Digital Twins in Insurance Underwriting and Claims Management: Global Evidence and Sustainable Adoption Challenges in India

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Abstract
Digital twin technology is transforming insurance underwriting and claims management by reducing information asymmetry between insurers and policyholders. Insurers are shifting from a static, disclosure-based risk assessment to real-time, evidence-driven decision-making by creating dynamic digital representations of physical assets, processes, or insured behaviour. Globally, digital twin technology contributes to the sustainability of insurance systems through cost efficiency, faster claim settlements, and greater financial resilience. The following study uses global case studies from insurers in the USA, China, and Europe to explain how digital twin-enabled systems mitigate information asymmetry across underwriting and claims functions. The present study focuses on the adoption of digital twins in the Indian insurance market, with a focus on motor, property, and industrial/commercial insurance. Using secondary sources and interviews of practitioners in the insurance domain, this study identifies regulatory, technological, operational, and economic hurdles for digital twin adoption. The study also proposes segment-specific solutions to enhance the integration of digital twins in underwriting and claims management. The findings of this study indicate that only telematics-based motor insurance represents an impactful deployment of the digital twin principle in India. Property and industrial insurance still rely on static, manual, and post-loss processes. Furthermore, digital twin adoption will evolve incrementally in India and augment human expertise in underwriting and claims assessment.

Keywords: Digital Twins, Information Asymmetry, Insurance Underwriting, Claims Management

Introduction

Traditional insurance systems often rely on information asymmetry, whereby insurers must depend upon historic loss data, self-reported disclosures, and post-loss assessments. This kind of information asymmetry causes adverse selection, pricing inefficiency, and frequent disputes over claims. Of late, digital twin technology has started to reshape the way insurance operations function. Digital twins continuously update the digital representation of physical assets, systems, or behaviors. This digital twin technology is empowered through sensors, IoT devices, data analytics, and

simulation models. Through digital twin technology, insurers are able to observe real-world risk exposures dynamically rather than based on their static proxies.

Insurers worldwide have demonstrated that digital twin technology can help reduce informational gaps in both underwriting and claims management. Moreover, digital twin-enabled underwriting and claims processes are aiding sustainable development goals by reducing resource-intensive manual inspections, lowering costs related to disputes, and enhancing efficiency overall within the system. In contrast, the insurance market in India has so far witnessed unbalanced growth on the adoption of digital twin technology. To that effect, this study analyzes global best practices of digital twin technology, evaluates the level of adoption in India, discusses challenges, and provides context-specific solutions for the Indian insurance market.

Scope and Significance of the Study

This research focuses on digital twin applications of underwriting and claims management. The analyzed insurance segments in this study included motor, property, and industrial/commercial segments. Digital twin technology applications were discussed from the USA, China, and Europe. Regulatory, operational, and economic constraints affecting adoption in India were discussed. Lastly, insurance practitioner perspectives were also taken with reference to digital twin application in India. This study by evaluating relevance, feasibility, and constraints of digital twin application within the Indian insurance market will provide actionable insights for insurers, regulators, and technology providers.

Research Objectives

- To illustrate how digital twins enabled system mitigate information asymmetry in both underwriting and claim management through global usage
- To discuss the status of adoption of digital twins in Indian underwriting and claim management practices
- To discuss the barriers for digital twin adoption in India from underwriting and claims management perspective
- To propose solutions for addressing the problem of low digital twin adoption barriers across underwriting and claims management in India
- To discuss the practitioner perspectives on technology usage, constraints, and future adoption of digital twins in underwriting and claims management for motor, property, and industrial/commercial segments in India

Literature Review

Digital Twins: Conceptual Foundations

Grieves and Vickers (2017) conceptualized digital twin as a virtual representation of a physical system which is updated continuously through real time data flows. The three components of digital twins are the physical entity, the virtual entity, and data connection linking the physical and virtual entity. Thus, insurers can observe insured risk dynamically and reduce dependence on static disclosures.

Digital Twins and Industry 4.0

Tao et al. (2019) evaluated the role of digital twins within Industry 4.0. Digital twins can support real time decision making, predictive maintenance and system optimization. Organizational decision making is thus shifted from reactive to proactive modes. Insurers can leverage operational digital twins for industrial insurance underwriting to simulate losses and safety compliance before policy issuance.

Information Asymmetry and Insurance Markets

Akerlof's (1970) theory of information asymmetry emphasized how market fails when one party has superior information. With reference to insurance markets, this leads to the problem of adverse section

during underwriting stage and moral hazard during the policy period. Digital twins by converting private risk behaviour into observable and verifiable data streams addresses the "lemon problem" of Akerlof's theory.

Telematics, Usage-Based Insurance, and Behavioural Risk Assessment

Baecke and Bocca (2017) by analysing telematics-based motor insurance models found improvements in risk classification due to behaviour-based pricing. Usage-based insurance (UBI) based on telematics are the example of early and practical forms of digital twins' application in motor insurance.

Digital Twins as Governance and Control Mechanisms

Fuller et al. (2020) emphasized that digital twins can be used as governance tools that enhances transparency, traceability, and accountability. With reference to insurance, digital twin technology can reduce disputes due to ability to provide neutral data backed records of pre and post loss conditions.

Research Gap

The academic examination of digital twins integrated with underwriting and claims system remains limited in the context of emerging markets such as India. Hence, this study links digital twins to information asymmetry theory and examines adoption barriers and solutions with the Indian insurance ecosystem.

Research Methodology

The researchers adopted an exploratory and a qualitative research design because application of digital twin adoption in insurance remains nascent and under-theorised. There was an absence of quantitative data on operational usage of digital twin technology. Hence, qualitative analysis of global case studies from USA, China, and Europe were carried out with reference to underwriting and claims management for motor, property, and industrial/commercial insurance segments. Semi-structured interview with five insurance industry practitioners with more than 15 years of experience were conducted for gaining deeper insights on adoption barriers and feasible implementation pathway.

Discussion of Research Objectives

Research Objective 1

To illustrate how digital twins enabled system mitigate information asymmetry in both underwriting and claim management through global usage

Case Study 1: Progressive Insurance (USA)

One of the earliest and most mature application of digital twin is seen in motor insurance through Progressive Insurance's Snapshot program. This program continuously captures driving behaviors such as braking intensity, speed patterns, mileage, and time of day driving. This collective data forms a dynamic behavioral digital twin of the driver to reflect real world risk exposure. Snapshot program can simultaneously improve underwriting precision and claims transparency.

Underwriting Implications

Traditional underwriting of motor insurance involves self-reported information and demographic proxies which can create a scope for adverse selection. Snapshot's program can help in reducing information asymmetry as insurers will be able to make decisions based on observed behavior instead of declared characteristics of the insured. Thus, Progressive insurer can more accurately differentiate between low risk and high-risk drivers as premium rates are adjusted based on actual driving patterns instead of assumed risk categories.

Claim Management Implications

In the event of claim, telematics generated digital twins are able to provide time-stamped evidence of driving conditions before accidents. This will minimize liability dispute, misrepresentation, and accelerate validation of claim. Furthermore, the availability of granular data related to driving behavior will enhance fraud detection by highlighting inconsistencies between recorded driving data and reported events.

Case Study 2: Ping An Insurance (China)

Ping An Insurance deploys digital twin technologies for property and catastrophe insurance. Ping An uses IoT sensors, drones, satellite imagery, and AI analytics to generate digital twins of properties and environments that are being insured. These digital twins can monitor in real time and simulate various outcomes.

Underwriting Implications

Traditional underwriting of properties relies on historical loss data and manual inspections, often leading to incomplete or outdated risk assessments. Ping An's digital twin underpins dynamic environmental factors relative to flood exposures, structural vulnerability, and supporting infrastructure, thereby reducing informational gaps between insurers and property owners and allowing for the proper pricing of premiums on that property risk.

Claim Management Implications

For large-scale catastrophe events in particular, Ping An's digital twin allows for remote damage assessment with the help of satellite and drone imagery that supports the claim settlement process. This minimizes disputes on the extent of damage, reduces on-site inspection dependency, and shortens claim processing timelines. Furthermore, digital twins also address moral hazard concerns by making it easier to distinguish between event specific damage and pre-existing conditions.

Case Study 3: Zurich Insurance (Switzerland)

Zurich Insurance applies digital twin technologies in commercial and industrial insurance. Here, the risks are of high value, complex, and difficult to assess through conventional methods. Zurich insurance stimulates operational risk through the creation of digital twins for factories, machinery, and industrial processes.

Underwriting Implications

There is a problem of information asymmetry in industrial underwriting typically from limited visibility into operational processes and safety compliance. Zurich insurance is able to model production processes, stress test equipment usage, and evaluate safety protocols virtually. This allows underwriters to move to a forward looking and risk prevention-oriented underwriting. Thus, premium is aligned with actual operational risk levels.

Claims Management Implications

Digital twins help to identify the root causes of industrial losses by providing a detailed operational history of digital twins in the event of claim situation. This will help in reducing ambiguity for determining liability and coverage applicability. Digital twins can transform claim management from a reactive compensation function to a more proactive risk mitigation process by recommending corrective measures post claim.

Research Objective 2

To discuss the status of adoption of digital twins in Indian underwriting and claim management practices

The usage of Digital Twins in insurance sector is relatively advanced in markets such as China and the United States. The relevance to insurance underwriting and claim management in India are discussed as follows:

Relevance to Indian Underwriting Practices

The insurance underwriting in India relies heavily on proposal forms and historical claim ratios. This creates the problem of information asymmetry which results in underwriting and claim related disputes. For property, commercial and industrial insurance, the digital twins are not used for pricing or underwriting decision. There is a static risk assessment in these segments with periodic inspections and historical data. The limited adoption in these segments is mainly related to weak economic incentives for insurers. Digital twin enabled models such as telematics-based motor insurance have been started in India on a limited scale through usage-based insurance (UBI) pilots. However, the adoption is still in nascent stage but regulation allows UBI as a mainstream add on product to motor policies. Below are some of the major Indian General Insurance Companies that use digital twin application partially based on usage and behavior data instead of a full real time vehicle simulation model.

Table 1 Telematics-Enabled UBI Motor Insurance in India

Insurer	UBI / Telematics Model	Data Source	Notes
Bajaj Allianz General Insurance	Pay-As-You-Consume (PAYC) add-on	Telematics device / mobile app	It was one of the first insurer which permitted premiums linked to vehicle usage (km) and safe driving behavior
Zuno (formerly Edelweiss) General Insurance	Pay-How-You-Drive (PHYD) behaviour-based add-on	Mobile telematics (Zuno app)	Drivers receive a driving score for safe driving habits and can earn renewal discounts.
ICICI Lombard General Insurance	Pay-As-You-Drive (PAYD)	Telematics device / mobile	ICICI Lombard has offered PAYD models although full commercial scale varies
HDFC ERGO General Insurance	UBI / PAYD	Telematics device / mobile	It offers usage-based motor insurance where distance and driving behaviour data help refine risk estimates and premium offerings
Reliance General Insurance	PAYD / usage-based	Odometer / basic telematics	Reliance has adopted PAYD products with mileage thresholds. This represents a simpler exposure-based telematics model where premiums and discounts reflect kilometres driven
Go Digit General Insurance	Pay-As-You-Drive (PAYD)	Mileage / basic telematics	Go Digit's pay-as-you-drive design uses mileage bands to offer premium discounts

Source: Author(s)' compilation based on IRDAI (2022), Times of India (2022), ETBFSI (2022), Business Time (2024), Mantra Labs (2022), and PolicyBachat (n.d.).

Relevance to Indian Claim Management

Claim management is one of the most cost intensive and contested functions in India for motor, property, industrial and commercial insurance lines. Due to information asymmetry, delayed surveys, and subjective damage assessment, disputes frequently arise. The only line in India where digital twin principles are visible in operation is motor insurance. But the usage of digital twin is in early stage and limited. Motor insurance using telematics can provide pre loss driving and usage data. Telematics can help in verification of accident

circumstances, it can settle low value claims at a faster pace, and can reduce surveyor dependence in some cases. The limitation is that digital twins are not used for comprehensive damage simulation but mainly for pricing and behavior monitoring. On the other hand, in property, industrial, and commercial insurance, claim management is mainly done on manual assessments and post loss documentation. There is no insurer led adoption of asset or process level digital twin usage during claim settlement.

Research Objective 3

To discuss the barriers for digital twin adoption in India from underwriting and claims management perspective

Table 2 summarizes major regulatory, operational, and economic barriers that restrict Digital Twin adoption in underwriting and claims management across motor, property and industrial/commercial insurance.

Table 2 Barriers for Digital Twin Adoption from Underwriting and Claim Management Perspective

Barrier Dimension	Motor Insurance	Property Insurance	Industrial/ Commercial Insurance
Pre-loss Data Availability (Underwriting)	Usage and driving behaviour data availability through telematics	Pre-loss asset condition data largely unavailable; underwriting relies on static proposal forms and inspections	Limited insurer visibility into operational processes; underwriting based on disclosures and periodic risk surveys
Data Ownership & Control	Insurer access to data is mediated through telematics vendors and policyholder consent	Asset and sensor data, where available, is controlled by property owners	Operational digital twins are firm-owned and not shared with insurers
Regulatory Guidance (IRDAI)	Explicit regulatory permission for telematics-based UBI models	No clear guidance on use of sensor or digital twin data for underwriting or claims	No regulatory standards for using operational or process-level digital twin data
Claims Data Objectivity	Telematics provides limited pre-accident benchmarks for claim verification	Absence of pre-loss digital baselines leads to subjective damage assessment	Claims rely on post-loss forensic analysis and negotiated loss estimates
Reliance on Intermediaries	Reduced but not eliminated reliance on surveyors and garages	Heavy dependence on loss assessors and manual surveys	Strong dependence on surveyors, risk engineers, and forensic auditors
Technological Integration Capability	Moderate; telematics systems partially integrated with insurer IT systems	Low; lack of IoT and real-time monitoring integration	Low at insurer level despite firm-side Industry 4.0 adoption (integration of industrial operations with sensors, automation, and data analytics)
Cost–Benefit Alignment	Economically viable at scale due to large policy volumes	High costs of sensor deployment relative to premium size	High implementation and integration costs with uncertain pricing benefits in the form of premium from customers
Claims Settlement Timeliness	Improved for low-value claims; limited impact on complex claims	Slow due to site inspections and documentation delays	Prolonged settlement due to complexity and dispute over causation and Business Insurance loss

Source: Author's Work

Research Objective 4: To propose solutions for addressing the problem of low digital twin adoption barriers across underwriting and claims management in India

The below Table 3 proposes solutions to address barriers of Digital Twin adoption (as shown in Table 2) from underwriting and claim management perspective.

Table 3 Solutions to Address Underwriting and Claims Management Barriers

Barrier Addressed	Motor Insurance	Property Insurance	Industrial / Commercial Insurance
Limited Pre-loss Data for Underwriting	Expand telematics beyond usage to include vehicle condition and incident reconstruction models	Introduce sensor-based monitoring for large commercial buildings and high-risk properties	Enable shared access to operational digital twins for critical machinery and processes
Data Ownership & Control Constraints	Standardised insurer–vendor–policyholder data-sharing agreements	Contractual clauses for insurer access to asset-level sensor data	Collaborative data governance frameworks between insurers and insured firms
Regulatory Ambiguity	Formal IRDAI guidelines on admissibility of telematics data for claims	IRDAI led pilots for sensor-enabled property underwriting and claims	Regulatory sandbox for industrial digital twin applications
Subjective Claims Assessment	Use pre-accident telematics benchmarks to validate claim circumstances	Compare pre- and post-loss digital baselines for objective damage assessment	Use operational history from digital twins for root-cause analysis
High Intermediary Dependence	Automate low-value claim assessment to reduce surveyor reliance	Remote damage assessment using sensor data and imagery	Supplement risk engineer reports with digital twin outputs
Low Technological Integration	Integrate telematics platforms with insurer core systems	Modular IoT integration for selected property portfolios	API-based integration between industrial systems and insurer platforms
Cost–Benefit Misalignment	Scale telematics across portfolios to spread fixed costs	Focus on high-value, catastrophe-prone assets	Target high-severity, low-frequency risks
Claims Settlement Delays	Automated triage (algorithms to automatically classify and prioritise cases) and fast-track settlement for minor claims	Remote and parallel assessment during catastrophes	Faster liability determination and Business Insurance loss validation

Source: Author's Work

Research Objective 5

To discuss the practitioner perspectives on technology usage, constraints, and future adoption of digital twins in underwriting and claims management for motor, property, and industrial/commercial segments in India

The practitioner insights reinforce the study's argument that digital twin adoption is likely to evolve gradually, shaped by regulatory clarity and economic feasibility. The below Table 4 summarizes the findings from insurance practitioners.

Table 4 Summary of Practitioner Interview Findings

Theme	Key Practitioner Insights from Underwriters
Current use of technology	Digital Twin Technology is most prominent in motor insurance with support for only premium adjustments and preliminary claim processing
Property and industrial insurance practices	Underwriting and claim management rely on proposal forms, site inspections, and post-loss surveys.
Barriers to wider adoption	High implementation costs, asset heterogeneity, and uncertainty over premium volumes limit investment in Digital Twin technology beyond motor insurance
Role of intermediaries	Surveyors, loss assessors, and risk engineers continue to play a central role in underwriting and claims validation reducing incentives for technology substitution.
Regulatory constraints	Lack of explicit regulatory guidance for technology use in property and industrial insurance
Future adoption pathways	Practitioners foresee selective and gradual adoption of technology to complement human assessment particularly for large commercial and high-risk assets.

Source: Author's Compilation based on Practitioner Interviews

Summary and Conclusion

The study shows that digital twin adoption can reduce information asymmetry in insurance underwriting and claim management. Global insurers have successfully implemented digital twins into motor, property, and industrial/commercial segments. However, in India, the adoption of digital twins is uneven and fragmented. Telematics-based motor insurance in India is the only meaningful application of the digital twin principle. Property and industrial insurance remain stuck in static and manual post-loss processes. The findings from insurance practitioners show that digital twin adoption would happen in an evolutionary manner in India and would complement human expertise in underwriting and claims assessment.

Recommendations and Suggestions

- The Insurance Regulatory and Development Authority of India should issue explicit guidelines on the admissibility of digital twin data usage into underwriting and claims management.
- Insurers should prioritize catastrophe prone and high value assets for early digital twin application.
- There should be hybrid assessment model in which digital twins should supplement and not replace surveyor and risk engineers.

Managerial Implications

- Insurers must proactively engage with regulators and technology partners to ensure compliant, scalable, and economically viable adoption of digital twin technology.
- Insurance managers should adopt a segment-specific digital twin implementation strategy which prioritises high value and high severity risks.
- Digital twin adoption supports sustainable insurance operations by reducing repetitive surveys, minimising claim disputes, and enabling faster recovery for policyholders.

Limitations of the Study and Further Research

Qualitative and exploratory in nature, the study has on offer practical insights that are indicative rather than statistically representative. Further research can be carried out to find out the quantitative impact assessment of digital twins on claims settlement time and policyholder perception towards digital twin enabled insurance.

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