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Smart surveillance systems as a tool for mitigating claims frequency in commercial property insurance portfolio in Nigeria

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ABSTRACT
Increasing claims frequency in commercial property insurance portfolios in Nigeria continues to undermine underwriting profitability, premium adequacy, and portfolio stability. This study investigated the influence of smart surveillance systems, namely AI-enabled CCTV coverage, real-time monitoring, detection accuracy, and operational reliability of automated alarm systems, on claims frequency in commercial property insurance. A quantitative cross-sectional explanatory survey research design was adopted. Primary data were obtained through structured questionnaires administered to 150 technical personnel engaged in underwriting, risk surveying, claims management, and loss control across selected insurance companies. Data were analyzed using Poisson regression with exposure-adjusted claim frequency ratios. Findings indicated that both AI-enabled CCTV surveillance and automated alarm systems significantly lowered the expected claims frequency, demonstrating their effectiveness in mitigating property loss risk. The study concluded that smart surveillance technologies function as actuarial risk modifiers and recommended incorporating surveillance metrics into underwriting and pricing frameworks to improve risk assessment, premium adequacy, and portfolio stability.

Keywords
AI-enabled CCTV, Automated Alarm Systems, Claims Frequency, Commercial Property Insurance

1. Introduction

Smart Surveillance Systems have become an integral component of contemporary commercial property risk management, mirroring the insurance industry's increasing emphasis on proactive loss prevention and data-driven underwriting. These systems combine artificial intelligence (AI), closed-circuit television (CCTV), real-time monitoring platforms, and automated alarm technologies to strengthen threat detection, incident verification, and response effectiveness. Beyond their conventional security role, smart surveillance technologies equip insurers with measurable risk information that can enhance risk visibility, minimize information asymmetry, reinforce claims validation, and facilitate more accurate underwriting decisions. As a result, insurers in advanced markets increasingly consider surveillance-related indicators as important inputs in risk assessment and portfolio management. Empirical evidence indicates that AI-enabled surveillance technologies are associated with lower property loss ratios and reduced claims incidence (Piza et al., 2019). Likewise, improved surveillance capabilities have been linked to enhanced risk control outcomes and stronger insurance performance (Sølvsten & Kaiser, 2023). Nevertheless, despite growing technological adoption, it remains uncertain if the underwriting benefits documented in developed insurance markets are equally attainable within emerging insurance environments.

In Nigeria, particularly in Lagos State where commercial assets are highly concentrated, insurers are exposed to substantial commercial property losses resulting from burglary, vandalism, and other related property risks. Such losses can increase claim obligations, place pressure on underwriting profitability, premium pricing adequacy,

and stability of the non-life insurance portfolio (Agboola et al., 2025). Despite the policyholders' growing investment in surveillance technologies, evidence remains insufficient regarding whether these investments produce measurable reductions in claims frequency. Existing Nigerian studies have predominantly examined surveillance systems from crime prevention, security management, and operational perspectives instead of from an insurance-performance perspective (Nte et al., 2020). Although some studies have demonstrated the security and managerial value of surveillance technologies (Oloke et al., 2024), and monitoring effectiveness has also been reported (Ukwayi et al., 2019), their actuarial significance remains inadequately understood. Furthermore, Adzande and Terver-Gyuse (2024) emphasized the increasing relevance of technology-driven security systems without establishing their direct implications for insurance outcomes. Consequently, a significant knowledge gap remains regarding whether surveillance indicators constitute substantial predictors of claims experience within commercial property insurance portfolios.

This study extends the body of literature on technology-enabled risk management by investigating whether smart surveillance indicators possess explanatory relevance for claims experience within commercial property insurance portfolios. Departing from previous Nigerian studies that largely examined surveillance technologies from security and crime-prevention perspectives, the present study adopts surveillance within an insurance and actuarial framework, where its significance is assessed through its association with claims outcomes. Using insurer-level evidence from Lagos State, the study provides insights into the extent to which surveillance-related attributes contribute meaningful indicators of underwriting risk and portfolio performance. Specifically, the study examines the effect of CCTV coverage of premises, real-time monitoring, detection accuracy, and operational reliability of alarm systems on claims frequency, as well as the relative effectiveness of AI-enabled CCTV and automated alarm technologies in reducing commercial property losses based on insurer-level data from Lagos State.

2. Review of literature and hypothesis development

Smart surveillance systems

Smart surveillance systems encompass integrated security technologies that combine CCTV cameras, artificial intelligence, sensors, automated alarms, and networked monitoring platforms designed to detect, analyze, and respond to threats in real time (Aliyu & Airoboman, 2026). These technologies have become significantly relevant in commercial property risk management due to heightened concerns over theft, vandalism, fire outbreaks, and unauthorized access (Oloke et al., 2024). At the global level, insurers are increasingly integrating technology-driven loss prevention measures into underwriting and risk assessment processes (Eling & Lehmann, 2018). Within the Nigerian Insurance industry, the adoption of smart surveillance systems is steadily expanding as insurers seek sustainable approaches to reducing claims frequency and enhancing portfolio performance.

CCTV Coverage of Premises

CCTV coverage of premises describes the degree to which surveillance cameras are strategically positioned to monitor vulnerable areas of an insured property for deterrence, detection, and evidence generation purposes (Oloke et al., 2024; Welsh & Farrington, 2020). Adequate camera coverage enhances visibility, prevents criminal activities, and supports incident investigation through recorded evidence (Oloke et al., 2024). Internationally, extensive camera coverage has been linked with improved property protection and lower loss occurrences in commercial facilities (Piza et al., 2019). In the Nigerian environment, where commercial properties face diverse security threats, comprehensive CCTV coverage is increasingly recognized as an important loss control mechanism capable of reducing claim-generating incidents and improving underwriting outcomes (Nte et al., 2020).

Real-Time Monitoring

Real-time monitoring denotes the continuous observation and analysis of surveillance data as events unfold, allowing for the immediate detection, verification, and response to emerging threats (Myagmar-Ochir & Kim, 2023). In contrast to passive surveillance, real-time monitoring enables prompt intervention before losses develop into insurable claims (Vennam et al., 2021). Across global insurance markets, commercial property insurers increasingly regard active monitoring systems as valuable tools for strengthening risk control and reducing loss severity (Myagmar-Ochir & Kim, 2023). Within the Nigerian context, where delayed response often contributes to property losses, real-time monitoring offers an additional layer of protection that supports claims reduction and improved risk management outcomes (Aliyu & Airoboman, 2026). (Vennam et al., 2021).

Detection Accuracy

Detection accuracy represents the ability of surveillance systems to distinguish genuine threats while reducing false alarms and missed detections, thereby enhancing the reliability of security interventions (Ohanaka et al., 2025; Erhan et al., 2020). Recent advancements in artificial intelligence and machine learning have largely improved the precision of modern surveillance systems in identifying fraudulent activities and potential security breaches (Erhan et al., 2020). International best practices consistently identify high detection accuracy as a pivotal determinant of surveillance effectiveness and operational efficiency. For commercial property insurers in Nigeria, precise threat detection strengthens preventive risk management, minimizes avoidable losses, and contributes to lower claims frequency across insured portfolios (Afolabi et al., 2024).

Operational reliability of alarm systems

Operational reliability of alarm systems describes the consistency with which alarm infrastructure detects, transmits, and responds to security incidents without system failures, excessive downtime, or false activations (Jacke & Furmaniak, 2021). Reliable alarm systems enable rapid emergency response and help minimize the likelihood of minor incidents escalating into major insured losses (Ciholas et al., 2019). In advanced insurance markets, alarm reliability is commonly incorporated during property risk inspections and underwriting evaluations because dependable systems are associated with lower loss exposure (NFPA, 2022). Likewise, within the Nigerian commercial property sector, reliable alarm infrastructure is increasingly regarded as a valuable risk mitigation mechanism capable of supporting claims reduction and promoting portfolio stability (Aliyu & Airoboman, 2026).

Claims Frequency in Commercial Property Insurance.

Claims frequency in commercial property insurance represents the number of claims reported per insured portfolio within a defined period and serves as a key indicator of risk exposure and underwriting performance (Oladunni & Okonkwo, 2022). It is typically measured using claims per policy, exposure unit, or insured value and is fundamental to pricing adequacy and loss forecasting in non-life insurance markets (Agboola et al., 2025). Across global insurance markets, insurers use technology-driven risk controls to reduce claim incidence and improve portfolio stability (Sølvsten & Kaiser, 2023). In Nigeria, regulatory and market evidence shows that rising loss experience and environmental risk factors continue to shape claims patterns, making effective risk monitoring vital for profitability and underwriting sustainability (Dabbugudi, 2022).

Commercial property insurance

Commercial property insurance provides financial protection for tangible assets against perils such as fire, theft, and environmental hazards, with specified exclusions for wear, deterioration, or intentional acts. Underwriting and risk assessment rely on comprehensive property surveys, historical loss experience, and exposure analysis to establish premiums and policy conditions, in compliance with NAICOM regulatory standards (Agboola et al., 2025). Insurers systematically adopt AI-enabled CCTV and automated alarm systems to improve monitoring, enhance detection accuracy, mitigate claims frequency, and optimize risk pricing (Dabbugudi, 2022). In Lagos, adoption of these systems complements traditional surveys, while quantifiable indicators such as incident detection rates and response reliability provide valuable inputs for underwriting, premium adjustments, and portfolio-level loss mitigation.

Empirical Review

Surveillance technologies influence property crime patterns and the occurrence of loss events that may generate insurance claims. Within commercial property insurance, smart surveillance systems are viewed as proactive loss-control mechanisms because they strengthen physical security, improve risk visibility, reduce information asymmetry between insurers and policyholders, and limit opportunities for moral hazard through continuous monitoring and rapid response capabilities. These conceptual mechanisms provide the basis for understanding how AI-enabled surveillance may affect commercial property claims frequency in emerging insurance markets.

CCTV coverage of premises refers to the extent to which surveillance cameras provide continuous visual monitoring of vulnerable areas of an insured property. Broad and uninterrupted coverage is expected to deter unauthorized activities, improve incident detection, and support post-event verification. In support of this mechanism, Oloke et al. (2024) conducted a quantitative cross-sectional survey involving 171 users of CCTV-equipped shopping malls and warehouses in Lagos Metropolis. Using descriptive and inferential statistical techniques, the study found that CCTV was more effective in shopping malls than in warehouses, although the differences were not statistically significant. The authors also identified power instability and technical failures

as major constraints, indicating that surveillance effectiveness depends not only on camera presence but also on coverage quality and operational continuity. The findings suggest that inadequate surveillance infrastructure may weaken the loss-reduction benefits expected from CCTV deployment.

Real-time monitoring represents the continuous observation and analysis of surveillance data as events occur, thereby enabling immediate threat verification and intervention before losses escalate into insurable claims. Effective monitoring increases the perceived probability of detection and strengthens active guardianship over commercial assets. Consistent with this conceptual expectation, Alabi et al. (2021) examined CCTV deployment in private gated communities in Eti-Osa Local Government Area, Lagos, using a structured questionnaire survey analyzed through descriptive and inferential methods. Their findings showed that CCTV presence reduced reported crime incidents and improved perceived safety, although maintenance deficiencies and differences across crime categories remained evident. The study demonstrates that surveillance effectiveness is enhanced when camera coverage is supported by active monitoring and adequate system maintenance.

Technology-integrated security strategies combine surveillance infrastructure with coordinated detection and response mechanisms that can identify threats and facilitate timely intervention. Such integration is expected to reduce the probability that minor security breaches develop into major property losses with insurance consequences. Shittu et al. (2023) investigated the influence of technology-based policing strategies, including CCTV systems, on crime incidence in Lagos State. Employing a descriptive survey of 384 respondents and ordinary least squares regression analysis, the study reported that technology-driven security measures significantly reduced crime rates. The evidence reinforces the proposition that enhanced surveillance and coordinated monitoring systems contribute to lower property loss exposure and may consequently reduce the frequency of commercial insurance claims.

The operational reliability of surveillance infrastructure is equally important because the effectiveness of any monitoring system depends on its ability to function consistently without prolonged downtime, false activations, or response failures. Reliable systems maintain continuous protection, whereas interruptions restore opportunities for theft, vandalism, and related property losses. Abdullahi et al. (2025) assessed CCTV effectiveness and operational challenges in Kano Metropolis using a mixed-methods design involving 320 respondents. The study found that CCTV systems were valuable for crime detection and legal investigation, but electricity instability, inadequate personnel training, and weak coordination with enforcement agencies constrained their operational performance. These findings indicate that reliability and supporting infrastructure are critical determinants of the extent to which surveillance systems can contribute to loss mitigation and insurance risk reduction.

Automated alarm systems operate by detecting unauthorized intrusion, abnormal movement, or emergency events and transmitting alerts for immediate response, thereby reducing the likelihood that security incidents escalate into substantial insured losses. Afolabi et al. (2024) developed and evaluated a cost-efficient automated intrusion detection and reporting system in Nigeria and reported that automated detection significantly improved incident identification and response coordination. Although the study was conducted in a residential security context, its findings provide empirical support for the proposition that detection accuracy and operational responsiveness are important components of technology-enabled loss prevention that may influence commercial property insurance claims experience.

International evidence further strengthens the relationship between surveillance effectiveness and property loss reduction. Active monitoring transforms surveillance from a passive evidence-recording tool into an active preventive mechanism capable of facilitating immediate threat assessment and response. Piza et al. (2019) conducted a meta-analysis of 40 years of CCTV evaluation research across multiple jurisdictions and found that CCTV systems significantly reduced property crime, with actively monitored, multi-component surveillance arrangements producing stronger effects than passive systems. The study provides robust international evidence that real-time monitoring and comprehensive surveillance coverage are associated with meaningful reductions in property loss events that could otherwise translate into insurance claims.

Overall, the empirical literature demonstrates that CCTV coverage, real-time monitoring, operational reliability, and automated detection responsiveness are important determinants of property loss outcomes and security effectiveness. Nigerian studies consistently show that surveillance technologies can reduce crime and improve property protection, although power instability, maintenance deficiencies, and operational limitations often

constrain their effectiveness. International evidence provides stronger support for the loss-prevention benefits of actively monitored surveillance systems. Nevertheless, existing studies predominantly evaluate surveillance technologies from crime prevention, security management, or operational perspectives, while little evidence directly examines how AI-enabled CCTV and automated alarm systems influence actuarial claims frequency within commercial property insurance portfolios in Nigeria. This unresolved gap provides the empirical justification for the present study.

Hypothesis Development

Drawing from the conceptual arguments and empirical evidence reviewed, the following hypotheses were formulated to guide the study:

H_{o1}: There is no significant relationship between CCTV coverage of premises, real-time monitoring, and claims frequency

H_{o2}: There is no significant relationship between detection accuracy, operational reliability, and claims frequency.

H_{o3}: There is no significant difference in influence between AI-CCTV and automated alarm systems on claims frequency

Theoretical Framework

The theoretical framework for this study is based on Routine Activity Theory and Risk Management Theory, which together explain how surveillance technologies influence opportunities for property loss, risk exposure, and loss-control effectiveness in commercial property insurance.

Routine Activity Theory (RAT)

Routine Activity Theory, postulated by Cohen and Felson in 1979, asserts that a loss event arises when three elements converge: a motivated offender, a suitable target, and the absence of a capable guardian. This study examines how AI-enabled CCTV surveillance and automated alarm systems serve as technology-driven guardians, altering the opportunity landscape for theft, vandalism, and malicious damage across the commercial property sector of Lagos. The pervasiveness of comprehensive CCTV coverage substantially reduces the chances of concealment, while real-time monitoring enhances both the continuity of surveillance and response readiness. Likewise, improved alarm detection accuracy and operational reliability reduce opportunities for intrusion and mitigate the risk of system failures. Routine Activity Theory supports the proposition that strengthening protective and guardianship mechanisms greatly reduces the occurrence of preventable losses. Despite its relevance, a notable weakness of RAT is the displacement effect: the security provided by AI surveillance may simply redirect criminal activity to nearby properties with less effective security, thus influencing the insurer's broader risk pool. Furthermore, RAT assumes rational offender behavior; however, in the high-pressure urban context of Lagos, certain criminal acts may occur despite the presence of visible guardianship, particularly under conditions of economic hardship.

Risk Management Theory

Risk Management Theory, originally advanced in modern finance by Harry Markowitz in 1952 and later developed into enterprise risk management frameworks, holds that organizations can reduce uncertainty and financial loss by adopting a systematic approach to risk identification, assessment, and control. In the insurance industry, this theory emphasizes prevention and mitigation as more effective strategies than post-loss indemnification. In the context of commercial property insurance, AI-enabled CCTV systems and automated alarm systems represent structured loss control mechanisms that strategically reduce exposure to theft, vandalism, and malicious damage. By enhancing surveillance coverage, detection accuracy, and operational reliability, these systems improve risk quality, reduce claims frequency, and enhance underwriting precision and portfolio performance in Lagos State. The theory is founded on the premise of consistent system efficiency and rational enforcement. Nevertheless, it tends to inadvertently understate contextual factors such as infrastructure failures, human interference, technological downtime, and crime displacement, all of which may affect the anticipated reductions in claims frequency.

Risk Management Theory complements Routine Activity Theory (RAT) by providing a systematic approach to understanding how controls can improve risk outcomes. Whereas RAT focuses on the reduction of opportunities

for crime, Risk Management Theory explains how implementing controls, like surveillance and alarm systems, can systematically reduce risk by improving oversight and response strategies. Collectively, these theories underscore the importance of proactive measures in mitigating risks effectively.

3. Methodology

This study used a quantitative cross-sectional explanatory survey research approach to examine the impact of smart surveillance system features, specifically automated alarm systems and AI-enabled CCTV surveillance, on the frequency of commercial property insurance claims in Nigeria. Because the study relied on primary data from structured questionnaires given to technical staff involved in underwriting, risk assessing, claims management, and loss control in particular insurance companies, the design was deemed adequate. The explanatory method allowed for the empirical verification of the proposed correlations between surveillance system parameters and claims frequency using Poisson regression analysis, while the cross-sectional design allowed data to be collected at a specific moment in time.

The target population comprised 200 technical personnel drawn from insurance companies operating in Lagos State. Respondents were selected using **purposive sampling** because only personnel directly engaged in commercial property risk assessment and claims administration possessed the specialized knowledge required for the study.

Sample Size Determination

Sample size was determined using Cochran's (1977) finite population procedure, which is widely applied in quantitative and actuarial research. The initial sample size for an infinite population was estimated as:

$$n_0 = \frac{(Z^2 Pq)}{e^2}$$

where Z = 1.96, p = 0.50, q = 0.50, and e = 0.05. The calculation produced an initial estimate of 384.16. Applying the finite population correction for N = 200 yielded a minimum sample size of approximately 132 respondents. To improve representativeness and accommodate possible non-response, 150 questionnaires were administered, and the completed responses were used for the analysis. Consistency reliability was assessed using Cronbach's Alpha, with coefficients surpassing 0.70 b

A structured 4-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree) was used as the primary tool for data collection. The neutral midpoint was excluded to limit central tendency bias. Constructs measuring CCTV coverage, real-time monitoring, detection accuracy, and operational reliability were coded as ordered predictors. Claim Frequency (CF) was measured using the exposure-based Claim Frequency Ratio, defined as the number of reported claims per insured property-year. Internal con enchmark, demonstrating acceptable reliability for risk management journals. Content validity was verified through expert review by senior underwriting and actuarial professionals. For econometric modeling, the dependent variable was the claim count, and insured property-years were incorporated as a logarithmic offset to standardize outcomes as claim rates rather than raw counts. Exposure-adjusted segmented frequencies were computed across surveillance categories (CCTV only, automated alarms only, both, or neither) to support actuarially consistent comparisons.

Analytical Technique and Model Specification

Data were analyzed using IBM SPSS Statistics (Version 30). Descriptive statistics were used to summarize respondents' characteristics and variable distributions, while Poisson regression analysis was employed to estimate the effect of surveillance technologies on commercial property insurance claims frequency. Poisson regression was considered appropriate because the dependent variable represents count data observed over a specified exposure period. The models incorporated the natural logarithm of insured property-years as an offset variable to obtain exposure-adjusted claim frequency estimates.

The econometric model is specified as:

Model 1

$$\ln(E[CFi]) = \beta_0 + \beta_1 AICT_i + \ln(Exposure_i) + \varepsilon_i$$

Where:

- CF_i = Claim Frequency
- $AICT_i$ = AI-enabled CCTV Surveillance (composite of CCTV Coverage and Real-time Monitoring)
- $Exposure_i$ = Insured property-years (offset)
- β_0 = Constant
- ε_i = Error term

Model 2

$$(E[CF_i]) = \beta_0 + \beta_1 AAS_i + \ln(Exposure_i) + \varepsilon_i$$

Where

- AAS_i = Automated Alarm Systems (composite of Detection Accuracy and Operational Reliability)

Model 3 (Comparative Model)

$$\ln(E[CF_i]) = \beta_0 + \beta_1 AICT_i + \beta_2 AAS_i + \ln(Exposure_i) + \varepsilon_i$$

Regression coefficients were interpreted using Incidence Rate Ratios (IRRs) to determine the relative effect of surveillance technologies on commercial property insurance claims frequency. Model adequacy was evaluated using the Deviance statistic, Pearson Chi-square statistic, and the Omnibus Likelihood Ratio test.

Operational Measurement of Variables

Table 1 shows the Operational Measurement of Variables

Table1. Operational Measurement of Variables

Symbol	Variable	Measurement	Source
CF_i	Claims Frequency	Exposure-adjusted number of claims (dependent variable)	Oladunni & Okonkwo (2022)
$AICT_i$	AI-enabled CCTV Surveillance	Composite score of CCTV coverage and real-time monitoring measured on a four-point Likert scale	Oloke et al. (2024); Alabi et al. (2021)
AAS_i	Automated Alarm Systems	Composite score of detection accuracy and operational reliability measured on a four-point Likert scale	Afolabi et al. (2024); Hakilo (2025)
$\ln(Exposure_i)$	Offset Variable	Natural logarithm of insured property-years	Exposure-adjusted actuarial frequency modeling literature
β_0	Intercept	Constant term of the regression model	Model specification
β_1, β_2	Regression Coefficients	Estimated effects of surveillance technologies on claims frequency	Poisson regression estimation
ε_i	Random Error	Unobserved variation not captured by the explanatory variables	Statistical assumption

Hypothesis Testing and Decision Rule

The hypotheses were tested using Poisson regression estimation with exposure-adjusted claim frequency specified as the dependent variable. Statistical significance was evaluated at the 5% significance level ($\alpha = 0.05$). The decision criterion for all hypotheses was to reject the null hypothesis (H_0) when the p-value was less than 0.05; otherwise, fail to reject H_0. To facilitate actuarial interpretation, the estimated coefficients were transformed into Incidence Rate Ratios (IRR = e^β), which measure the multiplicative effect of surveillance variables on expected claim frequency. An IRR less than 1.00 indicates a reduction in expected claim frequency, while an IRR greater than 1.00 indicates an increase. The percentage change in expected claim frequency was computed as (1 − IRR) ×

100% for IRR values below unity. This approach is consistent with actuarial applications of Poisson frequency modelling, where exposure-adjusted claim rates are interpreted in multiplicative rather than linear terms.

4. Results

The study uses a Poisson regression framework to model claim frequency as a function of AI-enabled CCTV surveillance and automated alarm system characteristics. The choice of model is statistically relevant given the count nature of the dependent variable (claim frequency) and the inclusion of exposure-adjusted offsets, ensuring actuarial consistency.

Case Processing Summary

As shown in Table 2, a total of 150 technical personnel participated in the study with100% completion and inclusion rate.

Table 2. Case Processing Summary

	N	Percent
Included	150	100.0%
Excluded	0	0.0%
Total	150	100.0%

Goodness of Fit[a]

Table 3. Goodness of Fit Diagnostics

	Value	Df	Value/df
Deviance	118.518	147	.806
Scaled Deviance	147.000	147	
Pearson Chi-Square	92.450	147	.629
Scaled Pearson Chi-Square	114.668	147	
Log Likelihood[b,c]	-251.960		
Adjusted Log Likelihood[d]	-312.511		
Akaike's Information Criterion (AIC)	509.920		
Finite Sample Corrected AIC (AICC)	510.085		
Bayesian Information Criterion (BIC)	518.952		
Consistent AIC (CAIC)	521.952		

Source: Authors Computation 2026

The goodness-of-fit diagnostics presented in Table 3 confirm strong model adequacy. Specifically, the Deviance/df (0.806) and Pearson Chi-square/df (0.629) are both below unity, showing absence of overdispersion and validating the suitability of the Poisson specification for insurance claims modeling. This aligns with actuarial best practices where equidispersion supports unbiased parameter estimation.

Omnibus Test[a] of Model Coefficient

Table 4: Omnibus Test[a]

Likelihood Ratio Chi-Square	Df	Sig.
15.850	2	.000

Source: Authors Computation 2026

The Omnibus Likelihood Ratio test ($\chi^2 = 15.850$, $p < 0.001$) as shown in Table 4 affirms that the predictors jointly explain significant variation in claims frequency. Thus, the model possesses explanatory power and satisfies the statistical robustness needed for underwriting analytics.

Hypothesis Testing

Hypothesis One (H_{01})

There is no significant relationship between CCTV coverage of premises, real-time monitoring, and claims frequency (Table 5).

Table 5. Tests of Model Effects for Hypothesis One

Source	Type III Wald Chi-Square	df	Sig.
(Intercept)	120.105	1	.000
Ai CCTV Coverage of Premises/ Real-time monitoring	16.511	1	.000

Source: Authors Computation 2026

Table 6. Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval Lower	Upper	Hypothesis Test Wald Chi-Square	df
(Intercept)	1.415	.1291	1.162	1.668	120.105	1
Ai CCTV Coverage of Premises/ Real-time monitoring	-.196	.0481	-.290	-.101	16.511	1
(Scale)	.802[a]					

Decision Rule: Reject H_0 if p-value < 0.05.

The Tests of Model Effects and Parameter Estimates for Hypothesis One are presented in Table 6. The Poisson regression results indicate that AI-enabled CCTV coverage and real-time monitoring significantly lowered frequency of commercial property insurance claims ($\beta = -0.196$, Wald $\chi^2 = 16.511$, $p < 0.001$). The estimated IRR of 0.822 suggests that a one-unit enhancement in the effectiveness of CCTV coverage and monitoring is linked to an expected claim frequency reduction of about 17.8%. Thus, H_{01} is rejected. This discovery bolsters the Routine Activity Theory and Risk Management Theory, indicating that ongoing surveillance enhances preventive risk control and diminishes underwriting exposure. The outcome aligns with the findings of Piza et al. (2019), Oloke et al. (2024), and Alabi et al. (2021), which indicated that property protection results are enhanced by effective and actively monitored CCTV systems. The current research broadens this evidence by showing that improved CCTV coverage and real-time monitoring yield quantifiable actuarial decreases in the frequency of claims on commercial property insurance, thereby endorsing their application in underwriting evaluations and portfolio-level loss reduction in the Nigerian insurance market.

Hypothesis Two (H_{02})
There is no significant relationship between detection accuracy, operational reliability, and claims frequency (Table 7).

Table 7. Tests of Model Effects for Hypothesis Two

Source	Type III Wald Chi-Square	Df	Sig.
(Intercept)	32.005	1	.000
Alarm Accuracy/ Reliability	6.915	1	.009

Source: Authors Computation 2026

Table 8. Parameter Estimates for Hypothesis Two

Parameter	B	Std. Error	95% Wald Confidence Interval Lower	Upper	Hypothesis Test Wald Chi-Square	Df
(Intercept)	1.693	.2993	1.107	2.280	32.005	1
Alarm Accuracy/ Reliability	-.274	.1042	-.478	-.070	6.915	1
(Scale)	.847[a]					

Decision Rule: Reject H_0 if p-value < 0.05.

The estimates for Hypothesis Two as reported in Table 8: The findings suggest that detection accuracy and operational reliability have a statistically significant inverse effect with commercial property insurance claims frequency ($\beta = -0.274$, Wald $\chi^2 = 6.915$, $p = 0.009$). The estimates of detection accuracy and operational reliability suggest that there is a statistically significant decrease in the frequency of commercial property insurance claims ($\beta = -0.274$, Wald $\chi^2 = 6.915$, $p = 0.009$). An IRR of 0.760 indicates that enhancing alarm detection precision and system reliability by one unit is associated with an expected claim frequency reduction of about 24.0%, resulting

in the rejection of H_{02}. In comparison to CCTV surveillance, the greater effect size highlights the significance of early threat detection and reliable response activation in preventing the escalation of minor incidents into insured losses. This result is consistent with Risk Management Theory. It mirrors the findings of Afolabi et al. (2024) and Abdullahi et al. (2025), who stressed the central role of detection precision and operational reliability in surveillance effectiveness. For insurers, the finding indicates that reliable automated alarm systems can contribute materially to risk selection, pricing, and portfolio-level loss control.

Hypothesis Three (H_{03})
There is no significant difference in influence between AI-CCTV and automated alarm systems on claims frequency (Table 9).

Table 9: ***Comparative Model Effects and Parameter Estimates for Hypothesis Three***

Source	Type III Wald Chi-Square	Df	Sig.
(Intercept)	16.557	1	.000
Ai CCTV Coverage of Premises/ Real-time monitoring	8.403	1	.004
Alarm Accuracy/ Reliability	.138	1	.710

Source: Authors Computation 2026

Table 10. ***Comparative Model Effects and Parameter Estimates for Hypothesis Three***

Parameter	B	Std. Error	95% Wald Confidence Interval Lower	Upper	Hypothesis Test Wald Chi-Square	df
(Intercept)	1.306	.3209	.677	1.935	16.557	1
Ai CCTV Coverage of Premises/ Real-time monitoring	-.217	.0748	-.363	-.070	8.403	1
Alarm Accuracy/ Reliability	.057	.1541	-.245	.359	.138	1
(Scale)	.806[a]					

Decision Rule: Reject H_0 if p-value < 0.05.

In the Poisson regression model, as depicted in Table 10, when both surveillance technologies are included at the same time, AI-enabled CCTV surveillance remains statistically significant ($\beta = -0.217$, $p = 0.004$), while automated alarm systems are not ($\beta = 0.057$, $p = 0.710$). As a result, H_{03} is rejected, signifying that the two technologies do not equally contribute to explaining the frequency of commercial property insurance claims. The enduring importance of CCTV implies that in a unified surveillance context, continuous visual oversight encompasses a wider array of risk indicators than alarm-triggering systems. This interpretation aligns with Risk Management Theory and the findings of Piza et al. (2019) and Oloke et al. (2024), which emphasize the greater independent contribution of active surveillance systems to preventing property loss. The outcome suggests that while both technologies are effective loss-control measures, AI-enabled CCTV serves as the more robust independent predictor for underwriting risk assessment and commercial property portfolio management.

5. Conclusion

This study has shown that smart surveillance systems significantly reduce claim frequency in commercial property insurance through improved detection, monitoring, and response efficiency. AI-enabled CCTV surveillance emerged as the primary structural control mechanism, while automated alarm systems provided an important complementary trigger for rapid incident response. The findings support greater emphasis on prevention-oriented underwriting and loss control within commercial property insurance. They further indicate that surveillance-related indicators, particularly CCTV coverage, real-time monitoring capability, detection accuracy, and alarm system reliability, can strengthen commercial property risk assessment, support premium adequacy, and enhance portfolio stability when incorporated into underwriting and pricing decisions. Overall, the study affirms the growing importance of technology-enabled surveillance in data-driven underwriting and commercial property insurance risk management in Nigeria.

Recommendations

To enhance risk assessment, reinforce loss prevention, and promote premium adequacy, insurers should integrate AI-enabled CCTV surveillance metrics, specifically CCTV coverage and real-time monitoring capability, into

commercial property underwriting and pricing frameworks. Insurance companies should also promote the adoption of automated alarm systems with high detection accuracy and operational reliability by defining minimum technical criteria within underwriting guidelines and offering premium incentives to customers who comply. In addition, the National Insurance Commission (NAICOM), in collaboration with insurers, should establish industry-wide standards for assessing smart surveillance systems and integrate surveillance-based risk indicators into commercial property insurance risk assessment and pricing models to support underwriting consistency and portfolio stability.

References

Abdullahi, H. G., Sabitu, M., Musa, A. U., & Abubakar, A. S. (2025). The effectiveness and challenges of CCTV cameras in crime prevention and control in Kano Metropolis, Nigeria. *International Journal of Multidisciplinary Research and Growth Evaluation, 6*(5),255-264. [Link]

Adzande, P., & Terver-Gyuse, A. (2024). Surveillance measures and crime incidence in urban centres in Nigeria. *Journal of Urban Security Studies, 12*(1), 45–63.

Afolabi, O., Abhulimen, O., & Amos, J. (2024). Cost-efficient automated intrusion detection and reporting system for homes in Nigeria. *ABUAD Journal of Engineering Research and Development, 7*(2), 35–47.. [Crossref]

Agboola, A. B., Obalola, M. A., & Aduloju, S. A. (2025). Underwriting risk and performance in the non-life insurance sector in Nigeria. *Nigerian Journal of Risk and Insurance, 15*(1). [Crossref]

Alabi, A. M., Balogun, F. A., & Adeleye, J. A. (2021). CCTV and crime prevention in private gated communities: A case of Eti-Osa Local Government Area, Lagos, Nigeria. *KIU Journal of Humanities, 6*(1), 39–50.

Aliyu, A.-Q. H., & Airoboman, A. E. (2026). Design and implementation of a cost-effective, AI-enabled smart security system for real-time threat detection in Nigerian rural communities. Journal of Scientific and Engineering Research, 2025, 12(11):42-58

Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). John Wiley & Sons.

Ciholas, P., Lennie, A., Sadigova, P., & Such, J. M. (2019). *The security of smart buildings: A systematic literature review*. *arXiv*. [Crossref]

Dabbugudi, M. (2022). *Artificial intelligence on property and casualty insurance*. ResearchGate.. [Link]

Eling, M., & Lehmann, M. (2018). The impact of digitalization on the insurance value chain and the insurability of risks. *The Geneva Papers on Risk and Insurance – Issues and Practice, 43*(3), 359–396. [Crossref]

Erhan, L., Ndubuaku, M., Di Mauro, M., Song, W., Chen, M., Fortino, G., & Liotta, A. (2020). Smart anomaly detection in sensor systems. *Information Fusion*, 64-79. [Crossref]

Hakilo, S. (2025). Artificial intelligence-based smart security system using Internet of Things for smart home applications. *Electronics, 14*(3), Article 608. [Crossref]

Jacke, P., & Furmaniak, M. (2021). *Operational analysis of fire alarm systems with a focused, dispersed and mixed structure in critical infrastructure buildings*. *Energies, 14*(23), Article 7893. [Crossref]

Myagmar-Ochir, B., & Kim, J. (2023). Real-time surveillance monitoring and active response systems in commercial risk management. *Journal of Digital Security and Risk Analytics, 5*(2), 44–60.

National Fire Protection Association. (2022). *NFPA 72: National fire alarm and signaling code* (2022 ed.). [Link]

Nte, N. D., Gande, T., & Uzorka, M. (2020). The challenges and prospects of ICTs in crime prevention and management in Nigeria: A review of CCTV camera in Abuja. *African Journal of Criminology and Justice Studies, 14*(2), 88–104.

Ohanaka, B. U., Michael, D. O., Udeogu, C., Bardi, I. A., & Odoemene, I. O. (2025). Leveraging a Hybridized CNN-HARS Surveillance Model for Security Threat Detection in Imo State, Nigeria. *Faculty of Natural and Applied Sciences Journal of Computing and Applications*, *2*(3), 52–61. [Crossref]

Oladunni, O., & Okonkwo, C. (2022). Impact of risk retention on claims management of insurance companies in Nigeria. *FUOYE Journal of Finance and Contemporary Issues, 5*(1), 12–28. 3(1), 63-79. [Link]

Oloke, O. C., Keke, O. V., Mushanga, S., & Nwokolo, B. O. (2024). Efficacy of closed-circuit television in security management of commercial properties in Lagos Metropolis, Nigeria. *International Journal of Safety and Security Engineering, 14*(6), 1719–1727. [Crossref]

Piza, E. L., Welsh, B. C., Farrington, D. P., & Thomas, A. L. (2019). CCTV surveillance for crime prevention: A 40-year systematic review with meta-analysis. *Criminology & Public Policy,18*(1),135159. [Crossref]

Shittu, H. B., Adekola, N. O., Zamani, A. E., Adegboye, L. A., & Uzamere, I. O. (2023). Crime management strategies on crime incidence in Lagos State, Nigeria. *International Journal of Conflict and Security Management, 3*(1), 1–12.

Sølvsten, S., & Kaiser, A. (2023). Loss prevention technologies' effect on property damage cost and financial savings. *Journal of Risk Management and Insurance, 27*(1), 57–81. [Link]

Ukwayi, J. K., Obafaye, M., & Akintola, O. (2019). Security technologies and crime reduction strategies in Nigeria's urban commercial centres. *Journal of Contemporary African Studies, 37*(4), 512–529.

Vennam, P., Pramod, T. C., Thippeswamy, B. M., Kim, Y.-G., & Pavan Kumar, B. N. (2021). *Attacks and preventive measures on video surveillance systems: A review*. *Applied Sciences, 11*(12), Article 5571. [Crossref]

Welsh, B. C., & Farrington, D. P. (2002). *Crime prevention effects of closed circuit television: A systematic review* (Home Office Research Study No. 252). Home Office Research, Development and Statistics Directorate.