Smart Contracts for Automated Insurance Claim Settlement

Ejielo Ogbuefi[1*], Theophilus Onyekachukwu Oshoba[2] Stephen Ehilenomen Aifuwa[3], Jennifer Olatunde-Thorpe[4], David Akokodaripon[5]
[1]Company: Soodle Technology LLC, Baltimore, MD, USA
[2]Independent Researcher, UK
[3] Independent Researcher, Nigeria
[4]NowNow Digital System, Lagos, Nigeria
[5]Kyndryl (IBM SPINOFF), Brazil
*Corresponding Author: Ejielo Ogbuefi
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Abstract
The integration of smart contracts into insurance operations has the potential to transform claim settlement processes by enabling automation, transparency, and efficiency. Smart contracts—self-executing agreements with terms directly encoded into blockchain-based code—can streamline claim verification, adjudication, and payment without the need for extensive manual intervention. This examines the design, implementation, and performance implications of smart contract-enabled insurance claim settlement systems, focusing on their capacity to reduce administrative overhead, minimize fraudulent claims, and accelerate payout timelines. Drawing from both industry case studies and experimental prototypes, this evaluates how predefined triggers, such as verified event data from Internet of Things (IoT) devices or third-party oracles, can automatically initiate and execute claim settlements. Key performance indicators, including claim processing time, operational cost savings, and dispute frequency, are analyzed to assess the effectiveness of smart contract deployment relative to conventional insurance claim workflows.
Findings suggest that automation through smart contracts can significantly reduce claim settlement times from weeks to hours, enhance accuracy through immutable data records, and improve customer satisfaction via faster payouts and reduced disputes. However, challenges remain in ensuring regulatory compliance, managing interoperability between blockchain platforms, and addressing limitations in data verification, particularly for complex or subjective claims. Security vulnerabilities, coding errors, and the rigidity of immutable smart contracts present additional operational risks. This concludes that while smart contracts represent a viable technological pathway to more efficient insurance operations, successful adoption requires a robust governance framework, standardized data protocols, and hybrid models combining automation with human oversight for exceptional cases. These insights contribute to the growing body of literature on blockchain applications in financial services, offering practical guidance for insurers, regulators, and technology providers pursuing digitally enabled, trust-enhanced insurance ecosystems.

Keywords: *Smart contracts, Automated insurance, Settlement*

1 Introduction

Traditional insurance claim settlement processes have long been plagued by inefficiencies that

impact both policyholders and insurers. The current model typically relies on manual verification procedures involving extensive paperwork, human review, and multiple approval layers (Dogho, 2021; Dogho, 2023). This manual nature leads to prolonged processing times, often stretching from days to several weeks, creating frustration for customers awaiting financial relief. Furthermore, the complexity of claim documentation provides opportunities for fraud, as falsified or exaggerated claims can bypass limited verification controls (Annan, 2021; Adebowale and Etukudoh, 2022). Industry reports suggest that insurance fraud accounts for billions of dollars in annual losses, driving up premiums and operational expenses.

In recent years, the emergence of blockchain technology and smart contracts has introduced a potential paradigm shift in how financial and legal processes are executed (Adebowale and Etukudoh, 2022; Akpe*et al*., 2022). Smart contracts—self-executing agreements with terms directly written into code—offer the ability to automate transactions once predefined conditions are met. On a blockchain, these contracts operate in a transparent, immutable, and decentralized environment, significantly reducing the need for intermediaries (UZOKA *et al*., 2021; Adebowale and Nwokediegwu, 2022). When applied to insurance claim settlement, smart contracts can integrate with trusted data sources such as IoT devices, weather APIs, or hospital systems, triggering claim approval and payment automatically upon verification of event conditions (Abdulsalam*et al*., 2021; Ogeawuchi*et al*., 2021).

Despite technological advances in digital insurance platforms, bottlenecks remain a persistent challenge in claim settlement. Delays occur due to manual inspection, cross-verification with external agencies, and back-and-forth communication between the insurer and claimant (Fasasi *et al*., 2023; Crawford *et al*., 2023). In high-volume claim events—such as natural disasters—these bottlenecks intensify, leading to widespread dissatisfaction among policyholders and reputational damage to insurers. Additionally, administrative overhead from repetitive manual tasks increases operational costs, reducing profitability (Fasasi *et al*., 2023; Nwokediegwu and Adebowale, 2023). Fraudulent claims compound the issue, as human-based detection methods can be slow, error-prone, and resource-intensive. Without a streamlined, automated, and secure claims process, the insurance industry struggles to meet the growing demand for faster, more reliable settlements (Komperla, 2021; Machireddy, 2022).

The potential for automation in claims processing extends beyond cost savings—it represents a critical step toward improving trust and transparency in the insurance sector. By embedding business rules into smart contracts, insurers can ensure consistent execution without subjective bias or delays (Ghodoosi, 2021; Shetty *et al*., 2022). Automated verification through blockchain-integrated oracles can substantially reduce the likelihood of fraudulent claims while minimizing administrative intervention. The combination of speed, security, and auditability has implications for both customer satisfaction and industry competitiveness. For global insurers operating across jurisdictions, smart contracts also offer a standardized and interoperable framework for managing claims, which could streamline cross-border settlements and regulatory compliance (Ajuwon*et al*., 2021; Joginipalli, 2022).

This posits that smart contracts have the potential to revolutionize insurance claim settlement by automating the core processes of verification, payment, and record-keeping. Through the integration of blockchain's immutable ledger and automated execution logic, these systems can address long-standing inefficiencies, reduce operational costs, and significantly mitigate fraud risks (Zhang *et al*., 2021; Capetillo *et al*., 2022). While adoption will depend on overcoming regulatory, technological, and interoperability challenges, the strategic implementation of smart contracts could redefine efficiency standards in the insurance industry. By leveraging real-time

data inputs, robust security protocols, and transparent audit trails, insurers can deliver faster, fairer, and more trustworthy claim settlements, transforming both the customer experience and operational landscape (Nwangene*et al*., 2021; Omopariola and Aboaba, 2021).

2.0 Methodology

The PRISMA methodology was employed to conduct a systematic review of literature on smart contracts for automated insurance claim settlement. Searches were carried out in Scopus, Web of Science, IEEE Xplore, ScienceDirect, and Google Scholar using combinations of keywords and Boolean operators such as "smart contracts," "blockchain," "automated insurance claims," "insurance settlement," "parametric insurance," and "distributed ledger technology." The search covered publications from 2015 to 2025, including peer-reviewed journal articles, conference proceedings, and authoritative industry reports. The initial search retrieved 1,142 records, of which 287 duplicates were removed, leaving 855 unique entries. Screening of titles and abstracts was conducted using predefined inclusion criteria, which required studies to address the application of smart contracts in automating insurance claims, provide details on implementation or operational mechanisms, and present empirical, technical, or conceptual analysis. Studies that focused on blockchain in general insurance administration without explicit claim settlement automation were excluded, resulting in 618 records being removed and 237 articles proceeding to full-text review.

Full-text eligibility assessment applied stricter standards, excluding works without methodological transparency, empirical validation, or a clear link between smart contract functionalities and claim settlement outcomes. This process resulted in 79 studies meeting all inclusion criteria. Data extraction captured blockchain framework specifications, coding and execution of smart contracts, integration with external data sources such as IoT sensors and third-party APIs, security and privacy mechanisms, processing time reductions, cost efficiencies, and fraud prevention capabilities (Okesiji et al., 2023).

The synthesis revealed that smart contracts enable automated, trustless, and transparent claim processing by executing settlements based on pre-programmed conditions and verified data inputs. Common applications included parametric insurance models, where payouts are triggered by predefined external events, and fraud reduction through immutable and auditable transaction records. Despite these benefits, recurring challenges were identified, including interoperability with legacy systems, legal and regulatory uncertainties regarding enforceability, data protection concerns, and the need for standardized protocols across jurisdictions. The findings present a consolidated evidence base for understanding the operational potential, benefits, and constraints of smart contract-based insurance claim automation.

2.1 Fundamentals of Smart Contracts in Insurance

Smart contracts are code-based, self-executing agreements where the terms and conditions of an arrangement are embedded directly into computer code. They operate on blockchain or other distributed ledger technologies (DLTs), ensuring that execution occurs automatically once predefined conditions are met, without the need for manual intervention or centralized oversight (Sunyaev, 2020; Antal *et al*., 2021). In the context of insurance, this means that claim verification, approval, and payment can proceed seamlessly once relevant triggers—such as proof of loss or occurrence of a specific event—are validated.

A defining characteristic of smart contracts is their immutability. Once deployed on a blockchain, the code cannot be altered without consensus among network participants, which protects the

integrity of the agreement and prevents post-deployment tampering. This immutability is paired with transparency; all transactions executed through the contract are visible on the distributed ledger to authorized participants, creating an auditable history of claims and settlements. The combination of automation, immutability, and transparency positions smart contracts as a transformative tool for addressing inefficiencies and fraud in insurance claim management (Ajuwon*et al*., 2021; Nwangene*et al*., 2021).

Smart contracts in insurance operate through three core components; A triggering event is a verifiable occurrence that activates the execution of the smart contract. In insurance applications, triggering events could include sensor data from IoT devices (e.g., vehicle telematics indicating a collision), meteorological reports confirming extreme weather, or hospital records validating a medical incident. The use of trusted oracles—third-party services that feed off-chain data into the blockchain—ensures that triggers are accurate and tamper-resistant.

At the heart of a smart contract lies the business logic, which encodes the insurance policy's terms and conditions. This logic specifies eligibility criteria, coverage limits, deductibles, and procedures for claim validation. For example, in a travel insurance policy, the contract might state that if an airline delay exceeds a certain number of hours, the insured passenger automatically receives a payout. By encoding these rules, smart contracts eliminate the ambiguity inherent in manual interpretations of policy documents.

Once the triggering conditions are met and verified, the smart contract's automated execution mechanism initiates the corresponding actions—most commonly the release of payment to the policyholder's account. This mechanism also handles associated tasks such as updating records, notifying stakeholders, and archiving the transaction on the distributed ledger. Because execution is autonomous, it removes delays caused by human approval workflows and reduces administrative overhead (Devan *et al*., 2021; Adepoju *et al*., 2022).

For smart contracts to deliver maximum value, they must integrate seamlessly with the broader insurance ecosystem, encompassing data sources, operational systems, and external service providers.

IoT-enabled devices, such as vehicle telematics, home security sensors, and wearable health trackers, provide real-time, objective data that can serve as reliable triggers for smart contracts. In property insurance, for instance, a connected water leakage detector can instantly alert the system and initiate an automated claim assessment process.Smart contracts require secure access to customer data—policy information, claim history, and identity records—to verify eligibility and ensure compliance with underwriting guidelines. Integration with customer relationship management (CRM) systems and secure identity management platforms allows the contract to authenticate claimants and match events to specific policyholders.Trusted third-party data sources play a critical role in verifying claims. Examples include national weather services for natural disaster insurance, healthcare providers for medical claims, and government databases for official records. These entities feed structured data into the blockchain via oracles, enabling the smart contract to execute decisions without manual cross-checking (Oladimeji et al., 2023).

The integration of smart contracts into the insurance sector offers a multi-layered advantage: real-time responsiveness, reduced administrative friction, and enhanced fraud prevention through immutable, transparent records. However, successful deployment hinges on robust interoperability standards, strong cybersecurity measures, and regulatory acceptance. As insurance companies adapt to the digital economy, smart contracts represent not only a technological innovation but also a strategic enabler of faster, more reliable, and customer-centric claim settlements (Ustinova *et al*., 2021; Eckert *et al*., 2022).

2.2 Architecture of Automated Claim Settlement Systems

Automated claim settlement systems leveraging smart contracts represent a significant advancement in insurance technology, enabling faster, more transparent, and fraud-resistant processes. Their architecture integrates multiple technical components—data sources and oracles, smart contract workflows, blockchain infrastructure, and security protocols—into a seamless framework that minimizes manual intervention while maintaining high accuracy and compliance standards as shown in figure 1(Greenwald, 2020; Ezzat *et al*., 2022).

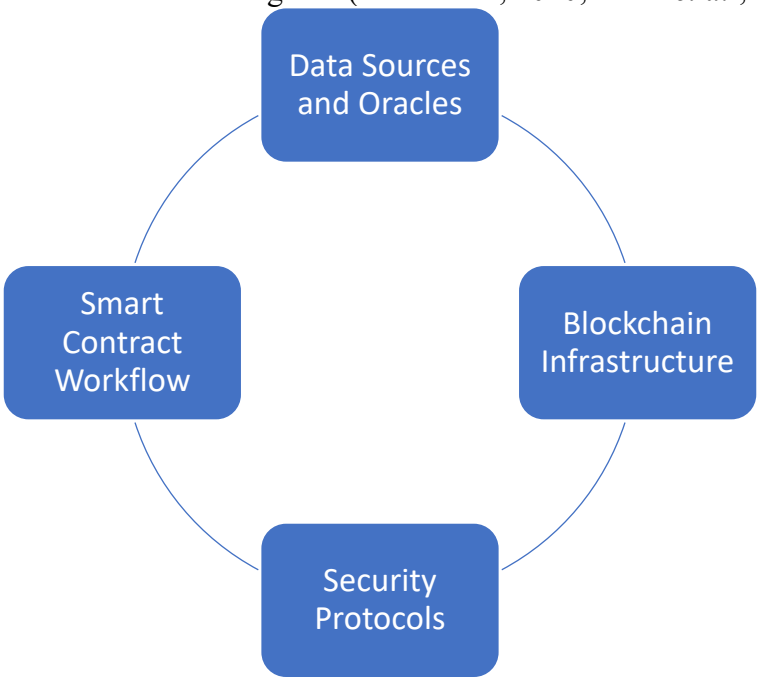

Figure 1: Architecture of Automated Claim Settlement Systems

The efficiency and reliability of an automated claim settlement system depend on the quality and credibility of its input data. IoT sensors embedded in insured assets—such as vehicles, homes, or industrial equipment—can provide real-time event data, including collision impact metrics, environmental conditions, or usage patterns. Weather APIs offer verified meteorological data critical for processing claims related to natural disasters or extreme weather events. Police reports serve as authoritative evidence for accident verification in automotive or property damage cases, while electronic health records provide medical evidence for health or life insurance claims. Oracles, acting as secure bridges between the blockchain and external data sources, ensure that these inputs are verified and tamper-resistant before triggering any smart contract action. Selecting trustworthy oracles and ensuring redundancy in data feeds is critical to avoid single points of failure and data manipulation (Oladimeji et al., 2023).

The operational logic of claim settlement unfolds through a three-step smart contract process. First, claim initiation occurs when an event triggers a data input—such as an IoT sensor alert or an uploaded official report—automatically recorded on the blockchain. Second, automatic verification is conducted through pre-programmed validation rules that match the incoming data against policy terms, claimant identity, and historical records to detect anomalies or inconsistencies. Third, upon successful verification, the smart contract executes conditional payment release, transferring settlement funds directly to the claimant's account or designated payee. This workflow eliminates bottlenecks caused by manual document reviews, reducing

processing times from weeks to hours while maintaining auditability through immutable transaction logs (Oladimeji et al., 2023).

Choosing the appropriate blockchain infrastructure is a foundational architectural decision. Public blockchains, such as Ethereum, offer high transparency, decentralized trust, and broad interoperability, making them suitable for open insurance ecosystems where multiple stakeholders—insurers, reinsurers, regulators—require independent verification of transactions (Papaioannou *et al*., 2021; Lee and Lim, 2021). However, public chains often face scalability challenges, higher transaction costs, and regulatory uncertainties. Private or permissioned blockchains, like Hyperledger Fabric, provide greater control over participant access, faster transaction speeds, and compliance-friendly governance models. In the insurance context, a hybrid approach can be effective, using a private blockchain for operational efficiency while anchoring key settlement proofs on a public blockchain for audit transparency (Brophy, 2020; Belchior *et al*., 2021).

Security is paramount in automated claim settlement systems, as vulnerabilities in code or data channels can lead to fraudulent payouts or operational disruptions. Encryption protocols ensure that sensitive claimant data—such as medical records or personally identifiable information—remains secure in transit and at rest. Multi-signature authorizations add a layer of fraud prevention by requiring multiple parties (e.g., insurer, reinsurer, regulatory authority) to digitally approve high-value or high-risk payouts before execution. Fraud detection algorithms, integrated into the verification stage, analyze historical claims, behavioral patterns, and anomaly indicators to identify suspicious activity before funds are released. Additionally, robust code audits and formal verification of smart contract logic are necessary to prevent exploits arising from programming errors or malicious inputs, given the immutable nature of blockchain transactions.

The architecture of automated claim settlement systems reflects a convergence of data integration, algorithmic execution, secure infrastructure, and governance safeguards. By linking verified external data sources through oracles, structuring deterministic workflows in smart contracts, deploying blockchain infrastructure tailored to insurance requirements, and embedding rigorous security protocols, insurers can create systems that are faster, more cost-effective, and more resistant to fraud. However, the optimal design requires balancing transparency with privacy, automation with oversight, and efficiency with compliance, ensuring that technological advancements translate into trustworthy, customer-centric insurance services (Olayinka, 2021; Pamisetty*et al*., 2022).

2.3 Use Cases and Applications

Smart contracts, deployed on blockchain platforms, are transforming insurance claim processes by automating verification, approval, and settlement workflows. These contracts are self-executing code that enforces contractual obligations when predefined conditions are met, eliminating manual intervention and reducing processing time, errors, and fraud risk. The application of smart contracts spans multiple insurance sectors, including auto, health, travel, and property insurance, each leveraging data from connected devices, external APIs, and enterprise systems to trigger claims automatically (Shetty *et al*., 2022; Trivedi and Malik, 2022).

In auto insurance, smart contracts are increasingly integrated with connected vehicle technologies and telematics systems. Vehicles equipped with sensors and GPS devices continuously capture driving data, including speed, location, collision impact, and accident severity. When a defined threshold—such as a collision or sudden deceleration indicative of an

accident—is detected, the smart contract is automatically triggered. This initiates the claims process without requiring the policyholder to submit extensive documentation manually. Automated accident verification reduces administrative overhead, accelerates claims settlement, and minimizes the potential for fraudulent claims. Furthermore, real-time data from vehicles allows insurers to implement dynamic pricing models that reflect actual driving behavior, enhancing risk-based premium adjustments (Barry and Charpentier, 2020; Holland and John, 2021; Che *et al*., 2022).

In health insurance, smart contracts are deployed to streamline claims by integrating directly with hospital billing and electronic health record (EHR) systems. When a covered medical procedure is completed, the hospital system automatically communicates treatment data to the insurer through secure APIs. The smart contract verifies patient eligibility, policy coverage, and treatment codes before authorizing payment. This automation significantly reduces the time lag between treatment and reimbursement, improves accuracy in claims adjudication, and decreases the administrative burden on both providers and insurers. Additionally, integrating smart contracts with health data ensures consistent auditability and compliance with regulatory standards, promoting transparency and trust among stakeholders.

Travel insurance provides another compelling application. Smart contracts utilize flight information from airlines and global distribution systems (GDS) to monitor delays, cancellations, or diversions. If a flight delay exceeds a predefined duration or a cancellation occurs, the smart contract automatically initiates a payout to the insured passenger (Lu *et al*., 2020; Zhou and Wei, 2022). This eliminates the need for travelers to submit claim forms and supporting documents, resulting in near-instant settlements. By automating verification using authoritative flight data, travel insurers can reduce operational costs while enhancing customer satisfaction and loyalty. The real-time nature of this application exemplifies the efficiency and convenience that smart contract-based automation introduces to event-driven insurance products.

In property insurance, the integration of Internet of Things (IoT) devices enables continuous monitoring of insured assets. Sensors can detect environmental anomalies such as smoke, water leakage, temperature fluctuations, or structural vibrations indicative of fire, flooding, or other forms of damage. Once a triggering event is detected, the smart contract executes predefined procedures, including claim verification and payout initiation. For instance, a water sensor detecting flooding in a property can prompt an immediate insurance payout to facilitate repairs, reducing downtime and mitigating further damage. This proactive automation not only accelerates claim settlements but also enhances risk management by providing insurers with real-time insights into asset conditions.

Across all these use cases, the adoption of smart contracts reduces operational inefficiencies, enhances transparency, and minimizes human error. They also provide a tamper-proof audit trail, strengthening regulatory compliance and mitigating fraud risks. Additionally, the integration with external data sources and connected devices creates opportunities for predictive analytics and risk-based pricing models, enabling insurers to better align premiums with actual exposure (Ajayi et al., 2023).

Smart contracts are increasingly redefining the insurance landscape by enabling automated, real-time claim settlement across auto, health, travel, and property insurance sectors. The seamless integration with connected devices, hospital systems, airline databases, and IoT sensors allows claims to be processed faster, more accurately, and with reduced administrative overhead. As these applications mature, the widespread adoption of smart contracts is expected to enhance operational efficiency, improve customer experiences, and strengthen risk management

capabilities, ultimately contributing to a more resilient and transparent insurance ecosystem.

2.4 Benefits of Smart Contract-Driven Settlements

The adoption of smart contracts in insurance claim settlement represents a significant advancement in operational efficiency, risk mitigation, and customer satisfaction as shown in figure 2. By leveraging blockchain technology and self-executing code, insurers can streamline processes that have historically been time-consuming, error-prone, and vulnerable to fraud (Ajuwon*et al*., 2021; Adewale *et al*., 2022). The benefits of smart contract-driven settlements are multifaceted, encompassing speed and efficiency, fraud reduction, cost savings, and enhanced transparency and trust.

One of the most immediate and tangible benefits of smart contracts is the dramatic improvement in processing speed. Traditional claim settlement involves multiple stages, including document submission, manual verification, approvals from underwriters, and final payment processing. These steps often take days or even weeks, especially in cases requiring coordination with third-party agencies or expert assessments. In contrast, smart contracts enable automation of these workflows, executing predefined actions as soon as the conditions encoded in the contract are met. For example, in travel insurance, a flight delay recorded by an airline database can automatically trigger a payout to the policyholder without human intervention. By reducing human bottlenecks and eliminating redundant manual checks, settlement times can shrink from weeks to mere minutes, enhancing customer satisfaction and operational agility.

Fraud represents a persistent challenge in the insurance industry, inflating premiums and eroding trust. Smart contracts address this issue through immutable record-keeping and automated verification. Each transaction and contract execution is permanently recorded on the blockchain, creating a tamper-resistant ledger accessible to authorized parties. Additionally, smart contracts can integrate with trusted data oracles that provide verified, real-time information from external sources such as IoT devices, hospital systems, or government databases. Automatic validation of claims against these reliable data inputs significantly reduces the likelihood of false or exaggerated claims. This dual layer of transparency and automation ensures that only legitimate claims trigger payments, lowering the risk of internal and external fraud.

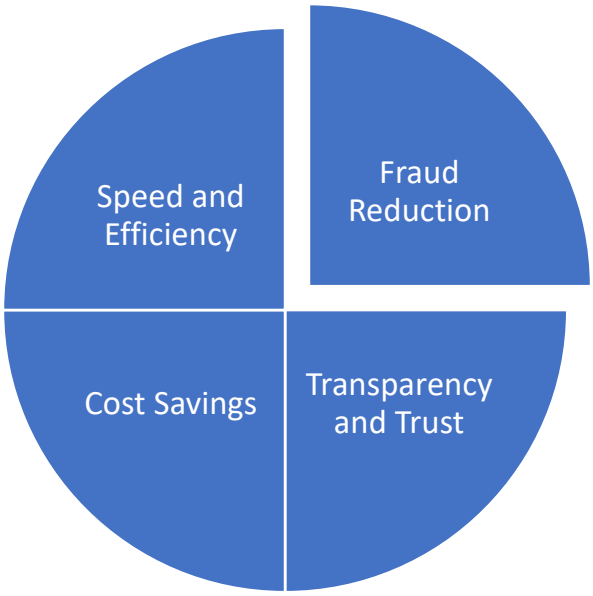

Figure 2: Benefits of Smart Contract-Driven Settlements

The operational cost of processing claims manually is substantial, encompassing salaries for claims adjusters, administrative staff, and overhead related to document management and verification. Smart contracts substantially reduce administrative overhead by automating repetitive and time-intensive tasks. Automated workflows decrease reliance on human resources, minimize errors that can result in costly rework, and streamline coordination across multiple departments. Furthermore, the reduction in fraudulent payouts directly contributes to cost efficiency. By combining these effects, insurers can achieve significant savings, allowing for more competitive premiums and enhanced profitability while reallocating resources to strategic initiatives, such as customer experience improvements or product innovation (Curto *et al*., 2021; Ge, 2022).

Transparency and trust are critical for maintaining strong insurer-policyholder relationships. Smart contract-driven settlements enhance auditability by providing a permanent, immutable record of every claim and payment. Policyholders and regulators can trace the execution of claims in real time, verifying that contracts have been executed according to the agreed terms. This visibility fosters trust between insurers and customers, mitigating skepticism about delays, denials, or arbitrary decisions. Moreover, transparency extends to regulatory compliance, as blockchain records provide verifiable evidence of adherence to legal and policy requirements, simplifying audits and reducing disputes (Ajayi et al., 2023).

Collectively, these benefits illustrate why smart contracts are increasingly viewed as a strategic enabler for the insurance sector. The combination of speed, fraud reduction, cost savings, and transparency positions smart contract-driven settlements as not merely a technological innovation but a transformative approach that enhances efficiency, integrity, and customer satisfaction. As insurers continue to integrate blockchain-based solutions, these advantages will likely redefine industry standards for claim processing, creating a more responsive, trustworthy, and cost-effective ecosystem.

2.5 Challenges and Limitations

Smart contract-based automated claim settlement systems offer significant potential to improve efficiency, transparency, and fraud resistance in insurance operations. However, their adoption is constrained by several critical challenges and limitations, including data reliability, legal uncertainties, scalability constraints, and user trust issues (Byabazaire*et al*., 2020; Rejeb*et al*., 2020). Addressing these challenges is essential to ensure both operational effectiveness and widespread acceptance of automated insurance solutions.

The functionality of automated claim systems relies heavily on accurate and trustworthy external data sources. IoT sensors, weather APIs, police reports, and electronic health records provide inputs that trigger smart contract execution. However, incorrect, incomplete, or manipulated data can compromise the validity of automated claims, potentially resulting in wrongful payouts or claim denials. The use of oracles as intermediaries between external data sources and blockchain networks introduces additional points of vulnerability. A compromised oracle or single-source dependency can propagate errors across the system. Solutions such as multi-source data aggregation, decentralized oracle networks, and cryptographic verification protocols can mitigate these risks, but they introduce additional complexity and costs. Ensuring end-to-end data integrity remains a central technical challenge in implementing reliable automated claim settlements.

Smart contracts operate autonomously, executing predetermined conditions without human intervention. This characteristic raises questions about their legal enforceability across different jurisdictions. Traditional insurance contracts are subject to well-established legal frameworks, which define dispute resolution procedures, liability standards, and regulatory compliance. In contrast, the legal status of smart contracts is still evolving, and courts may interpret their enforceability differently depending on the jurisdiction. Issues such as contract ambiguity, liability in case of coding errors, and regulatory recognition of digital signatures complicate adoption. Regulators are gradually developing frameworks—such as the United Nations Commission on International Trade Law's Model Law on Electronic Transferable Records—but until harmonized standards are established globally, insurers face compliance risks and potential legal uncertainties when deploying automated systems.

The performance of blockchain infrastructure is another limiting factor in large-scale adoption. Public blockchains, while highly transparent and decentralized, often face transaction throughput limitations that can impede real-time claim processing under high volumes. Private or permissioned blockchains offer faster processing speeds but may require additional resources to maintain network integrity and security (Solat*et al*., 2021; Habib *et al*., 2022). Scalability constraints can lead to delayed claim settlements, increased operational costs, or bottlenecks in multi-stakeholder networks. Techniques such as layer-2 solutions, sharding, and hybrid blockchain architectures can partially address these concerns, but trade-offs between speed, decentralization, and security remain a persistent challenge in designing scalable automated claim systems.

Finally, the adoption of smart contract-based insurance depends on customer trust and acceptance. Many clients are unfamiliar with blockchain technology and may feel uncomfortable delegating decision-making to automated systems, particularly in high-stakes scenarios like large insurance claims. Misunderstandings about the immutability of smart contracts, concerns over data privacy, or fear of technical errors can deter participation. Moreover, overreliance on automation may reduce financial literacy and engagement, potentially limiting users' ability to detect anomalies or exercise discretion when needed. Effective adoption requires comprehensive

customer education, transparent communication of system operations, and hybrid models that allow human oversight for exceptional or complex claims(Ogedengbe et al., 2023).

Despite the transformative potential of automated claim settlement systems, challenges related to data reliability, legal enforceability, scalability, and user trust remain significant obstacles. Ensuring secure, verified data inputs, harmonizing regulatory frameworks, designing scalable blockchain architectures, and fostering customer confidence are all critical to successful implementation. Addressing these limitations is essential not only for operational efficiency but also for creating a reliable, legally compliant, and widely accepted automated insurance ecosystem that balances the benefits of technological innovation with the safeguards necessary for trust and accountability.

2.6 Future Directions

The adoption of smart contracts in insurance claim processing has already demonstrated the potential to streamline workflows, reduce administrative overhead, and improve transparency. However, the evolution of this technology presents multiple avenues for further enhancement, particularly when integrated with advanced analytics, cross-border capabilities, standardization efforts, and hybrid operational models (Chang *et al*., 2020; Rizopoulos *et al*., 2022). These future directions are essential to addressing current limitations and expanding the applicability of automated claims across diverse insurance sectors as shown in figure 3.

One of the most promising avenues is the integration of artificial intelligence (AI) for fraud detection. While smart contracts automate claim verification and settlement based on predefined conditions, they currently rely heavily on accurate and trustworthy input data. AI-powered predictive models can complement these contracts by analyzing historical claims data, behavioral patterns, and anomaly signals to flag potentially fraudulent claims before execution. For instance, machine learning algorithms can detect inconsistencies in accident reports, unusual billing patterns in health claims, or repeated claims from the same policyholder. When integrated with smart contracts, AI can serve as an additional validation layer, preventing erroneous payouts while maintaining the speed and efficiency of automated settlement. This convergence of AI and blockchain-driven automation enhances both operational efficiency and risk management, addressing a major challenge in the insurance industry.

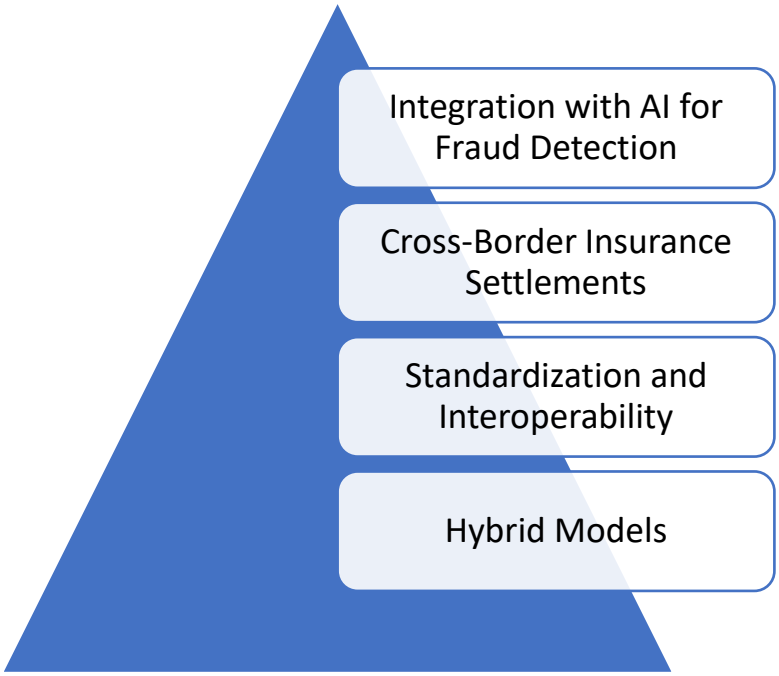

Figure 3: Future Directions

Cross-border insurance settlements represent another significant future direction. Many insurance products, particularly travel and health coverage, require international coverage and multi-currency payments. Blockchain-based smart contracts can facilitate global claim settlements by providing a secure, decentralized ledger accessible to insurers, reinsurers, and regulatory authorities across jurisdictions. By integrating digital identity verification, multi-currency payment systems, and automated compliance checks, smart contracts can execute payouts to policyholders anywhere in the world without delays or intermediaries. This approach not only increases convenience for consumers but also reduces settlement costs and minimizes exposure to foreign exchange and compliance risks. The standardization of blockchain protocols and regulatory frameworks will be critical to enabling these cross-border capabilities(Ogedengbe et al., 2023).

Standardization and interoperability are key enablers for scaling smart contract adoption across the insurance industry. Currently, variations in smart contract design, coding languages, and blockchain platforms create challenges in integration, particularly for insurers working with multiple technology vendors or partners. Developing industry-wide protocols for smart contract architecture, data formats, and security standards can facilitate interoperability, ensuring that contracts executed on one platform are compatible with others. Standardized frameworks will also support regulatory compliance, auditing, and reporting requirements, making it easier for insurers to deploy automated claims solutions at scale while maintaining consistency and reliability (ODETUNDE*et al*., 2021; Machireddy, 2022).

Another important future direction involves hybrid models that combine human oversight with automated execution for complex claims. While smart contracts are highly effective for parametric, event-driven insurance where conditions are clear and verifiable, certain claims—such as those involving partial damages, multi-party disputes, or ambiguous documentation—require human judgment. Hybrid models can retain automation for routine verification and settlement while routing complex or high-value cases to human adjudicators. This approach

preserves the efficiency and transparency of automation while ensuring that nuanced decisions incorporate expertise, ethical considerations, and contextual knowledge that algorithms alone may not capture. Such models are particularly relevant in property, liability, and corporate insurance, where claims can involve multiple stakeholders, variable coverage terms, and significant financial implications (Ogedengbe et al., 2023).

The integration of AI, expansion to cross-border settlements, development of standardized protocols, and adoption of hybrid models collectively signal a maturation of smart contract technology within the insurance sector. These future directions will enhance operational resilience, improve fraud mitigation, broaden accessibility, and maintain ethical and regulatory compliance. As insurers continue to innovate, the combination of automation and intelligent oversight promises a more responsive, transparent, and secure claims ecosystem, ultimately benefiting both policyholders and the broader financial industry (Huneberg*et al*., 2020; Lior, 2021; Georgosouli and Okonjo, 2022).

Conclusion

The integration of smart contracts into insurance claim settlement presents a transformative opportunity for the industry, addressing long-standing inefficiencies and operational challenges. This highlights that smart contracts can significantly reduce settlement times by automating the verification, approval, and payment processes, transforming workflows that traditionally took weeks into transactions completed within minutes. The automation inherent in smart contracts also contributes to cost savings, as administrative overhead and manual intervention are minimized. Furthermore, the immutable and transparent nature of blockchain records enhances trust among policyholders, regulators, and insurers by providing an auditable and tamper-resistant history of claims and payments. These combined benefits demonstrate the potential for smart contracts to elevate both operational efficiency and customer satisfaction.

From an industry perspective, these findings suggest a potential shift toward fully digital, self-executing insurance processes. By embedding policy terms into code and integrating trusted data sources such as IoT devices, third-party databases, and customer records, insurers can create systems that operate autonomously while maintaining compliance and accountability. Such a shift could redefine competitive standards, emphasizing speed, reliability, and transparency as critical differentiators. Insurers that adopt smart contract-driven solutions may achieve superior operational performance, enhanced customer loyalty, and more robust fraud prevention, ultimately reshaping the business model for claim management.

However, realizing this potential requires collaborative development between insurers, technologists, and regulators. Effective deployment hinges on secure and interoperable blockchain platforms, robust oracle integration, and adherence to evolving regulatory frameworks. Collaboration can ensure that smart contracts are designed to meet industry-specific requirements, safeguard customer data, and comply with legal standards across jurisdictions. By fostering partnerships between technical developers, insurance professionals, and policy makers, the sector can accelerate the adoption of smart contract-based solutions while addressing technological, operational, and ethical considerations. In conclusion, smart contracts represent a promising pathway to a more efficient, transparent, and trustworthy insurance ecosystem, but their full benefits will be realized only through coordinated innovation and cross-sector engagement.

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