Impact of Safety Management Practices on Safety Performance in Workplace Environment: A Case Study in Iraqi Electricity Production Industry

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ABSTRACT

Organizations are becoming more aware of the need to ensure a safe working environment for their staff. Technological advancements and industrial growth have enhanced efficiency, however, they present new challenges and risks for employees. Accidents remain a concern despite International Labor Organization (ILO) guidelines, governmental bodies, and industry institutions promoting workplace safety. Therefore, it is crucial to evaluate the determinants of workplace safety performance, particularly in the electrical power industry. This study formulates a theoretical model to assess the predictors of safety practices of managers and staff in the Iraqi electricity sector, extending the safety climate model with four external constructs and a moderating variable. Data were collected from 374 participants using an online questionnaire and the PLS-SEM method for analysis. The factor loadings exceeded the recommended value of 0.7 and internal consistencies were greater than the threshold value of 0.8. The findings showed that the safety performance in the Iraqi electric power sector is influenced by safety communication, safety policy, safety control, prevention planning, and safety commitment. Safety commitment is affected by safety policy, prevention planning, control, and communication, while safety training and safety control were found to be insignificant. Furthermore, safety communication had the most significant effect. The results of this study provide some theoretical and practical implications for employees' safety performance toward their overall safety in the electric power industry.

Keywords- component; sustainability; safety performance; workplace safety; electric power

I. INTRODUCTION

With increasing industrialization and technological progress, efficiency and productivity have been augmented but workplaces have also seen the emergence of new risks. Organizations recognize the importance of maintaining safe work environments for the well-being of their employees and the overall success of their operations [1]. Despite advances in this area, worker safety remains a pressing concern. Although organizations that prioritize safety enjoy several benefits, many developing countries are trailing behind in terms of safety regulations and practices due to inadequate regulations, outdated safety measures, and lack of awareness. This study examines the challenges of occupational safety and health, highlighting the pivotal role of policies, regulations, and training in shaping workplace culture and fostering secure behaviors. Safety Management Systems (SMS) represent a proactive approach to safety management to identify, mitigate, and control hazards. SMS is seamlessly integrated into the fabric of an organization, becoming an intrinsic aspect of its culture [2]. This study also explores the concept of Occupational Safety Management (OSM) and underscores the importance of behavioral-based safety management. OSM emphasizes the promotion of safety-conscious behaviors to

alleviate work-related injuries, while behavioral-based safety management underscores the crucial role of behaviors in ensuring workplace security [3]. This study assesses the influence of safety management system practices, including safety policy, safety training, prevention planning, safety control, and safety communication, as well as the impact of safety commitment on safety performance. Furthermore, the moderating role of safety knowledge on the safety performance of workers in the Iraqi electric power industry is also investigated.

II. LITERATURE REVIEW AND RESEARCH HYPOTHESES

The Ministry of Electricity (MOELC) of the Republic of Iraq, established in 2003 after transitioning from the Electricity Authority, oversees policies and electricity supply across the country, including power generation, transmission, and distribution. These responsibilities were previously managed under the Ministry of Industry and Minerals. The ministry comprises three main directorates: production, transmission, and distribution. It also ensures compliance with safety, health, and environmental standards through the electric power company. However, several challenges, such as fuel type selection and financial issues, persist. The Central Statistics Division highlighted a significant number of workplace accidents in the electric power sector between 2018 and 2022 [4]. Annually, the General Company of Production reported 5698 accidents, the General Transmission Company reported 1396, and the General Distribution Company reported 3012 [4]. To address this critical issue, a comprehensive framework, shown in Figure 1, and tools were proposed to evaluate safety performance in the electrical power industry in Iraq. Figure 1 includes safety knowledge as a moderator between safety management systems and safety performance, with safety commitment mediating this relationship, given its recognized importance in organizational safety [5-8]. This study explores the effect of safety knowledge on the relationships between several variables and safety performance in the Iraqi electricity industries. The framework demonstrates the relationships and interdependence among seven key factors: safety policy, safety training, prevention planning, safety control, safety communication, safety commitment, and safety knowledge. Furthermore, the relationship among the seven factors is examined in the Iraqi context.

A. Safety Policy

Safety policy is an essential framework for determining a company's commitment to ensuring safety and health in the workplace. Various countries have established their own health and security guidelines, and prominent organizations have provided guidelines for safety statements [9]. The importance of these policies is demonstrated by their ability to promote a positive attitude toward safety, which subsequently improves safety performance, particularly in the electrical sector. Compliance with safety policies can increase safety productivity and performance benchmarks [10]. Additionally, the effectiveness of safety performance is not only based on policies but also requires the steadfast commitment of both employers and employees. This underscores the need for organizations to establish their safety standards following legal or regulatory requirements [11]. Given the significance of safety policies in organizational safety performance, robust safety policies are assumed to improve safety performance in the Iraqi electricity industry by setting clear expectations and guidelines. Accordingly, two hypotheses were put forward:

H1: Safety policy positively influences safety performance.

H2: Safety policy positively influences safety commitment.

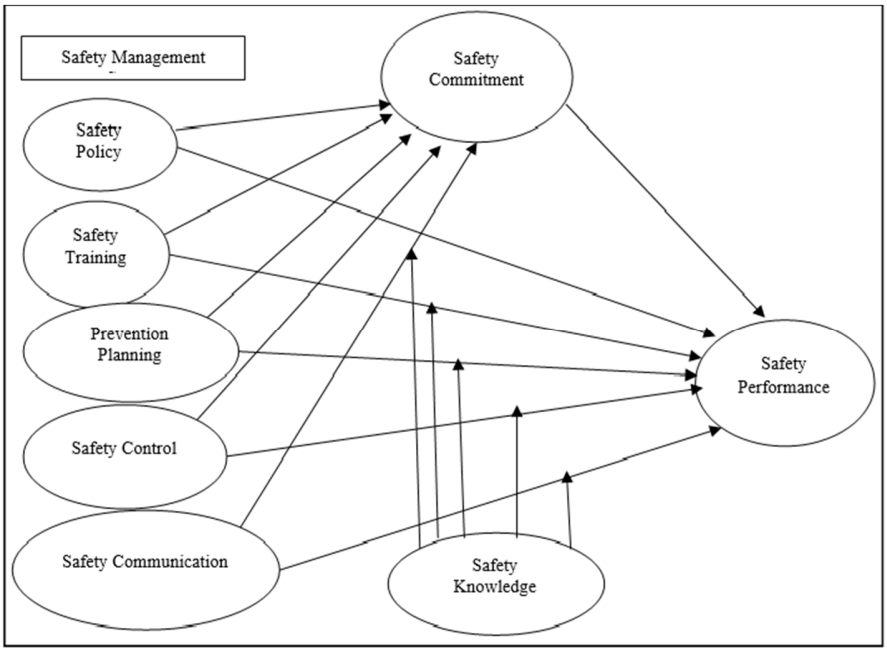

Fig. 1. Conceptual framework.

B. Safety Training

Safety training is a systematic approach to providing individuals with the knowledge, technical skills, and awareness to ensure safety at work, thus reducing the risk of injuries [12]. As many studies have consistently highlighted the relationship between comprehensive training and improved safety outcomes, training is indispensable in mitigating workplace accidents. In the construction industry, previous studies have highlighted the criticality of safety training [13]. Effective training can reduce common construction accidents, such as falls from heights and injuries from falling materials. It is crucial to note that safety training should be an ongoing effort to continuously enhance employees' security. This perspective is reinforced by management's commitment to safety and training in shaping the security climate. Hence, management commitment fosters a culture where employee safety is prioritized and guided by comprehensive training [14]. Therefore, the following two hypotheses were posed:

H3: Safety training positively influences safety performance.

H4: Safety training positively influences safety commitment.

C. Prevention Planning

Prevention planning is essential in fostering a secure work environment and ensuring the successful execution of projects. Historically, safety management was more reactive, addressing issues after they occurred. However, the modern safety approach emphasizes a proactive stance, integrating safety into broader managerial and production processes. This shift recognizes that an organization's safety culture is deeply influenced by its inherent attributes, such as its overall culture and climate. The role of upper management is pivotal in this transformation, as they are tasked with cultivating an environment that prioritizes safety. This involves the establishment of safety-centric policies, systems, and leadership styles. Organizations with a strong emphasis on prevention planning not only experience fewer accidents, but also exhibit a profound commitment to safety. Therefore, the following hypotheses were formulated:

H5: Prevention planning positively influences safety performance.

H6: Prevention planning positively influences safety commitment.

D. Safety Control

Safety control encompasses the implementation of measures, strategies, and procedures to ensure a safe and healthy work environment [5, 15]. It aims to mitigate hazards, making it the basis for a secure and efficient workplace. Beyond safeguarding employees, safety control also aims to manage and contain risks to acceptable levels. This process is multifaceted, encompassing safety equipment, managerial decisions, workforce training, and development. It operates on feedback mechanisms tailored to specific work environments, ensuring the adherence to industry safety standards [15]. Safety control not only assesses internal working conditions and incidents, but also benchmarks against the safety records of other businesses. Employee safety evaluations are hevily based on safety control, which monitors work activities, environments, and task performance. A robust safety control system correlates with a positive safety environment, while weak controls are linked to reduced safety engagement [16-17]. Based on this, the following hypotheses were posited:

H7: Safety control positively influences safety performance.

H8: Safety control positively influences safety commitment.

E. Safety Communication

Safety communication is pivotal in disseminating health and safety information within an organization [5]. It involves an open dialogue between management, supervisors, and workers, which has been shown to enhance workplace performance and safety [5, 18-22]. Effective two-way communication is a hallmark of high safety performance, as highlighted by various studies. However, communication lapses, especially in conveying risk warnings, can negatively impact safety performance and overall productivity [18-22]. Positive reinforcement through feedback and incentives can strengthen the safety attitude of employees. Furthermore, after accidents, it is essential to focus on constructive communication about improving processes rather than placing blame [23]. Thus, communication is vital to foster a positive safety climate. Consequently, the hypotheses suggested are:

H9: Safety communication positively influences safety performance.

H10: Safety communication positively influences safety commitment.

F. Safety Commitment as a Mediator

According to [9, 24], safety commitment refers to the extent of dedication and devotion expressed by leadership and the workforce toward safety in an organization. This commitment is closely tied to safety policies, as it is reflected in the performance of both the workforce and the management. Previous studies have demonstrated that management policies, especially those responsible for promoting work motivation, boost safety commitment and enhance organizational value, effectiveness, and employee well-being [5-8]. Furthermore, a strong link has been identified between workers' dedication to health, safety, and their overall performance, with committed employees taking greater personal responsibility for their tasks and safety outcomes [25-27]. In this study, safety commitment plays a mediating role between all the variables and safety performance. Hence, the following hypotheses were posited:

H11: Safety commitment positively influences safety performance.

H12 Safety commitment mediates the relationship between safety policy and safety performance.

H13 Safety commitment mediates the relationship between safety training and safety performance.

H14 Safety commitment mediates the relationship between prevention planning and safety performance.

H15 Safety commitment mediates the relationship between safety control and safety performance.

H16 Safety commitment mediates the relationship between safety communication and safety performance.

G. Safety Knowledge as a Moderator

In [28], safety knowledge was defined as employees' understanding of the safe execution of job tasks. Safety knowledge goes beyond basic safety policies and includes aspects, such as training, prevention planning, control, and communication. Although safety policies provide foundational support, safety knowledge is crucial in effectively interpreting and implementing these policies [29-30]. Safety training is a dynamic process that integrates various elements, like skills, equipment, and social interactions [31]. However, training alone does not guarantee improved safety performance. This is because its application in real-world scenarios also requires safety knowledge for greater effectiveness [32]. According to [33-36], safety knowledge improves understanding of preventive measures and safety controls and facilitates effective communication, ultimately influencing safety performance. In [37], it was reported that effective safety knowledge can reduce accidents and construction costs, especially in developing countries. According to the aim of the current study, the following hypotheses were presented:

H17: Safety knowledge has a significant moderating role in the relationship between safety policy and safety performance.

H18: Safety knowledge has a significant moderating role in the relationship between safety training and safety performance.

H19: Safety knowledge has a significant moderating role in the relationship between prevention planning and safety performance.

H20: Safety knowledge has a significant moderating role in the relationship between safety control and safety performance.

H21: Safety knowledge has a significant moderating role in the relationship between safety communication and safety performance.

H. Materials and Methods

This study aimed to investigate the influence of safety management practices on safety performance, considering the mediating role of safety commitment and the moderating role of safety knowledge. Quantitative research was employed using an online questionnaire. The questionnaire was distributed to workers and engineers actively employed in the Ministry of Electricity in Iraq using a simple random sampling method. A sample of 374 participants was chosen from 23 power plants located in the central region of Iraq, with a response rate of 61.6%. A meticulously designed questionnaire was used to collect the required data. Not only was this questionnaire structured, but also underwent a rigorous design and validation process. It consisted of seven distinct sections and a total of 63 questions. A 5-point Likert scale was used, where a score of 1 indicated "strongly disagree" and a score of 5 represented "strongly agree". All measurements achieved acceptable reliability scores, with Cronbach's alpha scores above 0.7. Each section of the questionnaire covered specific aspects of safety management. The sections included safety policy, safety training, prevention planning, safety control, safety communication, safety commitment, and safety knowledge. After data collection, the responses were processed and analyzed using SPSS and PLS. Specifically, the Partial Least Squares - Structural Equation Modeling (PLS-SEM) regression algorithm was employed to derive insights from the data and understand the relationships and influences between the variables in the hypothesized model.

III. RESULTS AND DISCUSSION

A. Descriptive Data

A total of 376 responses were received, comprising 355 males and 19 females. Table I presents a summary of the demographic information of the 376 respondents. The gender disparity highlights the male predominance within the electrical power industry in Iraq, aligning with global trends where the power sector is primarily male-dominated [38]. The majority of respondents fall within the 26-30 age group (39%), followed by the 18-25 age group (34%). In particular, a significant portion of respondents hold a bachelor's degree (58%), predominantly working as technicians (45%) or engineers (37%). Most of the employees had 7-10 years of experience (38%).

TABLE I. DEMOGRAPHIC PROFILES OF SAMPLES (N=374)

Demographic Profile	Frequency	Percentage (%)
Gender		
Male	355	95
Female	19	5
Age Group		
18-25	127	34
26-30	146	39
31-35	71	19
36-40	22	6
Above 40	7	2
Level of Education		
High school	86	23
Diploma	60	16
Bachelor's degree	217	58
Master's degree	11	3
Current Employment		
Technician	168	45
Engineer	138	37
Senior engineer	22	6
Head power plant assistant	26	7
Head power plant	19	5
Years of Employment		
Less than 3 years	60	16
3-6 years	101	27
7-10 years	142	38
More than 10 years	71	19

B. Statistical Analysis

This study established multiple hypotheses on the associations between the six main study variables (safety policy, safety training, prevention planning, safety control, safety communication, and safety commitment). Path analysis was performed through SmartPLS to test those hypotheses. Figure 2 illustrates the specific paths that correspond to the relationships among those six variables. The coefficient of

determination (R^2) for the endogenous variable safety performance was 0.50, indicating that it explained 50% of the variation. R^2 for the endogenous variable safety commitment was 0.48, indicating that it explained 48% of the variation.

Regarding common method bias, Harman's single-factor test displayed a ratio of extracted variables of 34.4%, below the threshold value of 50% [39]. The inner Variance Inflant Tolerance (VIF) values from the results of the measurement model were less than five. These results indicated no existence of multicollinearity in the data [40]. Table II shows that all Cronbach's Alpha values surpassed the recommended threshold of 0.7. Furthermore, the composite reliability values ranged from 0.894 to 0.947, signifying strong internal consistency [41]. The Average Variance Extracted (AVE) values were within the range of 0.742 to 0.828, confirming convergent validity. Finally, Heterotrait-Monotrait Ratio (HTMT) values were all below the threshold of 0.9, and less than the cut-off value of 0.85. Therefore, discriminant validity was established.

TABLE II. INTERNAL CONSISTENCY AND CONVERGENCE VALIDITY RESULTS

	Cronbach's Alpha	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
PP	0.902	0.932	0.773
SC	0.926	0.947	0.819
SCO	0.899	0.930	0.768
SCOM	0.896	0.935	0.828
SP	0.842	0.894	0.778
SPER	0.918	0.942	0.804
ST	0.884	0.920	0.742

C. Results from SEM

After analyzing the measurement model, the structural model was assessed. The results of the path analysis indicated that safety policy positively and significantly predicted safety performance (β = 0.184, t = 3.463, p < 0.001) and safety commitment (β = -0.081, t = 1.725, p <0.01). Therefore, H1 and H2 were supported. The safety training did not influence safety performance or safety commitment. Hence, H3 and H4 were not supported. Prevention planning had a positive and significant influence on safety performance (β = 0.153, t = 2.795, p<0.05) and safety commitment (β = 0.327, t = 5.190, p < 0.000). Thus, H5 and H6 were supported. Regarding safety control, it did not influence safety performance (p > 0.05) but had a positive and significant influence on safety commitment (β = 0.084, t = 2.256, p < 0.05). Therefore, H7 was not supported while H8 was supported.

H9 and H10 focused on the relationships between safety communication, safety performance, and safety commitment. This study hypothesized that safety communication influences safety performance and safety commitment. The results of path analyses indicated that safety communication had a positive influence on safety performance ($\beta = 0.164, t = 2.601, p < 0.05$) and safety communication (β = 0.377, t = 5.542, p < 0.001). Thus, H9 and H10 were supported. Moreover, safety commitment positively influenced safety performance (β = 0.276, t = 4.077, p < 0.001), indicating that H11 was also supported.

Regarding the moderating effect of safety knowledge, the findings revealed no moderating effect of safety knowledge on the relationship between safety policy and safety performance (p > 0.05). There was also no moderating effect of safety knowledge on the influence of prevention planning on safety performance (p > 0.05). Additionally, the relationship between safety control and safety performance was not moderated by safety knowledge (p > 0.05). Nonetheless, safety knowledge moderated the relationship between safety training and safety performance (β = 0.100, t = 1.745, p < 0.05). Finally, safety knowledge moderated the relationship between safety communication and safety performance (β = -0.156, t = 2.707, p < 0.001). Table III presents the results for each hypothesis' relationship. Overall, 15 out of 21 (71%) hypotheses were supported.

TABLE III. ESTIMATES AND SIGNIFICANCE OF EACH HYPOTHESIS IN THE SEM.

	Hypothesis	Result
H1	Safety Policy → Safety Performance	Supported
H2	Safety Policy → Safety Commitment	Supported
H3	Safety Training → Safety Performance	Not Supported
H4	Safety Training → Safety Commitment	Not Supported
H5	Prevention Planning → Safety Performance	Supported
H6	Prevention Planning → Safety Commitment	Supported
H7	Safety Control → Safety Performance	Supported
H8	Safety Control → Safety Commitment	Supported
H9	Safety Communication → Safety Performance	Supported
H10	Safety Communication → Safety Commitment	Supported
H11	Safety Commitment → Safety Performance	Supported
H12	Safety Policy→ Safety Commitment → Safety Performance	Supported
H13	Safety Training → Safety Commitment → Safety Performance	Not Supported
H14	Prevention Planning→ Safety Commitment → Safety Performance	Supported
H15	Safety Control→ Safety Commitment → Safety Performance	Supported
H16	Safety Communication→ Safety Commitment → Safety Performance	Supported
H17	Safety Knowledge × Safety Policy → Safety Performance	Not Supported
H18	Safety Knowledge × Safety Training → Safety Performance	Supported
H19	Safety Knowledge × Prevention Planning → Safety Performance	Not Supported
H20	Safety Knowledge × Safety Control → Safety Performance	Not Supported
H21	Safety Knowledge × Safety Communication→ Safety Performance	Supported

IV. DISCUSSION

This study aimed to examine the main predictors of safety performance in the Iraqi electric power sector. To this end, external variables were incorporated into the proposed model, including safety knowledge as a moderator. The empirical findings revealed that safety performance is influenced by safety communication, safety policy, safety control, prevention planning, and safety commitment. Safety commitment is affected by safety policy, prevention planning, control, and communication. Safety training and safety control were insignificant.

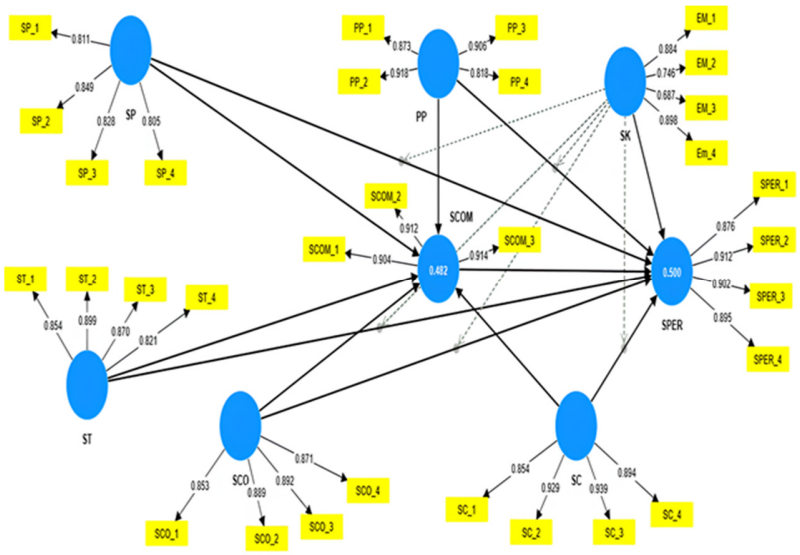

Fig. 2. Measurement model result.

. Furthermore, safety communication had the most significant effect compared to other variables. As expected, safety policy had a positive impact on safety performance, aligning with previous studies suggesting that a greater emphasis on safety policy within an organization enhances overall safety performance among employees [12, 36, 42]. Consequently, effective safety policies and initiatives are likely to foster a commitment to improving safety performance among staff. However, the empirical findings show that safety training does not notably influence safety performance, in contrast to previous studies that highlighted the impact of safety training on safety performance [12, 43-44]. This unexpected result may be specific to the electric power industry context. Even though other studies showed that safety training enhances safety performance across industries [43-44], it is plausible that employees in the Iraqi power sector perceive the training they receive as inadequate or irrelevant [45-46].

As hypothesized, prevention planning positively influenced safety performance. Similarly, in [44], it was reported that effective prevention planning leads to enhanced safety performance. Thus, regarding the workplace, when employees see that their employer is dedicated to preventing incidents and ensuring their well-being, it contributes to a culture where safety is prioritized, positively influencing safety performance. Therefore, employees are likely to be more committed to enhancing safety performance [45-47]. Furthermore, the empirical findings revealed that safety control did not influence safety performance. This unexpected finding contradicts [48-49] that reported that higher safety control leads to better safety performance in the workplace. According to the literature, safety control measures are explicitly implemented to improve safety performance [5, 49-50]. The findings indicate that enhanced safety control will not improve employees' safety performance. Therefore, the employees did not perceive safety control as essential to enhance their safety performance in the electric power sector. As expected, safety control had a positive influence on safety commitment. Previous studies did not assess the impact of safety control on safety commitment. This finding suggests that increased safety control at work will improve the safety commitment of employees. The results revealed that safety communication positively influenced safety performance, in line with [51-52] where safety communication positively affected employee safety performance. Effective communication is essential in providing health and safety-related information from management to workers and vice versa. The results also showed that safety communication positively influences safety commitment. This finding supports previous studies, which showed that effective safety communication can enhance the safety commitment of employees at the workplace [18-19]. Therefore, increased communication and awareness of safety procedures, potential hazards, and feedback will likely boost staff commitment to safety at work.

V. CONCLUSION

This study aimed to formulate a model for safety performance in the Iraqi electric power sector, integrating previous studies to develop an extended ECM that will provide some theoretical framework for future research. This study presented an extensive review of theoretical and empirical studies from the workplace safety domains to identify knowledge gaps in the safety performance of employees. The study addresses these gaps by proposing a model to forecast safety performance in the electric power sector, where security is a critical aspect of operations due to the unique and potentially hazardous nature of working with electricity. The novelty of this study is that it integrates critical safety-related variables. The model includes essential variables, such as safety policy, prevention planning, safety control, safety communication, and safety commitment. This study discloses that safety communication is critical to ensuring safety performance among employees in the electric power sector. The findings shed new light on the application of a tailored model to explain safety performance in this specific context, differentiating from previous studies, which mainly focused on past models that were not suited to this background. Although

several studies investigated the predictors of workplace safety performance [34, 53-55], limited studies have focused on the electric power sector. Safety commitment is the degree to which leadership within an organization demonstrates a strong commitment to safety [9]. The empirical findings revealed that safety performance is influenced by safety commitment, in agreement with [56].

In addition to the meaningful findings, some limitations remain to be addressed in the future. First, it would be beneficial to replicate the study in diverse cultural contexts to compare preferences and behaviors in different countries. This would improve cross-cultural generalizability and further explore the moderating effect of culture on the identified predictors of safety performance in the Iraqi electric power industry. Furthermore, future work might conduct a longitudinal study at successive time intervals to observe changes in user attitudes and intentions. This entails data collection over a longer period at different times and is particularly important as user perceptions can change over time. This method was not feasible in this study due to time constraints. Alternatively, a mixed-method approach that combines qualitative and quantitative methods can provide deeper insights and better outcomes.

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