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Development of Accident Reporting and Investigation Framework for Reducing Life-Threatening Incidents on Building Construction Sites in Ondo State, Nigeria

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Abstract- The construction industry is one of the most hazardous occupational sectors, with life-threatening incidents such as falls from height, struck-by incidents, electrocution, and equipment-related injuries occurring frequently. In Ondo State, existing accident reporting and investigation practices are largely informal and inconsistent, limiting effective accident prevention and organisational learning. This study therefore assessed accident reporting and investigation practices with a view to developing a standardized framework for reducing life-threatening incidents on building construction sites. The study adopted a quantitative cross-sectional survey design as the third phase of a sequential research programme. Structured questionnaires were administered electronically through Google Forms to construction professionals and site personnel in Ondo State using purposive sampling. A total of 71 valid responses were obtained. Data were analysed using descriptive statistics, factor analysis, and regression analysis to examine accident causes, reporting systems, and investigation methods.

Unsafe work practices recorded the highest perceived accident cause (Mean = 3.99), followed by defective equipment and inadequate safety training (Mean = 3.87 each). Respondents strongly supported immediate accident reporting (Mean = 4.07) and government-mandated standardized reporting templates (Mean = 4.03). For investigation practices, sharing lessons learned (Mean = 4.14), monitoring recommendations until implementation (Mean = 4.11), and multidisciplinary investigation teams (Mean = 4.10) ranked highest. Regression analysis revealed significant relationships between accident causes and accident reporting systems ($\beta = .879, p < .001$), and between reporting systems and investigation methods ($\beta = .843, p < .001$). Accident causes and reporting systems jointly explained 91.4% of the variance in investigation methods. The findings demonstrated that a structured accident reporting system is central to effective accident investigation and safety improvement. The results suggested that accident reporting may serve as an important intervening mechanism linking accident causes to investigation effectiveness, although formal mediation testing is required for confirmation. The study recommended that Construction organisations should adopt standardized and timely accident reporting procedures, strengthen systematic root-cause investigation, establish multidisciplinary investigation teams, monitor corrective actions to completion, and share lessons learned with workers. Government agencies should support standardized reporting requirements and centralized accident databases, while future studies should employ larger and longitudinal samples to develop a validated model.

Keywords: accident investigation; accident reporting; construction safety; root cause analysis; safety management.

I. INTRODUCTION

The construction industry plays a critical role in national economic development through infrastructure provision, employment generation, urban expansion, and industrial growth. The sector contributes significantly to gross domestic product, stimulates investment, and provides livelihood opportunities for millions of workers. However, construction activities are characterized by dynamic work environments, temporary organizational structures, multiple subcontracting arrangements, changing site conditions, and extensive exposure to physical hazards, making the industry one of the most dangerous occupational sectors globally (International Labour Organization [ILO], 2022, 2024). Globally, workplace accidents continue to constitute a major public health and economic challenge. The International Labour Organization estimates that millions of workers are injured annually, while hundreds of thousands lose their lives due to occupational accidents and work-related diseases. Construction remains disproportionately represented among fatal occupational accidents, with falls from height, electrocution, struck-by incidents, and caught-between accidents consistently identified as leading causes of worker fatalities (ILO, 2021, 2022). The persistence of these incidents indicates that accident prevention requires more than compliance with safety regulations; it requires effective accident reporting, systematic investigation, and continuous organizational learning.

A safe and healthy working environment has been recognized internationally as a fundamental principle and right at work. Contemporary occupational safety and health frameworks emphasize prevention through hazard identification, risk assessment, incident reporting, investigation, corrective actions, and institutional learning (ILO, 2024). Effective accident reporting systems provide organizations with reliable information on accident patterns, contributing factors, severity levels, and corrective measures, thereby supporting evidence-based safety management and policy development. However, in many developing countries, including Nigeria, construction site accidents remain significantly underreported. Many incidents are treated informally, resolved internally, or excluded from official records, resulting in incomplete accident databases and limited opportunities for organizational learning. Where accident reports exist, they often focus primarily on immediate causes while neglecting the underlying organizational, managerial, and systemic factors that contribute to accident occurrence. Consequently, similar accidents continue to recur across different construction projects despite previous experiences.

In addition, accident reporting and investigation are complementary processes within occupational safety management systems. Reporting involves the systematic documentation of accident occurrence, while investigation seeks to determine what happened, why it happened, and how similar incidents can be prevented. International best practice recommends that accident investigations identify both immediate causes, such as unsafe acts and unsafe conditions, and root causes, including inadequate supervision, insufficient training, poor planning, ineffective communication, deficient safety culture, and organizational management failures. Root cause identification is particularly important because interventions targeting only immediate causes frequently fail to prevent recurrence. Recent developments in safety management emphasize integrated accident reporting and investigation systems that combine standardized documentation procedures, structured causal analysis, corrective action tracking, and organizational feedback mechanisms. Such systems facilitate trend analysis, knowledge sharing, regulatory compliance, and continuous safety improvement. However, their implementation within many Nigerian construction organizations remains limited.

This study forms the final phase of a broader TETFund-sponsored research programme on construction site accidents in Ondo State. The first phase investigated accident characteristics in selected building projects in Owo Local Government Area and documented the prevalence of falls, struck-by incidents, equipment-related accidents, and inadequate reporting practices (Williams, Olowolayemo & Ogunbode, 2026a). The second phase evaluated accident patterns in Akure South Local Government Area and similarly identified significant deficiencies in accident documentation, investigation, and preventive safety management (Williams, Olowolayemo & Ogunbode, 2026b). Collectively, these studies demonstrated that accident reporting practices across the investigated locations lacked standardization, consistency, and analytical depth. The evidence generated from the earlier investigations established the need for a comprehensive accident reporting and investigation framework specifically designed for the Nigerian building construction industry. Existing reporting practices provide insufficient information for identifying recurrent hazards, understanding root causes, evaluating corrective actions, and preventing future life-threatening incidents. Consequently, there is a pressing need to develop a framework for accident reporting system, systematic investigation, root cause analysis, and corrective action management. This is intended to provide a practical framework for contractors, consultants, clients, regulatory agencies, and construction organizations in documenting accidents, investigating causal mechanisms, implementing corrective actions, and strengthening organizational learning for accident prevention.

1.1 Research objectives

The primary objective of this research is to develop a robust accident reporting and investigation framework designed to reduce life-threatening incidents on building construction sites in Ondo State.

The specific objectives are to:

1. investigate the immediate and root causes of accidents on building construction sites in Ondo State;

2. determine a standardized accident reporting system for the building construction industry; and
3. develop accident investigation framework useful in identifying immediate and root causes of life-threatening incidents.

1.2 Research hypotheses

Based on the conceptual relationships among accident causes, accident reporting systems and accident investigation methods, the study tested the following hypotheses:

H1: Accident causes (ACC) have a significant positive effect on the accident reporting system (ARS).

H2: Accident reporting system (ARS) has a significant positive effect on accident investigation methods (AIM), controlling for accident causes (ACC).

H3: Accident causes (ACC) have a significant positive effect on accident investigation methods (AIM) when considered independently.

H4: Accident causes (ACC) have a significant positive effect on accident investigation methods (AIM) after controlling for accident reporting system (ARS).

H5: Accident reporting system (ARS) significantly mediates the relationship between accident causes (ACC) and accident investigation methods (AIM).

1.3 Significance of the study

The study is significant because it moves beyond accident occurrence analysis to the development of a practical safety management tool. The proposed framework will assist contractors in standardizing accident documentation, enable investigators to conduct systematic root cause analyses, support regulatory agencies in improving accident surveillance, and provide researchers with a structured framework for accident data collection and safety performance evaluation. Furthermore, the framework is expected to strengthen organizational learning, improve preventive safety management, and contribute to the reduction of life-threatening construction site incidents in Nigeria.

2.1 Construction safety and occupational accidents

The construction industry consistently records one of the highest occupational injury and fatality rates worldwide because of its complex work environment, temporary project organizations, hazardous tasks, and multiple subcontracting arrangements (ILO, 2022, 2024; Newaz et al., 2025). Construction workers are routinely exposed to falls, electrocution, struck-by incidents, machinery accidents, structural collapses, and material handling hazards, making effective safety management a critical project management function (Woźniak & Hoła, 2024; Shayboun et al., 2025). The industry's accident burden has significant economic, social, and organizational consequences, including productivity loss, compensation costs, project delays, legal liabilities, and reputational damage (ILO, 2024; Newaz et al., 2025).

2.2 Life-threatening incidents on building construction sites

Life-threatening incidents include accidents with a high probability of fatality, permanent disability, or severe trauma. Falls from height remain the leading cause of fatal construction accidents globally, followed by struck-by incidents, electrocution, and caught-in or between accidents (ILO, 2022; Newaz et al., 2025). Near-miss events are increasingly recognized as precursors to fatal accidents, and organizations that systematically report and investigate near misses generally achieve better safety outcomes (Woźniak & Hoła, 2024). Effective prevention therefore depends on identifying hazardous conditions before they develop into severe incidents.

2.3 Immediate causes of construction accidents

Immediate causes refer to unsafe acts and unsafe conditions directly preceding accident occurrence. These include failure to use personal protective equipment, unsafe scaffolding, defective equipment, poor housekeeping, inadequate edge protection, unsafe lifting operations, and exposure to energized electrical systems (ILO, 2022; Newaz et al., 2025). However, focusing exclusively on immediate causes often produces superficial investigations that fail to prevent recurrence because the underlying organizational factors remain unaddressed (Reason, 1997; Bird & Germain, 1996).

2.4 Root causes of construction accidents

Root causes represent the fundamental organizational and management failures that create conditions for accidents. Research consistently identifies inadequate supervision, poor safety culture, insufficient training, weak communication, ineffective planning, production pressure, subcontractor coordination failures, and inadequate management commitment as major contributors to construction accidents (Darimaani et al., 2024; Woźniak & Hoła, 2024). Addressing root causes requires systematic investigation procedures capable of tracing accident pathways beyond immediate site conditions.

2.5 Accident reporting systems

Accident reporting systems provide structured mechanisms for documenting accidents, near misses, hazardous conditions, causal factors, injuries, corrective actions, and organizational responses. Standardized reporting systems improve data quality, facilitate trend analysis, support regulatory compliance, and enhance organizational learning (Shayboun et al., 2025). Recent research emphasizes digital reporting systems, mobile reporting applications, and centralized accident databases as effective tools for improving reporting efficiency and safety intelligence (Shayboun et al., 2025; Wang & Li, 2026).

2.6 Under-reporting of construction accidents

Under-reporting remains one of the most serious challenges affecting accident prevention in developing countries. Factors associated with under-reporting include fear of blame, job insecurity, poor safety culture, inadequate management commitment, limited regulatory enforcement, and ineffective communication systems (Darimaani et al., 2024). Under-reporting reduces the availability of reliable accident data and limits the ability of organizations to identify recurring hazards and evaluate preventive interventions.

2.7 Research gap

Although numerous studies have investigated construction accidents in Nigeria and other developing countries, three major gaps remain. First, most studies rely primarily on perception-based questionnaires rather than standardized accident reporting records. Secondly, limited research has integrated accident reporting with systematic root cause investigation and corrective action tracking. Thirdly, few studies have considered developing a standardized reporting and investigation framework incorporating standardized accident reporting records and accident reporting system. However, the present study addresses these gaps by developing a standardized reporting and investigation framework incorporating immediate cause analysis, root cause analysis, and corrective action management.

III. MATERIALS AND METHODS

3.1 Study area

The study was conducted in Ondo State, Nigeria, located in the South-West geopolitical zone. Ondo State has experienced substantial growth in residential, commercial, institutional, and infrastructure development, resulting in increased construction activities across its eighteen local government areas. The study focused on registered construction firms, ongoing building projects, consulting organizations, and construction professionals operating within the state.

3.2 Research design

The study adopted a quantitative cross-sectional survey research design. The design was considered appropriate because it enables the collection of data from a large number of respondents at a single point in time and facilitates the examination of perceptions regarding accident causation, reporting practices, investigation procedures, and safety management systems. However, the research represents the third phase of a sequential mixed-methods research programme. The first and second phases involved accident case investigations in Owo and Akure South Local Government Areas (Williams, Olowolayemo & Ogunbode, 2026a,b), respectively, while the current phase focuses on assessment of accident reporting system and investigation methods using questionnaire-based survey data.

3.3 Target population

The target population comprised construction professionals and site personnel involved in building construction projects across Ondo State. The respondents included: Builders, Quantity Surveyors, Architects, Civil and Structural Engineers, Project Managers, Site Engineers, Site Supervisors, Safety Officers, Contractors, and Construction Managers. These categories were reached because they participate directly in construction planning, supervision, accident reporting, safety management, and incident investigation.

3.4 Sampling technique

A purposive sampling technique was employed to select respondents with relevant experience in construction site safety, accident reporting, project supervision, and incident investigation. The inclusion criteria required that respondents had participated in building construction projects in Ondo State and

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possessed sufficient knowledge of construction safety practices.

3.5 Research instrument

Data were collected using a structured questionnaire developed and administered through Google Forms. The online survey platform was selected because it facilitates rapid distribution, broader geographical coverage, automated data recording, improved response management, and efficient data export for statistical analysis. The questionnaire was developed based on: international accident reporting guidelines, occupational safety and health management principles, accident causation theories, root cause analysis frameworks, and existing construction safety literature. Moreover, the questionnaire consisted of six sections: Section A: Respondents' demographic and professional characteristics; Section B: Immediate and root causes of construction accidents; Section C: Existing accident reporting system, and Section D: Accident investigation methods. Most questionnaire items were measured using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

3.6 Data collection procedure

The Google Forms questionnaire was distributed electronically through: professional associations, construction company networks, project management groups, email platforms, WhatsApp professional groups, and direct communication with construction organizations. However, participation was voluntary, and respondents completed the questionnaire anonymously. The online survey remained open for a predetermined data collection period, during which reminder messages were issued periodically to improve the response rate.

3.7 Data analysis

Data analysis was conducted after completion of the field survey. Descriptive statistics, reliability analysis, factor analysis, regression analysis, and appropriate inferential statistical techniques were employed to test the research hypotheses.

Results And Discussion

Table 1.0: Highest Qualification

Qualification		Frequency	Percent	Valid Percent	Cumulative Percent
OND/NCE	6	8.5	8.5	8.5	
HND/BSc	43	60.5	60.5	69.0	
MSc/MTech	18	25.4	25.4	94.4	
PhD	4	5.6	5.6	100.0	
Total	71	100.0	100.0		

Source: Field Survey, 2026.

Table 1.0 shows a highly educated pool of respondents, with over 91% possessing tertiary qualifications (BSc/HND at 60.5%, MSc/MTech at 25.4%, and PhD at 5.6%). Only 8.5% hold lower qualifications (OND/NCE). This high level of educational attainment suggests that the survey participants possess the cognitive capacity and technical background needed to comprehend site safety protocols, evaluate accident causes, and offer informed feedback on reporting systems.

Table 2.0: Profession

	Profession	Frequency	Percent	Cumulative Percent
Valid	Builder	3	4.2	4.2
	Quantity Surveying	51	71.8	76.1
	Architect	6	8.5	84.5
	Engineer	9	12.7	97.2
	Contractor	1	1.4	98.6
	Others	1	1.4	100.0
	Total	71	100.0	

Source: Field Survey, 2026.

In Table 2.0, the survey respondents are heavily concentrated in Quantity Surveying, accounting for 71.8% of the total sample (n = 51). Engineering (12.7%) and Architecture (8.5%) represent the next largest professional groups, with Builders, Contractors, and others making up the remaining small percentage. While this reflects strong participation from core construction cost and management experts, the heavy tilt toward Quantity Surveyors highlights a relative under-representation of direct site supervisors like builders and field engineers.

Table 3.0: Years of Experience

Years of Experience		Frequency	Percent	Cumulative Percent
Valid	Less than 5 years	16	22.5	22.5
	5 - 10 years	28	39.4	62.0
	11 - 15 years	6	8.5	70.4
	16 - 20 years	4	5.6	76.1
	Above 20 years	17	23.9	100.0
	Total	71	100.0	

Source: Field Survey, 2026.

Shown in Table 3.0, the respondents demonstrate substantial industry experience, as over 77% have more than 5 years of working experience. The largest single group consists of professionals with 5–10 years of experience (39.4%), followed closely by those with over 20 years in the field (23.9%). Early-career professionals (less than 5 years) account for 22.5%. This balanced distribution between mid-level and veteran practitioners enhances the reliability and practical relevance of the survey findings.

Table 4.0: Type of Profession

Type of Organisation		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Contracting Firm	20	28.2	28.2	28.2
	Consulting Firm	37	38.0	38.0	66.2
	Government Agency	13	18.3	18.3	84.5
	Client Organisation	10	14.1	14.1	98.6
	Others	1	1.4	1.4	100.0
	Total	71	100.0	100.0	

Source: Field Survey, 2026.

For type of organisation in Table 4.0, the majority of respondents work in Consulting Firms (38.0%) and Contracting Firms (28.2%), representing two-thirds of the total sample. Government Agencies (18.3%) and Client Organizations (14.1%) also have a notable presence. The strong representation from both consulting and contracting entities ensures that the findings capture perspectives from both project design/supervision and direct site execution environments.

Table 5.0: Descriptive Analysis of Root and Immediate Causes of Accidents

Rank	Description of Item	N	Mean	Std. Deviation
1	Unsafe work practices frequently result in accidents on construction sites.	71	3.99	1.399
2	Defective equipment contributes to serious accidents	71	3.87	1.264
3	Lack of safety training is a root cause of accidents	71	3.87	1.372
4	Failure to use personal protective equipment (PPE) is a major immediate cause of accidents.	71	3.83	1.483

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Rank	Description of Item	N	Mean	Std. Deviation
5	Poor safety culture within organisations contributes to accidents	71	3.81	1.376
6	Management's failure to enforce safety rules contributes to accidents	71	3.80	1.450
7	Lack of workers' safety awareness contributes significantly to construction accidents.	71	3.80	1.489
8	Worker fatigue contributes significantly to construction accidents	71	3.66	1.340
9	Inadequate supervision is a major cause of accidents.	71	3.64	1.310
10	Working under pressure increases accident occurrence	71	3.64	1.404
11	Environmental factors (weather, slippery surfaces, poor visibility) significantly contribute to accidents	71	3.63	1.386
12	Inadequate risk assessment leads to accidents	71	3.59	1.345
13	Poor planning of construction activities increases accident risks	71	3.54	1.400
14	Poor housekeeping increases accident occurrence.	71	3.54	1.411
15	Poor communication among workers contributes to accidents.	71	3.47	1.295

Source: Field Survey, 2026.

All listed causes in Table 5.0 received high mean agreement scores ranging from 3.47 to 3.99 on a 5-point scale. The top-ranked cause is "Unsafe work practices" (Mean = 3.99), followed by "Defective equipment" (Mean = 3.87) and "Lack of safety training" (Mean = 3.87). Notably, the findings highlight that practitioners view immediate physical hazards (such as PPE failure and defective gear) and underlying organizational failures (such as poor safety culture and lack of training) as almost equally influential drivers of construction accidents.

Table 6.0: Descriptive Statistics of Accident Reporting System

Rank	Description of Item	N	Mean	Std. Deviation
1	Every accident should be reported immediately after occurrence	71	4.07	1.407
2	Government agencies should mandate the use of a standard accident reporting template	71	4.03	1.373
3	The exact location of accidents should be documented	71	3.99	1.368
4	All accident reports should be reviewed by management	71	3.99	1.429

Rank	Description of Item	N	Mean	Std. Deviation
5	Standard reporting procedures improve safety performance	71	3.96	1.303
6	The reporting system should capture photographs of accident scenes	71	3.96	1.346
7	Accident reports should include recommendations for preventing recurrence	71	3.96	1.507
8	The date and time of accidents should always be recorded	71	3.90	1.426
9	Safety officers should be responsible for accident documentation	71	3.87	1.434
10	A central accident database should be maintained by construction firms	71	3.87	1.482
11	A standard accident report form should be adopted across the industry	71	3.84	1.430
12	Digital accident reporting should be encouraged	71	3.82	1.477
13	Accident reports should contain information on injured persons	71	3.77	1.396
14	Near-miss incidents should be included in accident reporting	71	3.67	1.431
15	The names of witnesses should be included in accident reports	71	3.51	1.393

Source: Field Survey, 2026.

In Table 6.0, the respondents strongly endorsed key structural features of a standardized reporting system. The highest-rated items include the requirement that "Every accident should be reported immediately after occurrence" (Mean = 4.07) and that "Government agencies should mandate the use of a standard accident reporting template" (Mean = 4.03). Documenting exact locations, management review, and capturing scene photographs also ranked very high (Means $\ge$ 3.96). Lower-ranked items like including witness names (Mean = 3.51) and reporting near-misses (Mean = 3.67) still indicate general agreement, pointing toward broad consensus for a formalized, mandatory reporting structure.

Table 7.0: Descriptive Statistics of Accident Investigation Methods

Rank	Description of Item	N	Mean	Std. Deviation
1	Lessons learned from investigations should be shared with workers	71	4.14	1.302
2	Recommendations should be monitored until implemented	71	4.11	1.326

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Rank	Description of Item	N	Mean	Std. Deviation
3	Investigation teams should consist of multidisciplinary professionals	71	4.10	1.278
4	Every serious accident should be formally investigated	71	4.06	1.403
5	Accident investigations should identify both immediate and root causes	71	4.04	1.449
6	The investigation model should be easy to apply on construction sites	71	4.00	1.352
7	Management practices should be evaluated during investigations	71	3.93	1.324
8	Physical evidence should be preserved during accident investigation	71	3.90	1.311
9	The model should include equipment and machinery assessment	71	3.90	1.311
10	Safety policy compliance should be examined during investigations	71	3.90	1.426
11	The investigation process should identify organisational weaknesses	71	3.89	1.389
12	The investigation model should include human factors analysis	71	3.87	1.287
13	A standard investigation model will reduce future accident occurrence	71	3.86	1.407
14	Witness interviews should be conducted immediately after accidents	71	3.84	1.261
15	Root Cause Analysis (RCA) should be part of every accident investigation	71	3.81	1.437

Source: Field Survey, 2026.

In Table 7.0, items related to closing the feedback loop and institutional learning received the highest scores in the survey. "Lessons learned from investigations should be shared with workers" ranked first (Mean = 4.14), closely followed by monitoring recommendations until implementation (Mean = 4.11) and using multidisciplinary investigation teams (Mean = 4.10). The high agreement across all items (Means ranging from 3.81 to 4.14) reflects strong demand among construction professionals for systematic investigation models that do not merely assign blame, but actively drive safety improvements on site.

Factor Analysis of Root and Immediate Causes of Accidents, Accident Reporting System, and Accident Investigation System

Table 8.0: Rotated Factor Matrix[a]

	Factor			
	1	2	3	4
COA1	.311	.467	.202	.515
COA2	.323	.348	.324	.533

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COA3	.418	.448	.428	.410
COA4	.293	.345	.356	.617
COA5	.445	.367	.557	.195
COA6	.500	.243	.608	.121
COA7	.244	.330	.631	.128
COA8	.455	.105	.527	.498
COA9	.373	.337	.455	.508
COA10	.359	.272	.561	.448
COA11	.397	.105	.603	.369
COA12	.323	.410	.478	.621
COA13	.165	.290	.681	.356
COA14	.116	.240	.784	.293
COA15	.368	.192	.465	.595
SARS1	.566	.457	.216	.347
SARS2	.591	.371	.287	.297
SARS3	.536	.466	.325	.322
SARS4	.336	.592	.442	.248
SARS5	.218	.641	.440	.097
SARS6	.496	.538	.377	.357
SARS7	.409	.593	.369	.336
SARS8	.531	.563	.232	.430
SARS9	.630	.478	.331	.321
SARS10	.408	.651	.258	.368
SARS11	.480	.574	.287	.394
SARS12	.358	.706	.276	.380
SARS13	.350	.634	.300	.441
SARS14	.638	.413	.312	.325
SARS15	.617	.454	.220	.386
CVAI1	.643	.486	.386	.312
CVAI2	.725	.416	.343	.319
CVAI3	.548	.537	.400	.088
CVAI4	.416	.723	.111	.213
CVAI5	.552	.633	.282	.341
CVAI6	.457	.616	.323	.261
CVAI7	.485	.593	.488	.095
CVAI8	.601	.556	.311	.328
CVAI9	.370	.681	.264	.229
CVAI10	.601	.508	.275	.398
CVAI11	.683	.465	.334	.270
CVAI12	.681	.477	.257	.353
CVAI13	.638	.392	.402	.252
CVAI14	.686	.424	.335	.313
VCVAI15	.680	.367	.282	.312

Source: Field Survey, 2026.
Extraction Method: Principal Axis Factoring.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 25 iterations.

Shown in Table 8.0 is the Rotated Factor Matrix. The factor analysis (Principal Axis Factoring with Varimax rotation) groups items across accident causes (COA), reporting systems (SARS), and investigation methods (CVAI) across four extracted factors.

Factor 1 shows high loadings on key investigation variables (e.g., CVAI2 at .725, CVAI14 at .686) and general reporting items (SARS9 at .630).

- Factor 2 captures digital and formal reporting mechanisms, with high loadings on digital reporting (SARS12 at .706) and central databases (SARS10 at .651).
- Factor 3 primarily represents operational site conditions and management factors (e.g., housekeeping COA14 at .784, planning COA13 at .681).
- Factor 4 reflects immediate human and equipment causes, such as inadequate risk assessment (COA12 at .621) and failure to use PPE (COA4 at .617).

Overall, the cross-loadings across these factors demonstrate strong statistical interrelationships among cause identification, reporting rigor, and investigation practices.

Table 9.0 Regression results for the relationships among Accident causes (ACC), Accident Reporting System (ARS) and Accident Investigation Methods (AIM)

Results section

Model/Relationship	R	R^2	Adjusted R^2	F	p-value
ACC → ARS	0.879	0.773	0.770	235.344	<0.001
ACC + ARS → AIM	0.956	0.914	0.912	362.229	<0.001
ACC → AIM	0.868	0.753	0.750	210.609	<0.001

Source: Field Survey, 2026.

The first model indicates a strong relationship between ACC and ARS, with ACC explaining 77.3% of the variance in ARS. The model was statistically significant, $F(1, 69) = 235.344$, $p < .001$.

The second model demonstrates that ACC and ARS jointly explain 91.4% of the variance in AIM. The overall model was statistically significant, $F(2, 68) = 362.229$, $p < .001$.

The third model shows that ACC alone explains 75.3% of the variance in AIM and the model was statistically significant, $F(1, 69) = 210.609$, $p < .001$.

Coefficient results

Dependent variable	Predictor	B	B	t	p
ARS	ACC	0.965	0.879	15.341	<0.001
AIM	ACC	0.138	0.127	1.701	.093
AIM	ARS	0.833	0.843	11.294	<0.001
AIM	ACC (alone)	0.942	0.868	14.512	<0.001

Source: Field Survey, 2026.

The results show that ACC significantly and positively predicts ARS ($\beta = .879$, $p < .001$).

When ACC and ARS are simultaneously included in predicting AIM, ARS remains a significant predictor ($\beta = .843$, $p < .001$), whereas ACC becomes non-significant ($\beta = .127$, $p = .093$).

Interestingly, ACC is a significant predictor of AIM when entered alone ($\beta = .868$, $p < .001$).

IV. DISCUSSION OF FINDINGS

The findings indicate that ACC is strongly associated with ARS. The magnitude of the standardized coefficient ($\beta = .879$) demonstrates a very strong positive relationship, while the high R^2 value of .773 indicates that ACC accounts for a substantial proportion of the observed variation in ARS. This finding suggests that variations in ACC are closely associated with corresponding variations in ARS within the study context.

The findings further reveal that ARS is a particularly important predictor of AIM. When ACC and ARS were entered simultaneously into the regression model, ARS produced a substantially stronger standardized coefficient ($\beta = .843$) than ACC ($\beta = .127$). Furthermore, ARS was statistically significant whereas ACC was not. This indicates that ARS possesses the stronger unique explanatory contribution to AIM when the two predictors are considered simultaneously.

The comparison between the second and third regression models is especially important. Although ACC independently explains 75.3% of the variance in AIM, its effect becomes statistically insignificant once ARS is introduced into the model. At the same time, the explanatory power of the model increases from 75.3% to 91.4%.

This pattern is consistent with a possible mediating role of ARS in the ACC–AIM relationship. However, the regression output alone does not formally establish mediation. A formal mediation analysis, preferably using bootstrapped confidence intervals for the indirect effect, would be required before the article can conclusively state that ARS mediates the relationship.

4.1 Hypotheses

Hypothesis	Relationship	Result	Decision
H1	ACC → ARS	$\beta = .879$, $p < .001$	Supported
H2	ARS → AIM	$\beta = .843$, $p < .001$	Supported
H3	ACC → AIM	$\beta = .868$, $p < .001$	Supported when tested independently
H4	ACC → AIM controlling for ARS	$\beta = .127$, $p = .093$	Not supported
H5	ARS mediates ACC → AIM		Requires formal mediation test

Source: Field Survey, 2026.

There is an important distinction here: H3 is supported for the simple/direct regression of ACC on AIM, but the effect is not significant after ARS is included in the multiple regression.

4.2 Article-level interpretation

The most interesting contribution of these results is therefore not simply that ACC affects AIM. Rather, the results indicate that the relationship between ACC and AIM changes substantially when ARS is taken into account. ACC has a strong independent relationship with AIM, but ARS appears to absorb much of this explanatory influence when both variables are considered simultaneously.

The regression pattern can therefore be represented conceptually as:

ACC → ARS → AIM

with:

- ACC → ARS: strong and significant;
- ARS → AIM: strong and significant;
- ACC → AIM: strong and significant when tested alone;
- ACC → AIM controlling for ARS: weak and non-significant.

4.3 Theoretical Implications

The findings have important theoretical implications for understanding the relationships among ACC, ARS and AIM.

First, the results demonstrate the importance of examining intervening relationships rather than relying exclusively on direct relationships between independent and dependent variables. The significant independent relationship between ACC and AIM might initially suggest that ACC directly determines AIM. However, the disappearance of the significant ACC effect after ARS is introduced indicates that the relationship is more complex.

Second, the findings provide empirical support for positioning ARS as a potentially important explanatory mechanism between ACC and AIM. The strong ACC–ARS relationship and strong ARS–AIM relationship suggests that theoretical models involving these constructs should consider ARS as more than a peripheral variable.

Third, the high explanatory power of the combined model suggests that incorporating both ACC and ARS provides a substantially better understanding of AIM than considering ACC alone. The increase in R^2 from 0.753 to 0.914 demonstrates the analytical value of incorporating ARS into the explanatory framework.

4.4 Development of the Proposed Accident Reporting and Investigation Framework

The proposed framework was derived from the study findings on accident causes, accident reporting and accident investigation. The regression results showed that accident causes significantly predicted accident reporting systems ($\beta = .879$, $p < .001$), while accident reporting systems significantly predicted accident investigation methods ($\beta = .843$, $p < .001$). Although accident causes independently predicted investigation methods ($\beta = .868$, $p < .001$), this relationship became non-significant when accident reporting was introduced ($\beta = .127$, $p = .093$). The combined model explained 91.4% of the variance in accident investigation methods.

Based on these findings, the framework positions the Accident Reporting System (ARS) as the central link between accident causes and systematic investigation, while extending the process to corrective action, monitoring and organisational learning.

4.5 Structure of the Proposed Framework

The framework consists of a continuous sequence:

Accident Causes → Accident Reporting System → Accident Investigation → Corrective Action → Monitoring/Feedback → Safety Improvement

Accident causes comprise immediate and underlying factors such as unsafe work practices, defective equipment, inadequate training, poor safety culture and inadequate supervision. The reporting stage emphasises timely and standardised documentation, while the investigation stage focuses on identifying immediate and root causes. These are followed by implementation and monitoring of corrective actions and sharing of lessons learned. The reporting and investigation components are supported by the high ratings obtained for standardised reporting, immediate reporting, multidisciplinary investigation, monitoring of recommendations and sharing lessons learned.

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4.5.1 Proposed Accident Reporting and Investigation Framework

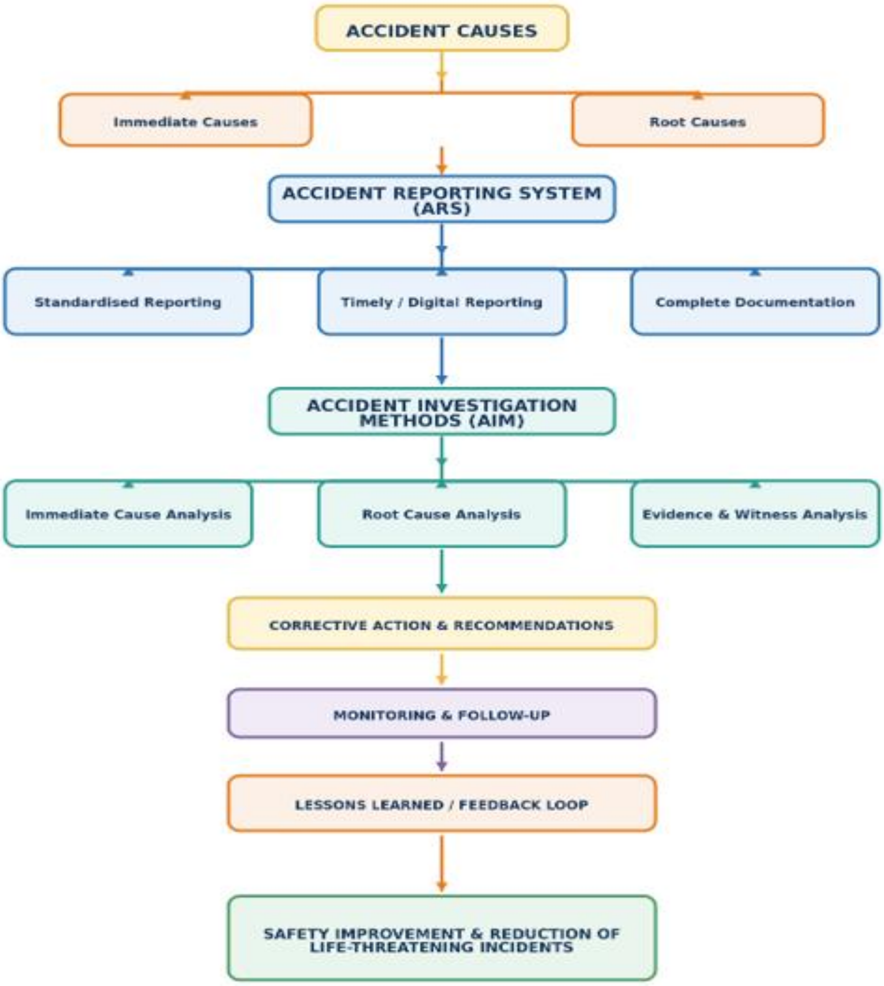

Figure 1: Proposed Accident Reporting and Investigation Framework

4.5.2 Explanation of the Framework

The framework proposes that effective accident prevention begins with identifying accident causes and documenting incidents through a standardised reporting system. The information generated from reporting provides the basis for systematic investigation of immediate and root causes. Investigation findings are subsequently converted into corrective actions, which are monitored until implementation. Lessons learned are communicated to workers and incorporated into future safety practices, creating a continuous feedback process for improving safety performance.

The central empirical relationship underpinning the framework is therefore:

ACC → ARS → AIM

V. CONCLUSION

This study examined the relationships among ACC, ARS and AIM using regression analysis. The findings demonstrate a strong and statistically significant positive relationship between ACC and ARS, with ACC accounting for 77.3% of the variance in ARS. ACC also independently predicts AIM, explaining 75.3% of its variance.

However, when ACC and ARS are simultaneously considered as predictors of AIM, the explanatory power of the model increases substantially to 91.4%. More importantly, ARS remains a strong and statistically significant predictor of AIM, whereas the independent contribution of ACC becomes statistically insignificant.

The findings therefore indicate that ARS occupies a central position in the relationship among the three constructs. The results are consistent with the possibility that ARS serves as an intervening mechanism through which ACC influences AIM. Nevertheless, because the present analysis does not formally estimate the indirect effect, this interpretation should be treated as suggestive rather than conclusive.

The study consequently contributes to a more nuanced understanding of the relationship among ACC, ARS and AIM by demonstrating that a strong direct relationship between an antecedent and an outcome may substantially diminish when an important intervening variable is incorporated into the analytical model.

VI. RECOMMENDATIONS

Based on the findings, the following recommendations are made:

1. Greater attention should be given to Accident Reporting System. Since it emerged as the strongest significant predictor of Accident Investigation Methods in the multiple regression model, practitioners should give priority to strategies that strengthen Accident Reporting System.
2. Accident Causes-related interventions should incorporate Accident Reporting System. The strong relationship between Accident Causes and Accident Reporting System suggests that improvements in Accident Causes should be designed in ways that also promote or strengthen Accident Reporting System.
3. Organisations should adopt an integrated approach. Rather than addressing Accident Causes, Accident Reporting System and Accident Investigation Methods independently, policies and interventions should recognise the interrelationship among the constructs.
4. Formal mediation analysis should be undertaken in future research. Researchers should test the indirect effect of Accident Causes on Accident Investigation Methods through Accident Reporting System using bootstrapping or another appropriate mediation technique. This would establish whether the apparent intervening role of Accident Reporting System is statistically significant.
5. Future studies should employ larger samples. A larger and more diverse sample would improve statistical power and enhance the generalisability of the findings.
6. Future research should incorporate additional predictors. Although Accident Causes and Accident Reporting System jointly explain 91.4% of the variance in Accident Investigation Methods, other explanatory variables may account for the remaining variation and should be investigated.
7. Longitudinal research is recommended. Where feasible, future studies should use longitudinal data to establish temporal ordering among Accident Causes, Accident Reporting System and Accident Investigation Methods and provide stronger evidence regarding causal relationships.
8. Future studies should replicate the framework in different contexts. Replication across different populations, sectors or geographical settings would help determine whether the observed relationships are robust and generalisable.

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