

Developing a Safety Competence Evaluation Framework for Artisans in the Nigerian Construction Industry

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Abstract

The construction industry is recognised worldwide as one of the most dangerous industries related to accidents, especially in developing countries. This is because the artisans, who play a crucial role in construction activities, have inadequate safety competencies, thereby contributing significantly to these unsatisfactory safety outcomes. However, despite considerable efforts to improve the safety competencies of construction artisans, initiatives aimed at evaluating safety-related competencies remain limited. Consequently, this research aims to address this deficiency by developing a safety competence assessment framework specifically for artisans in the Nigerian construction industry. A cross-sectional survey approach was used to gather data from 470 safety managers and supervisors, followed by exploratory factor analysis to identify factors influencing safety competence regarding knowledge and practical skills. The findings emphasise the complex nature of safety competence, providing insights into practical safety skills, decision-making, and the interpersonal and communication dimensions of safety competence. In addition, the framework presents a visual-based method for assessing competencies across the corresponding dimensions. The framework must be tailored to enhance safety outcomes on construction sites. Consequently, the study offers theoretical insights for improving artisan training, which would ultimately reduce the incidence of accidents, along with practical applications that would benefit safety managers significantly.

Keywords: Artisans, Competence Evaluation Framework, Construction Industry, Safety, Safety Competence

1. Introduction

The construction industry, particularly in developing countries such as Nigeria, is characterised by high rates of accidents due to poor safety performance, often arising from the incompetence of artisans (Ojo et al., 2025; Adebawale & Agumba, 2023; Williams, 2019). Artisans play a crucial role on construction sites, and their safety awareness directly influences safety performance (Boakye et al., 2023; Yap & Lee, 2020). Despite regulatory efforts and safety training programs, there remains an absence of frameworks to gauge the safety competence of artisans (Zou & Sunindijo, 2021). Existing studies have primarily focused on the managerial level, ignoring the organisational safety commitments of artisans, who are most exposed to on-site hazards (Sherratt & Aboagye-Nimo, 2022; Danso, 2022).

Prior assessment tools frequently ignore the educational and contextual realities of artisans, resulting in little or no effectiveness (Siabi, 2022; Tremblay & Badri, 2018). This raises important questions: What are the main elements for developing a safety competence assessment framework for Nigerian artisans? Which indicators best reflect their competence for improving safety performance? This study addresses these gaps by developing a framework for artisans in the Nigerian construction industry. Distinct from generic frameworks, this framework offers practical tools for safety managers to assess the

readiness of artisans for safe work, to reduce accidents, and to improve safety outcomes, specifically in developing nations.

2. Literature Review

2.1. Introduction

The construction industry has been widely recognised as one of the most hazardous industries globally, especially in developing countries such as Nigeria. The high number of accidents and fatalities in this industry can be attributed to various factors, including inadequate safety training and competencies among artisans (Antonioni & Agrafioti, 2023). Artisans who are pivotal in executing construction tasks often lack the necessary safety skills and knowledge, contributing to adverse safety outcomes (Hasanzadeh et al., 2017). Consequently, the need for a framework to evaluate and improve the safety competencies of these artisans has become increasingly urgent. This literature review examines relevant research on safety competencies in the construction industry, focusing on the Nigerian context, and highlights the gaps that the proposed framework seeks to address.

2.2. Understanding Safety Competence in Construction

Safety competence refers to the knowledge, skills, and behaviours necessary to execute construction tasks safely (Rahman et al., 2022; Liang, 2019). It includes

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technical awareness, hazard detection, communication, and decision-making. In developed nations, safety competence is often cultivated through formal training and regulation (Bautista-Bernal et al., 2024; Pilbeam & Karanikas, 2023). However, this ideal model does not reflect realities in developing countries such as Nigeria, where formal safety training is infrequent and regulatory enforcement is poor (Umeokafor et al., 2022; Umeokafor, 2017).

2.3. Nigerian Safety Landscape

Artisans form the operational pillar of construction sites, performing critical tasks such as masonry, carpentry, and plumbing works (Ebekozién et al., 2025). While their roles largely influence safety performance, Nigerian artisans characteristically enter the construction industry through informal apprenticeship systems, lacking formal safety education (Ebekozién, 2022; Abdullahi et al., 2015). Thus, many do not participate in formal safety practices such as risk assessments or safety audits, which remain the purview of engineers and supervisors.

2.4. Existing Frameworks and Gaps

Globally recognised safety competence frameworks, including OSHA regulations and European frameworks, are developed for formal training settings and managerial-level roles (Umeokafor et al., 2020; Zou et al., 2015; Hardison et al., 2014). These frameworks assume a level of knowledge, standardisation, and regulatory structure absent in the Nigerian construction industry. Therefore, existing models are insufficient for assessing and developing artisan-level competence in Nigeria.

2.5. Defining Artisan Safety Competence

This study uses a two-dimensional view of safety competence, comprising knowledge (e.g., hazard identification, PPE use, recognising unsafe conditions) and skills (e.g., safe tool handling, task-specific precautions) (Pourmazaherian & Musonda, 2022; Zou & Sunindijo, 2021). Acknowledging that several artisans cannot carry out formal risk assessments, the framework targets competencies achievable through incremental, experience-based learning. Thus, competence is conceptualised as developmental, varying across basic, intermediate, and advanced levels.

2.6. Contextual Influences on Competence

Artisan safety competence is influenced by numerous factors: age, education, experience, site culture, and supervision (Boakye et al., 2023). Informal skill acquisition and variable work conditions hinder consistent safety behaviour. Additionally, low literacy and limited access to resources limit the adoption of proper safety training methods (Chetty, 2024). These realities necessitate a framework that is adaptable, observable, and grounded in context-specific behaviours.

2.7. Rationale for a Context-Sensitive Framework

There is a need for an assessment framework tailored to the competencies attainable by artisans in the Nigerian construction industry. Such a framework must be practical and inclusive of both current competences and aspirational behaviours (Jadallah et al., 2021). This framework offers a roadmap for progressive safety improvement in developing countries by acknowledging the context while aligning with global best practices.

3. Research Methodology

This study employed a cross-sectional research design, using a structured questionnaire survey to assess artisans' safety competence in Abuja, Nigeria. Safety managers and supervisors, who supervise artisans on construction sites, were asked to appraise the competencies of artisans in terms of knowledge and skills. The objective was to gather insight from those with direct supervisory responsibilities over artisans, given that most artisans in Nigeria are not literate and cannot reliably self-assess competence using questionnaires.

3.1. Sampling and Respondent Recruitment

The study targeted safety managers and supervisors working on construction projects across the six municipal area councils of Abuja: Gwagwalada, Kuje, Bwari, Kwali, Abuja Municipal, and Abaji. Due to the lack of a publicly available sampling frame of all safety professionals in the area, a non-probability convenience sampling approach was used. This strategy was necessary given field access limitations and the informal employment structure of the Nigerian construction industry. The contact details of safety managers and supervisors were obtained through a multi-step approach: Collaboration with local chapters of professional bodies such as the Nigerian Institute of Building (NIOB), Council of Registered Builders of Nigeria (CORBON), and Nigerian Institute of Safety Professionals (NISIP). Site visits to active medium and large-scale construction sites, with formal introductions to site safety professionals through the main contractors. Referrals using the snowballing technique, where recognised safety officers introduced the research team to others in the industry.

Through this method, 744 questionnaires were distributed physically by hand between August 2023 and July 2024, across over 60 construction sites in the Abuja metropolis. Efforts were made to distribute the questionnaires evenly across public, private, residential, and commercial construction projects. Out of the 744 questionnaires distributed, 470 valid and complete responses were obtained and used for analysis, yielding a response rate of 63%. This rate is significantly higher than typical response rates in construction management research, which often fall below 30% (Baruch & Holtom, 2008). The relatively

high response rate can be attributed to in-person distribution, relationship-building with gatekeepers, and follow-up visits to collect completed questionnaires.

3.2. Instrument Development and Pilot Study

The questionnaire instrument was adapted from previously validated scales in the literature (e.g., Pourmazaherian & Musonda, 2022; Møller et al., 2021). It was organised into two sections: safety knowledge (32 items) and safety skills (13 items), all measured on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Before the survey, a pilot test was conducted with 16 safety supervisors from different construction sites in Abuja. The pilot aimed to assess the clarity, relevance, and contextual appropriateness of the items. Based on the results from the pilot test, Technical terms (e.g., "ergonomic hazard") were simplified. Questions were condensed to improve readability. Some double-barrelled items were divided into two for precision. Additional items relevant to local site operations (e.g., understanding of local safety signage and PPE usage practices) were added. Moreover, the final questionnaire was reviewed by a panel of three PhD holders in Construction Management and Health and Safety from a Nigerian university, all of whom had prior site-based experience in construction safety practice in Abuja and Lagos. Their expertise ensured that the instrument achieved both content and contextual validity for the Nigerian construction environment.

3.3. Data Analysis and Competence Categorisation

Descriptive statistics, including means and standard deviations, were computed to summarise the data. Exploratory Factor Analysis (EFA) was performed using principal axis factoring with oblique rotation to identify latent constructs within the knowledge and skill variables (Field, 2018). Variables were grouped under broader categories, including: Safety knowledge: hazard identification, safety regulations, risk assessment, and emergency procedures. Safety skills: practical safety skills, decision-making skills, and communication. The competence levels were then categorised using defined thresholds (Walliman, 2021) and presented using radar charts for interpretability. This approach allowed the study to identify areas of strength and deficiency in the perceived competence of artisans from the supervisors' perspective.

3.4. Justification for Methodological Choices and Scope

While the study relied on the perceptions of safety managers and supervisors rather than artisans themselves, this was a deliberate methodological decision informed by contextual realities: Most artisans in Abuja have limited literacy levels and are not well-versed in theoretical safety concepts or regulations. Direct observation methods, while ideal, were logistically and ethically challenging given the large

sample size, site access limitations, and variability in site conditions. Thus, the study prioritised contextual validity and feasibility over theoretical purity. Generalisations were limited to artisans working in Abuja and may not apply uniformly across all regions of Nigeria. The findings are most applicable to metropolitan areas with active construction sites, relatively formalised safety practices, and an accessible supervisory workforce.

4. Findings and Discussion

This section presents and interprets the results from the questionnaire responses, built around respondent demographics, knowledge and skill variables, factor loadings, and radar chart visualisation.

4.1. Demographic Characteristics

As depicted in Table 1, the most significant percentage of respondents (24.46%) have between 1–5 years of experience, followed by 21.49% with 6–10 years, demonstrating early-career and mid-career professionals. Only 11.06% reported over 30 years of experience. Educationally, most respondents held a Bachelor's degree (28.51%), followed by HND (20.21%) and Master's degree holders (18.72%). This suggests a relatively well-educated safety professional. However, there is an underrepresentation of doctoral-level professionals (14.56%). A majority of the respondents work in building and civil engineering firms (42.18%), with another 34.47% in general building construction and 23.40% in civil engineering-specific roles. In terms of job designation, 53.62% of participants identified as safety supervisors and 46.38% as safety managers.

Table 1: Demographics of the respondents

Demographics	Frequency	Percentage
Years of Experience		
1-5 years	115	24.46
6-10 years	101	21.49
11-15 years	78	16.6
16-20 years	69	14.69
20-25 years	55	11.7
Above 30 years	52	11.06
Education		
National Diploma	86	18.3
High National Diploma	95	20.21
Bachelors	134	28.51
Masters	88	18.72
Doctorate	67	14.56
Organisation		
Building	162	34.47
Civil	110	23.4
Building and Civil	198	42.18
Project Size		
Medium	217	46.17
Large	253	53.83
Job Title		
Safety Manager	218	46.38
Safety Supervisors	252	53.62

(Source: Field Survey, 2024)

4.2. Knowledge Dimensions of Safety Competence

Table 2 (Appendix 1) categorises safety-related knowledge into four dimensions: hazard identification, safety regulations, risk assessment, and emergency procedures. High mean scores in hazard identification (e.g., knowledge of fall protection systems, $M = 4.36$) and general hazard recognition ($M = 4.24$) suggest strong awareness of essential safety issues. However, knowledge related to adapting to changes in work systems ($M = 3.66$) and consulting on safety concerns ($M = 3.64$) received lower ratings, demonstrating gaps in adaptability and consultation procedures. These findings imply that while knowledge is strong, soft knowledge areas involving dynamic safety environments and interpersonal communication are relatively weaker. This understanding, however, is tempered by social desirability bias (Bryman, 2016). Although safety knowledge seems strong, respondents seem less assured in evolving safety situations and interpersonal aspects. These gaps are critical in high-risk settings where better communication and system awareness can prevent accidents.

4.3. Safety Skills Assessment

As shown in Table 3, the participants reported strong proficiency in practical safety skills such as techniques for controlling hazards ($M = 4.10$), but lower

competency in using technology for hazard identification ($M = 3.86$). Decision-making skills showed relatively high scores for communication ($M = 4.29$) and knowledge retention ($M = 4.22$). However, foresight ($M = 3.86$) and the ability to determine risk levels ($M = 3.87$) scored lower, highlighting a need for targeted interventions in predictive safety decisions. The technological gap may reflect broader infrastructural constraints in the Nigerian construction industry, where advanced safety technologies are not yet available. This limits the generalisability of results to settings with higher resource availability. These findings highlight a practical workforce with solid corrective skills but weak preventive and technical-driven skills. This may reflect systemic shortcomings in the Nigerian construction industry, where access to digital technologies for safety and predictive training is limited.

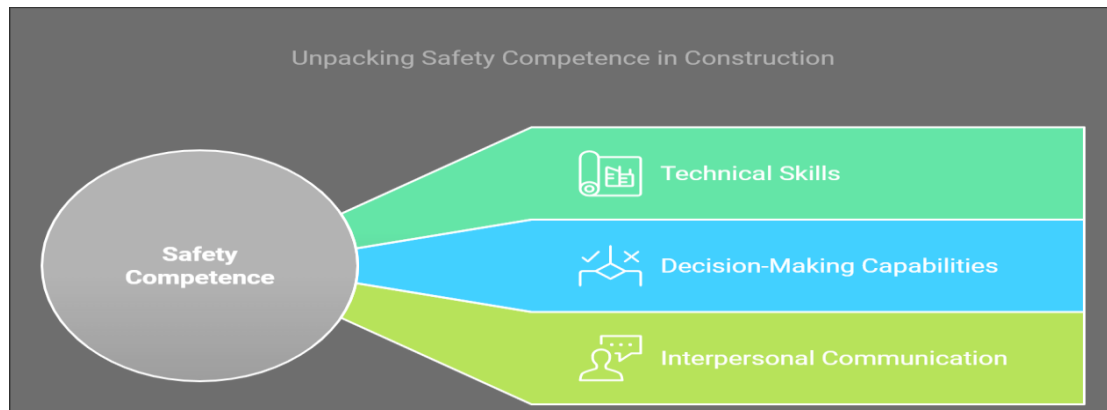
4.4. Inter-skill Relationships

Figure 1 illustrates the correlation matrix among different skill categories. There is a strong correlation ($r = 0.71$) between practical safety skills and decision-making skills, underpinning the argument that practical ability assists effective safety-related decisions. Communication skills showed moderate correlations with all categories ($r = 0.46$ – 0.56), while leadership had the weakest relationship with practical safety skills ($r =$

Table 3: Classification skill variables

Category	Skill variables	Mean	Std Dev
Practical Safety	S1: Techniques for identifying hazards in job hazards analysis	3.90	0.880
	S2: Techniques for hazard control	4.10	0.880
	S6: Using technological tools for hazard identification	3.86	0.999
	S9: Ability to maintain sensitivity to risks	3.82	0.887
	S10: Ability to anticipate mistakes co-workers make	3.93	0.990
	S11: Ability to learn and develop from co-workers	3.83	1.050
Decision-Making	S3: Ability to determine risk level at work	4.13	0.842
	S4: Timely decision when the worker identifies a hazard	4.05	0.867
	S5: Management of personal character	4.12	0.874
	S7: Ability to foresee abnormal situations and what to do if such a situation occurs	3.86	1.024
	S8: Ability to predict risk	3.87	0.931
Communication	S12: Ability to communicate clearly	4.22	0.858
	S13: Ability to retain acquired knowledge	4.29	0.834

(Source: Field Survey, 2024)

**Figure 1:** Safety Competence in the Construction Industry

0.29). This indicates that leadership skill in safety management requires a different developmental trajectory, not strongly associated with operational safety performance. Thus far, due to the absence of direct observational measures or third-party evaluations, these correlations must be seen as indicative rather than conclusive. These patterns show that although decision-making and technical skills are interdependent, leadership skill may depend on personality traits, organisational culture or training. This understanding emphasises the need for targeted leadership training as part of safety competence interventions.

4.5. Competence Levels Distribution

Figure 2 illustrates a bimodal distribution, with competence levels clustered at Intermediate and Advanced (each 50%). No participants were identified as Novices or Experts. This may reflect either a well-developed workforce or limitations in the categorisation instrument used—particularly its

inability to capture extremes. The lack of novice or expert ratings suggests potential limitations in respondent self-assessment accuracy. A deeper insight using task-based assessments could provide a more reliable distribution.

4.6. Factor Loadings and Underlying Competence Structures

Table 4 details the results of factor analysis, identifying seven latent factors. Factor 1 combines skill S4 with knowledge variables K30 and K14, suggesting a foundation in procedural and hazard management competence. Factor 2 blends S12 and K29, pointing to integrated frameworks where both skill and knowledge describe safety competence. Factor 3 is dominated by

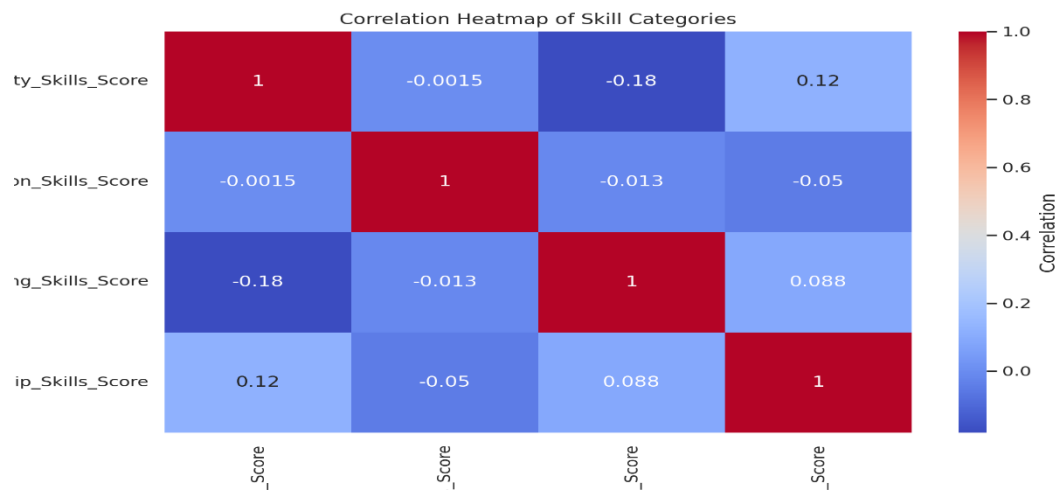


Figure 2: Correlation between skill categories, the distribution of competence levels, and a summary of team averages and individual scores (Source: Data analysis)

Table 4: Top five variables for each factor

Factors Number	Factors	Loadings
1	S4	0.5316
	K30	0.5192
	K14	0.4204
	K16	0.4101
	K28	0.3761
2	S12	0.5362
	K29	0.4500
	K3	0.3704
	K5	0.3543
	K17	0.3245
3	K4	0.4422
	K25	0.4165
	S8	0.3435
	K24	0.3426
	K37	0.3010
4	K17	0.4947
	K9	0.3685
	K20	0.3133
	K1	0.2896
	K26	0.2883
5	S3	0.4578
	K32	0.3884
	K34	0.3375
	K5	0.3331
	K20	0.3311
6	K2	0.3348
	K10	0.3042
	S2	0.2945
	K13	0.2822
	S4	0.2612
7	K30	0.4800
	K12	0.3235
	K14	0.2831
	K2	0.2722
	K17	0.2616

cognitive foundation in hazard planning and recognition. Factor 6, with high loadings for K15 and K17, highlights the role of regulatory understanding in safety management, resonating with a previous study by (Umeokafor et. al., 2022). The emergence of multidimensional competence constructs is consistent with literature identifying cognitive, behavioural, and contextual dimensions of safety competence (Møller et al., 2021; Hardison et al., 2014), supporting a more holistic understanding of competence. These structures show the interdependency of knowledge and skills across regulatory, predictive and procedural domains. However, it must be noted that factor interpretation is inherently subjective and sensitive to sample size and item quality—both of which may limit the strength of these findings.

4.7. Visualising Competence Dimensions: Radar Chart Analysis

Figure 3 presents a radar chart showing six dimensions of safety competence: risk assessment, hazard identification, safety regulations, communication skills, practical safety skills, and emergency procedures. High competence levels were observed in hazard identification and safety regulations, whereas communication and decision-making showed weaker performance. The chart shows an unequal safety competence profile—signifying strengths in basic knowledge areas but gaps in interactive and proactive domains. These findings are in line with prior studies emphasising the critical role of hazard identification (Carter & Smith, 2006), regulatory awareness (Yılmaz, 2023), and communication (Dai et al., 2021) in improving safety outcomes. Nevertheless, the radar chart provides a visual summary and should not be interpreted as an objective performance measure due to

its dependence on subjective inputs. These results echo prior studies highlighting the significance of communication and situational responsiveness in accident prevention (Carter & Smith, 2006; Dai et al., 2021; Yılmaz, 2023).

5. Conclusions and Future Research Directions

This study developed a Safety Competence Assessment Framework (SCAF) for construction artisans in Nigeria—an industry that has received little attention in empirical safety research. Using quantitative methods, the study identified and assessed key predictors of safety competence, including hazard identification, safety regulations, risk assessment, communication, emergency preparedness, and practical decision-making skills. The framework highlights the interrelationship among these competencies and their role in allowing safer work practices on construction sites.

One of the main contributions of this study lies in its integration of both knowledge and skill-based factors into a single empirical model tailored to the artisanal workforce. Prior literature tends to focus on safety at organisational levels; this study shifts the attention to the operational level, where artisans directly engage with safety-critical tasks. The study addresses a critical research gap and improves understanding of grassroots-level safety competence by focusing on artisans and empirically validating safety variables that matter in the Nigerian construction industry. Another contribution is the visual diagnostic tool (the radar chart), which operationalises the framework into a practical assessment tool for construction site managers and

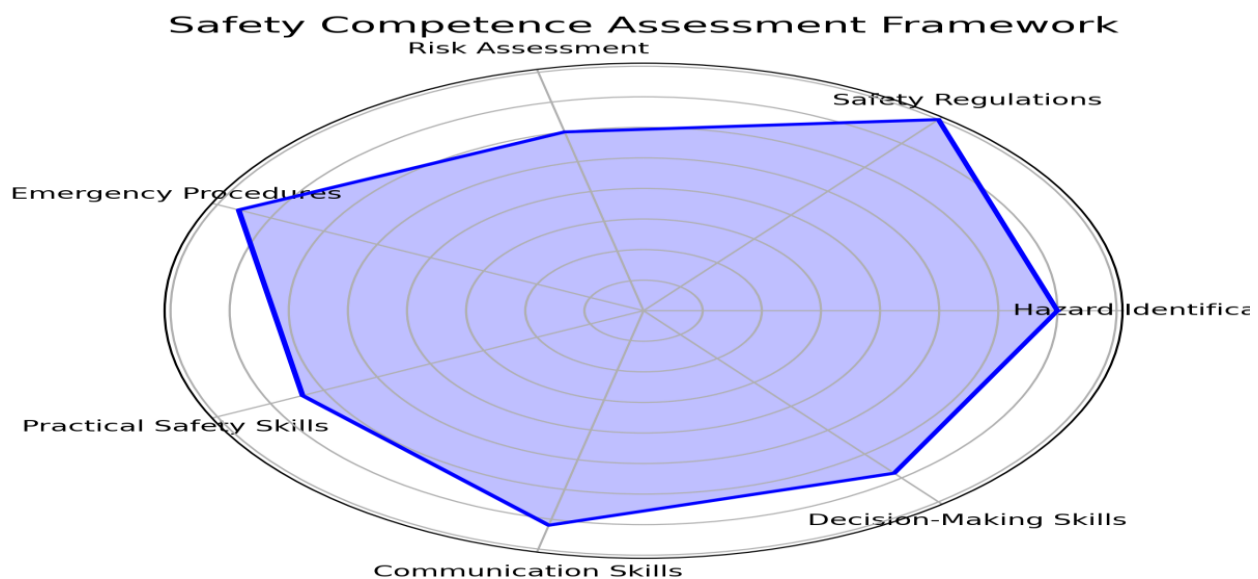


Figure 3: Radar chart for assessing various dimensions of safety competence

health and safety professionals. This instrument provides a multidimensional view of safety competence levels and aids data-driven programmes for safety planning and training. Besides, the radar chart is in line with the literature's call for hands-on assessment tools capable of highlighting gaps in specific areas of safety competence (e.g., communication and decision-making), especially in developing countries.

The results extend theory by echoing the multidimensional nature of safety competence and offer empirical support for frameworks that combine both cognitive and behavioural dimensions. Notably, the research advances existing frameworks of safety competence—mainly derived from developed countries—by validating them for a developing country, high-risk construction environment, hence providing a context-specific framework applicable to similar regions across Sub-Saharan Africa and other developing nations.

5.1. Implications for Future Research

While the framework provides a novel contribution, further validation is necessary. Future studies should test the framework's robustness across sub-sectors (e.g., road and industrial construction) and more diversified samples. Comparative research across countries could determine whether the framework will be valid in different safety cultures and regulatory environments. Additionally, longitudinal studies are recommended to explore how safety competence develops with continuous training and exposure to real-world hazards. Further research should also investigate psychosocial, behavioural, and socio-cultural influences—such as motivation, peer pressure, and communication

hierarchies—that may mediate or moderate the development of safety competence among artisans. These insights would be beneficial in fine-tuning the assessment framework and ensuring its relevance in improving safety performance in construction.

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Appendix 1

Table 2: Classification of knowledge variables

Category	Knowledge variables	Mean	Std Dev
Hazard Identification	K2: Understanding critical safety issues at the construction site	4.24	0.785
	K3: Knowledge of hazard recognition and controls	4.27	0.830
	K10: Understanding the risks of different hazards	4.06	0.698
	K12: Knowledge of the risks to which workers are exposed	4.30	0.756
	K22: Understanding in-depth hazard and risk techniques	4.19	0.796
	K23: Knowledge of fall hazards	4.19	0.811
	K24: Understanding the use of fall protection systems	4.12	0.846
	K25: Know the level of fall protection that should be provided	3.74	1.050
	K26: Know the areas and activities where fall protection should be provided	3.88	0.947
	K28: Understanding the kind of material to store within feet of working edges	3.83	0.779
	K29: Understanding how to erect and use a scaffold	3.98	0.882
Safety Regulations	K1: Understanding the safety policies, goals, and procedures of the construction company	4.15	1.044
	K6: Know when to use PPE	4.02	0.858
	K7: Know how to wear PPE	4.02	0.882
	K8: Understanding the risk that PPEs can avoid	4.18	0.829
	K11: Understanding how to keep the PPE in an efficient state, working order, and good repair	4.04	0.753
	K13: Understanding the new technology introduced	3.66	0.940
	K14: Understanding changes in the work system	4.03	0.838
	K15: Understanding the meaning of construction safety signs	4.03	0.838
Risk Assessment	K4: Do you know how to report hazards and injuries?	4.23	0.880
	K5: What to do in an emergency?	4.28	0.882
	K16: Understanding of manual handling (Loads, lifting, and carrying)	3.91	0.818
	K17: Understanding the conditions for the use of work equipment	3.74	1.050
	K18: Understanding the risks associated with the use of work equipment and the precautions to be taken	3.88	0.956
	K19: Understanding the classification, identification, and verification of known and unknown materials	3.90	0.824
Emergency Procedures	K20: Understanding how to use the local emergency response plan	4.07	0.947
	K21: Understanding the state emergency response plan	3.88	0.956
	K31: Understanding the effect of fatigue on safety	3.64	0.774
	K32: Who to consult on safety concerns	4.01	0.851

(Source: Field Survey, 2024)