance Dataset - EDA". It also maintains high accuracy rates with other datasets: MedClaimsData (96.7%), HealthCoverStats (95.8%), and HealthinsureDB (93.7%).

TABLE II. DATASET COMPARISON

Dataset	Proposed Method Accuracy
Health Insurance Dataset-EDA	97.6%
MedClaimsData	96.7%
HealthCoverStats	95.8%
Healthinsure DB	93.7%

A. Discussions

The proposed integration of blockchain technology and smart contracts in insurance claims processing offers several significant advantages. Firstly, it addresses the limitations of the existing method by adopting event-based smart contracts, eliminating the need for manual claims submission. This automation enables automatic triggers based on predefined events such as natural disasters or medical emergencies, accelerating the claims initiation process and ensuring accuracy and transparency. By doing so, it overcomes the existing challenges related to inefficiency and complexity, which require physical visits to facilities for certification before submitting paperwork to insurance firms, leading to delays in compensation and posing challenges in data verification and risk management., By encoding specific conditions and triggers within smart contracts, the entire claims process becomes transparent, secure, and immutable, thereby minimizing the potential for fraud and dispute. Thirdly, the automatic execution of payouts upon verification of triggering events bypasses traditional bureaucratic procedures, leading to significantly reduced processing times [15]. Through the streamlined system outlined, insurers and policyholders stand to benefit from increased efficiency, transparency, and trustworthiness in claims processing, ultimately enhancing the overall insurance experience for all stakeholders. These advantages address the limitations of the existing method, such as challenges related to infrastructure development, legal obstacles, and data availability, thus making the proposed system a more robust and effective solution.

VI. CONCLUSION AND FUTURE WORKS

The integration of blockchain technology and smart contracts has revolutionized the insurance industry by enhancing efficiency, transparency, and reliability. This research proposes a simplified system that automates the entire claims process from submission to reimbursement, eliminating the need for human claim filing. The system triggers policyholders' claims by predetermined occurrences, such as medical emergencies or natural disasters, allowing for prompt and precise claim initiation. Smart contracts, programme with precise triggers and conditions, guarantees the transaction immutability, security, and transparency. Reimbursements are carried out automatically after the triggering event has been verified, reducing processing times and reducing fraud and disagreement. This innovative approach to insurance claims processing has shown significant reductions in processing time, minimized fraud potential, and enhanced transparency. The Python-implemented system achieved 97.6% accuracy, demonstrating its efficacy and reliability. This study contributes to addressing the limitations of existing insurance claim procedures by providing a streamlined, automated, and secure solution. By integrating blockchain technology and smart contracts, the insurance industry can overcome challenges of inefficiency, complexity, and lack of transparency in the current claims processing system. The research questions regarding the feasibility and effectiveness of event-based smart contracts in automating insurance claims processing have been successfully addressed, providing valuable insights for future implementations in the insurance sector.

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