Development of Deployment Designs and Characterization of Safety Infrastructure in TVET Training Spaces Federal College of Education (Technical) Ekiadolor Benin-City Edo State

Acheneje, S.[1*]; Emmanuel, E.[2]

[1,2] Department of Agricultural Education School of Secondary Education (Vocational)
Federal College of Education (Technical) Ekiadolor Benin-City, Edo State

Corresponding Author: Acheneje, S.*

Abstract: Safety infrastructure is a precarious component of effective teaching and learning in Technical and Vocational Education and Training (TVET) environments, yet its establishment and use remain insufficient in many developing countries. This study assessed the development, deployment designs, and characterization of safety infrastructure in TVET training spaces at the Federal College of Education (Technical), Ekiadolor, Benin City, Edo State, Nigeria. A quantitative case study design was adopted, involving 123 staff and students selected from various TVET departments. Data were collected using a structured, closed-ended questionnaire and analysed using descriptive statistics. Findings revealed low levels of awareness and inadequate knowledge of basic safety devices among respondents, as well as limited familiarity with the locations of safety signage and emergency fire exits. The study further identified deficiencies in safety training, routine inspection, and maintenance culture within the training spaces. Following the design, installation, and deployment of safety infrastructure, coupled with targeted training, notable improvements were observed in safety awareness, preparedness, and compliance with safety protocols. The study concludes that systematic deployment of safety infrastructure, regular training, and continuous maintenance practices are essential for creating safe and effective TVET learning environments. It recommends institutionalization of periodic safety training, routine inspection of safety devices, and integration of safety management practices into TVET administration to align with global best practices.

Keywords: Safety Infrastructure; TVET; Safety Training; Deployment Design; Nigeria.

How to Cite: Acheneje, S.; Emmanuel, E. (2026) Development of Deployment Designs and Characterization of Safety Infrastructure in TVET Training Spaces Federal College of Education (Technical) Ekiadolor Benin-City Edo State. *International Journal of Innovative Science and Research Technology*, 11(2), 884-889. https://doi.org/10.38124/ijisrt/26feb518

I. INTRODUCTION

Safety infrastructure constitutes a fundamental requirement for effective teaching, learning, and skill acquisition in Technical and Vocational Education and Training (TVET) institutions. TVET training spaces such as workshops and laboratories expose staff and students to higher levels of occupational risk compared to conventional classroom environments, making safety infrastructure indispensable. Studies have consistently shown that inadequate safety infrastructure in TVET institutions increases the likelihood of accidents, injuries, and disruption of learning activities (Vengidason et al., 2021; Bello Birchi Abdullahi, 2018). In many developing countries, the provision of safety infrastructure in TVET institutions remains insufficient and poorly managed. Ahmad et al. (2024) reported that weak institutional safety policies and lack of coordinated management roles significantly undermine safety awareness among TVET instructors. Similarly, Marumbwa and Muzari (2024) observed that the absence of structured safety

management systems in workshops contributes to unsafe working conditions and poor compliance with safety standards.

Safety awareness and training are critical determinants of safe behaviour in vocational learning environments. Research indicates that the availability of safety infrastructure alone does not guarantee safety unless users are adequately trained on proper usage, inspection, and maintenance. Okwiri and Juma (2023) established a significant relationship between safety communication, safety training, and institutional performance in TVET institutions in Kenya. Their findings emphasize that effective safety communication enhances compliance and reduces workplace hazards. Several studies have reported low levels of safety awareness among TVET students and staff due to inadequate training and absence of routine safety drills. Johnson (2024) and Ogunmilade (2024) found that many technical college students lacked basic knowledge of safety equipment operation, particularly in auto-mechanics and engineering workshops. This deficiency reduces confidence during emergency situations and increases vulnerability to accidents.

Safety culture reflects shared values, beliefs, and practices regarding safety within an institution. A positive safety culture has been linked to improved compliance with safety regulations and reduced accident rates. Sayuti et al. (2024) demonstrated that strengthening safety culture in vocational education requires consistent enforcement of safety rules, visible safety signage, and continuous training. Similarly, Isa et al. (2024) emphasized that occupational safety and health practices in TVET institutions must align with industry standards to prepare learners for safe workplace behaviour. Management commitment has been identified as a key driver of safety culture in educational institutions. Ahmad et al. (2024) noted that leadership involvement, safety committees, and clearly defined safety responsibilities enhance safety awareness and accountability among staff and students. Without strong managerial commitment, safety initiatives often remain unsustainable.

The effectiveness of safety infrastructure is influenced not only by its availability but also by deployment design, strategic placement, and maintenance practices. Poorly positioned safety signs and emergency equipment limit visibility and reduce response efficiency during emergencies. Studies have shown that regular inspection and maintenance of safety devices are essential to ensure functionality and reliability (Marumbwa & Muzari, 2024; Safety training needs of educational institutions, 2024). Talib et al. (2024) further argued that integrating occupational safety and health components into TVET curricula enhances learners' understanding of safety procedures and fosters long-term safety compliance. This integration supports continuous improvement in safety practices and aligns TVET institutions with global best practices.

> *Problem Statement*

Although existing studies have examined safety awareness, safety culture, and occupational safety practices in TVET institutions across different contexts, limited empirical evidence exists on the combined effects of safety infrastructure deployment design, targeted training, and post-intervention assessment within a single institutional setting. Most previous studies focused on either safety awareness or infrastructure availability in isolation. This study addresses this gap by systematically assessing pre- and post-intervention conditions, thereby providing empirical evidence on the effectiveness of integrated safety infrastructure deployment and training in TVET training spaces.

II. METHODOLOGY

> *Research Design*

The study adopted a quantitative case study design to assess the development, deployment designs, and characterization of safety infrastructure in Technical and Vocational Education and Training (TVET) training spaces. This design enabled systematic collection and analysis of numerical data on safety infrastructure awareness, availability, usage, and maintenance within a real institutional context.

> *Study Area*

The study was conducted at the Federal College of Education (Technical), Ekiadolor, Benin City, Edo State, Nigeria. The institution offers various TVET programmes and utilizes workshops, laboratories, and training spaces where safety infrastructure is critical for effective teaching and learning.

> *Population of the Study*

The population comprised academic staff, technical staff, and students who utilize TVET training spaces in the institution. These groups were selected because they are the primary users of safety infrastructure and are directly exposed to potential safety risks during instructional and practical activities.

> *Sample Size and Sampling Technique*

A total of 123 respondents were selected from different TVET departments using purposive sampling, based on their involvement in workshop and laboratory activities.

> *Instrument for Data Collection*

Data were collected using a structured, closed-ended questionnaire addressing awareness, availability, usage, training, inspection, and maintenance of safety infrastructure. Responses were measured on a five-point Likert scale ranging from Strongly Agree (5) to Strongly Disagree (1), (Response Scale: Strongly Agree (SA) =5, Agree (A) =4, Neutral (N) =3, Disagree (D) =2, Strongly disagree (D)=1)

➢ *Validity and Reliability of the Instrument*

The instrument was subjected to face and content validation by experts in TVET, safety management, and educational research. Reliability was determined using Cronbach's Alpha method, with coefficients of 0.70 and above considered acceptable.

➢ *Procedure for Data Collection*

Data collection occurred in two phases: pre-intervention assessment of safety awareness and practices, followed by design, installation, and deployment of safety infrastructure, as well as training on usage, inspection, and maintenance. The questionnaire was then re-administered to assess post-intervention changes.

➢ *Method of Data Analysis*

Data were analyzed using descriptive statistics including frequencies, percentages, means, and standard deviations were used to present findings.

➢ *Ethical Considerations*

Participation was voluntary, informed consent was obtained, confidentiality was assured, and no personal identifiers were collected.

III. RESULTS AND DISCUSSION

Table 1: The findings of the study revealed notable gaps in the availability, awareness, and utilization of safety infrastructure within TVET training spaces prior to the intervention. A substantial proportion (61.3%) of respondents demonstrated limited knowledge of basic safety devices, their functions, and appropriate usage. Many respondents (47.1% and 17.9%) were either unaware of or uncertain about the locations of emergency fire exits, safety signage, and fire-fighting equipment within their training environments. This outcome indicates a weak safety culture and corroborates earlier studies which reported that safety infrastructure in TVET and educational institutions is often inadequate and poorly managed (Vengidason et al., 2021; Bello Birchi Abdullahi, 2018).

The results (41.2%) further showed that safety signs and emergency instructions were either insufficiently displayed or not easily noticeable in most TVET training spaces. Poor visibility of safety information undermines effective safety communication and increases vulnerability during emergency situations. This finding is consistent with previous research which established that inadequate safety signage and ineffective safety communication significantly heighten the risk of accidents in vocational and industrial training environments (Okwiri & Juma, 2023; Sayuti et al., 2024).

Analysis of responses (67.5%) relating to safety training indicated that the majority of staff and students had not received formal training on the use, inspection, and maintenance of safety devices prior to the intervention. This deficiency adversely affected respondents' confidence (62.6%) in handling emergency situations and highlighted institutional weaknesses in safety management practices. Similar observations have been reported in earlier studies, which identified lack of safety training and absence of routine safety drills as major contributors to unsafe practices in TVET workshops and laboratories (Johnson, 2024; Ogunmilade, 2024).

Table 1: Pre-Intervention Assessment of Safety Awareness, Practices, Design, Installation, and Deployment of Safety Infrastructure, Training on Usage, Inspection, and Maintenance

S/N	VARIABLES	SD	D	N	A	SA	TOTAL/%
1	I am aware of the existence of safety infrastructure in my TVET training space.	50 (40.6)	23 (18.7)	25 (20.3)	15 (12.2)	10 (8.1)	123 100
2	Safety infrastructure is important for effective teaching and learning in TVET environments.	45 (36.6)	35 (28.5)	20 (16.3)	13 (10.6)	10 (8.1)	123 100
3	Safety signs are clearly displayed in my workshop or laboratory.	20 (16.3)	15 (12.2)	35 (28.5)	33 (26.8)	20 (16.3)	123 100
4	I know the location of emergency fire exits in my training space.	18 (14.6)	40 (32.5)	22 (17.9)	15 (12.2)	28 (22.8)	123 100
5	I am aware of the location of fire extinguishers in my department.	20 (16.3)	31 (25.2)	10 (8.1)	22 (17.9)	40 (32.5)	123 100
6	I know how to operate a fire extinguisher correctly.	47 (38.2)	33 (26.8)	10 (8.1)	13 (10.6)	20 (16.3)	123 100
7	I have received formal training on the use of safety devices.	70 (56.9)	30 (24.4)	13 (10.6)	5 (4.1)	10 (8.1)	123 100
8	Emergency procedures are clearly displayed in my training space.	45 (36.6)	18 (14.6)	25 (20.3)	15 (12.2)	20 (16.3)	123 100
9	I understand the meaning of common safety signs and symbols.	35 (28.5)	15 (12.2)	45 (36.6)	18 (14.6)	5 (4.1)	123 100
10	First aid facilities are available in my workshop or laboratory.	21	17	35	15	35	123

S/N							
		(17.1)	(13.8)	(28.5)	(12.2)	(28.5)	100
11	I know how to use basic first aid equipment.	8 (6.5)	12 (9.8)	33 (26.8)	25 (20.3)	45 (36.6)	123 100
12	Safety rules are strictly enforced during practical sessions.	28 (22.8)	12 (9.8)	5 (4.1)	23 (18.7)	55 (44.7)	123 100
13	Safety drills are regularly conducted in my institution.	70 (56.9)	13 (10.6)	25 (20.3)	5 (4.1)	10 (8.1)	123 100
14	The available safety infrastructure in my training space is adequate.	65 (52.8)	25 (20.3)	10 (8.1)	13 (10.6)	10 (8.1)	123 100
15	Safety devices in my department are regularly inspected.	55 (44.7)	32 (26)	18 (14.6)	5 (4.1)	13 (10.6)	123 100
16	I know the personnel responsible for safety management in my training space.	62 (50.4)	13 (10.6)	31 (25.2)	7 (5.7)	10 (8.1)	123 100
17	I have witnessed a safety-related incident in my institution.	67 (54.5)	23 (18.7)	20 (16.3)	10 (8.1)	3 (2.4)	123 100
18	Lack of safety infrastructure negatively affects learning outcomes.	35 (28.5)	25 (20.3)	45 (36.6)	10 (8.1)	8 (6.5)	123 100
19	I feel confident handling emergency situations in the training space.	52 (42.3)	25 (20.3)	13 (10.6)	15 (12.2)	10 (8.1)	123 100
20	There is a need for improved safety infrastructure in TVET institutions	5 (4.1)	5 (4.1)	13 (10.6)	25 (20.3)	75 (60.9)	123 100

Table 2: Following the deployment of safety infrastructure and the implementation of targeted training programmes, significant improvements were observed across all measured variables. Respondents (65.1%) demonstrated increased awareness of installed safety devices, improved ability to interpret safety signs, and better understanding of emergency response procedures. These improvements support the assertion that structured deployment designs combined with practical training are effective strategies for enhancing safety consciousness and compliance in TVET training spaces (Ahmad et al., 2024; Talib et al., 2024).

Additionally, respondents (81.3%) reported increased confidence in operating fire extinguishers, using first aid facilities, and complying with safety regulations during practical sessions. This underscores the importance of hands-on training in reinforcing safety knowledge and translating awareness into practice. Improved perceptions of safety within the training spaces further suggest that well-designed safety infrastructure contributes positively to psychological comfort and effective teaching and learning outcomes, as also noted by Marumbwa and Muzari (2024).

The study further revealed heightened awareness of the importance of routine inspection and maintenance of safety infrastructure following the intervention. Respondents (73.2%) acknowledged the need for continuous monitoring, periodic inspection, and timely maintenance of safety devices to ensure functionality and reliability. This finding aligns with international evidence which emphasizes that sustainable safety management requires not only infrastructure provision but also institutional commitment to inspection, maintenance, and continuous improvement processes (Safety training needs of educational institutions, 2024; Ahmad et al., 2024).

Overall, the results demonstrate that systematic development, deployment, and characterization of safety infrastructure, supported by regular training and inspection, significantly enhance safety awareness, preparedness, and compliance among staff and students in TVET training spaces. These findings have important implications for TVET administrators and policymakers, particularly in developing countries where safety infrastructure is often neglected. Integrating safety management into institutional planning and administration is therefore essential for aligning TVET institutions with global best practices and safeguarding lives and property.

Table 2: Post-Intervention Assessment of Safety Awareness, Practices, Design, Installation, and Deployment of Safety Infrastructure, Training on Usage, Inspection, and Maintenance

S/N	VARIABLES	SD	D	N	A	SA	TOTAL/%
1	I can identify the safety infrastructure installed in my TVET training space.	17 (13.8)	16 (13.0)	10 (8.1)	30 (24.4)	50 (40.7)	123 100
2	I understand the functions of the installed safety devices.	10 (8.1)	11 (8.9)	22 (17.9)	25 (20.3)	55 (44.7)	123 100
3	I can correctly interpret safety signs and symbols in my training space.	20 (16.3)	13 (10.6)	10 (8.1)	35 (28.5)	45 (36.6)	123 100

4	I can easily locate emergency fire exits within the training environment.	13 (10.6)	10 (8.1)	16 (13.0)	33 (26.8)	51 (41.5)	123 100
5	I am confident in operating a fire extinguisher when necessary.	10 (8.1)	15 (12.2)	25 (20.3)	23 (18.7)	50 (40.7)	123 100
6	I understand emergency response procedures in case of accidents.	12 (9.8)	9 (7.3)	9 (7.3)	45 (36.6)	48 (39.0)	123 100
7	Safety training has improved my awareness of workplace hazards.	10 (8.1)	13 (10.6)	10 (8.1)	25 (20.3)	65 (52.8)	123 100
8	I am confident in using safety equipment during practical activities.	10 (8.1)	8 (6.5)	5 (4.1)	30 (24.4)	70 (56.9)	123 100
9	I understand the importance of routine inspection of safety devices.	10 (8.1)	13 (10.6)	10 (8.1)	35 (28.5)	55 (44.7)	123 100
10	I can identify damaged or faulty safety infrastructure.	23 (18.7)	25 (20.3)	45 (36.6)	10 (8.1)	20 (16.3)	123 100
11	I am aware of proper maintenance procedures for safety equipment.	10 (8.1)	13 (10.6)	10 (8.1)	30 (24.4)	60 (48.8)	123 100
12	Installed safety infrastructure has improved my sense of safety.	10 (8.1)	10 (8.1)	3 (2.4)	30 (24.4)	70 (56.9)	123 100
13	Safety infrastructure enhances effective teaching and learning.	10 (8.1)	8 (6.5)	70 (56.9)	15 (12.2)	20 (16.3)	123 100
14	Compliance with safety rules has improved in my training space.	10 (8.1)	7 (5.7)	6 (4.9)	35 (28.5)	65 (52.8)	123 100
15	I feel adequately prepared to respond to emergency situations.	20 (16.3)	25 (20.3)	8 (6.5)	35 (28.5)	35 (28.5)	123 100
16	Safety training has improved my safety consciousness.	11 (8.9)	9 (7.3)	22 (17.9)	26 (21.1)	55 (44.7)	123 100
17	I am willing to comply with safety regulations at all times.	5 (4.1)	5 (4.1)	8 (6.5)	35 (28.5)	70 (56.9)	123 100
18	Regular safety drills should be sustained.	13 (10.3)	7 (5.7)	3 (2.4)	15 (12.2)	85 (69.1)	123 100
19	Continuous safety training is necessary.	3 (2.4)	6 (4.9)	4 (3.3)	35 (28.5)	75 (60.9)	123 100
20	Deployed safety infrastructure aligns with best practices in TVET.	20 (16.3)	21 (17.0)	22 (17.8)	15 (12.2)	45 (36.6)	123 100

IV. CONCLUSION

The study revealed substantial deficiencies in safety infrastructure awareness, availability, and utilization in TVET training spaces prior to intervention. However, systematic deployment of safety infrastructure, strategic placement of safety signage and emergency equipment, and structured training programmes significantly improved safety awareness, preparedness, and compliance. The findings affirm that safety infrastructure is an essential component of institutional management and educational quality assurance in TVET institutions.

RECOMMENDATIONS

- TVET institutions should develop and implement comprehensive safety policy statements.
- Regulatory bodies should enforce minimum safety infrastructure standards for TVET institutions.
- Regular safety training and emergency drills should be institutionalized.
- Structured inspection and maintenance schedules should be established.
- Safety management should be integrated into institutional planning and quality assurance processes.
- Government and stakeholders should prioritize funding for safety infrastructure in TVET institutions.

ACKNOWLEDGEMENT

REFERENCES

[1]. Ahmad, S., Md Yunos, J., Zulkifly, S. S., Mohd Yaakob, M. F., Mohamad Zain, A. Z., & Hasan, N. H. (2024). Management roles in promoting safety awareness among teaching staff in TVET institutions. Journal of Technical Education and Training, 16(2), 89–102.

[2]. Bello, I. M., & Rabiu, A. (2025). From classroom to highway: How TVET can reduce road traffic accidents in Nigeria. International Journal of Research and Scientific Innovation, 12(15), 2781–2788.

[3]. Bello Birchi Abdullahi, A. (2018). Safety practices in technical workshop environments in Nigerian tertiary institutions. Journal of Vocational and Technical Education, 10(1), 45–56.

[4]. Bergström, J., van Winsen, R., & Henriqson, E. (2015). On the rationale of resilience in the domain of safety: A literature review. Reliability Engineering & System Safety, 141, 131–141.

[5]. Clarke, S. (2013). Safety leadership: A meta-analytic review of transformational and transactional leadership styles as antecedents of safety behaviours. Journal of Occupational and Organizational Psychology, 86(1), 22–49.

[6]. European Agency for Safety and Health at Work. (2022). Occupational safety and health in vocational education and training. EU-OSHA.

[7]. Gibb, A., Lingard, H., Behm, M., & Cooke, T. (2014). Construction accident causality: Learning from different countries and contexts. Construction Management and Economics, 32(4), 334–350.

[8]. Isa, M. A., Salleh, K. M., & Darus, Z. (2024). Occupational safety and health practices in technical and vocational education institutions. International Journal of Educational Management, 38(2), 215–229.

[9]. Johnson, T. R. (2024). Safety awareness and emergency preparedness among technical college students. Journal of Education and Training Studies, 12(3), 66–78.

[10]. Marumbwa, A., & Muzari, T. (2024). Management systems for workshop safety, health, and environmental hazards in Zimbabwe. International Journal of Research and Innovation in Social Science, 8(1), 112–121.

[11]. Ogunmilade, O. A. (2024). Safety training and risk management in engineering workshops. African Journal of Technical Education, 9(2), 101–114.

[12]. Okwiri, C., & Juma, D. (2023). Safety communication and performance of TVET institutions in Kisumu County, Kenya. Strategic Journal of Business & Change Management, 10(4), 356–367.

[13]. Reason, J. (1997). Managing the risks of organizational accidents. Ashgate.

[14]. Robson, L. S., Clarke, J. A., Cullen, K., Bielecky, A., Severin, C., Bigelow, P. L., Irvin, E., Culyer, A., & Mahood, Q. (2007). The effectiveness of occupational health and safety management system interventions: A systematic review. Safety Science, 45(3), 329–353.

[15]. Safety training needs of educational institutions. (2024). Quality Assurance in Education, 32(3), 510–525.

[16]. Sayuti, M., Susanto, H. A., Hasanah, N., Biddinika, M. K., & Kamis, A. (2024). Enhancing safety culture in vocational education: Insights from industrial workshops. Indonesian Journal on Learning and Advanced Education, 6(1), 1–14.

[17]. Talib, N., Rahman, A. A., & Hamzah, R. (2024). Integrating occupational safety and health into TVET curricula for sustainable skills development. Journal of Technical Education and Training, 16(1), 23–35.

[18]. Vengidason, S., Nashir, I. M., Tang, J. R., Ismail, M. A., Nallaluthan, K., & Subramaniam, T. S. (2021). Importance of safety in a workshop at schools for a safe and effective teaching and learning sessions. Journal of Technical Education and Training, 13(3), 155–161.

[19]. World Health Organization. (2021). Occupational health: A manual for primary health care workers. WHO.

[20]. Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. Accident Analysis & Prevention, 42(5), 1517–1522.