

Investigating the Impact of Safety Management Communications on Safety Culture in Construction Industry: Mediating Role of Behavioural Safety and Perceived Working Environment

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Abstract

The construction industry is high-risk by nature due to its outdoor operations, occupational hazards, work-at heights, complicated on-site plants, equipment operation, and workers' behaviours towards safety culture. Using a total safety culture model, this paper aims to investigate the relationship between behavioural safety, perceived working environment, safety management communications, and safety culture. A quantitative research approach was applied to collect data from employees working at different construction sites in Namibia. The hypothetical relationship between the constructs was tested using structural equation modelling. The results indicate that behavioural safety, perceived working environment, and safety management communications significantly impact safety culture. In addition, perceived working environment and behavioural safety mediate the relationship between safety management communications and safety culture. This study contributes new knowledge in controlling the safety culture at construction sites, and thereby, this study also contributed new knowledge to the literature on the safety culture model in the construction industry.

Keywords: Safety Management, Communications, Safety Culture, Construction Industry, Behavioural Safety, and Working Environment.

Introduction

Since the 1990s, modernisation and maintenance of safety culture has been the most critical areas of research driven by practical and industrial needs, especially in high-hazard industries (Harvey & Cregan, 2018; Al-Bayati, 2021). In most developing countries, high-hazard sectors like the construction industry still lack strategies for implementing a safety

culture. Ilvonen (2011), states that safety is the capacity of people or organisations to manage risks and hazards, prevent losses or damage, and accomplish their objectives. Safety can be defined as a state in which there are no incidents, injuries, accidents, or near misses or where the frequency of occurrences is tolerably low (Lee & Dahinten, 2020). Therefore, several studies have determined the elements that improve safety in the construction sector; managerial commitment is the most essential component of culture associated with safety (Boateng et al., 2019). According to Bates & Plog (1990), culture is the set of shared values, beliefs, behaviours, practices, and artifacts that people in society use to get by in their daily lives and with each other. Culture is passed down via education from one generation to the next. According to Hofstede (2001), culture is the transmitted and generated content as well as patterns of ideas, values, and other symbolic-meaningful systems that have a role in influencing human conduct and the artifacts that result from it. Therefore, culture is essential in designing and implementing safety in a hazardous working environment.

However, Pidgeon (1998), highlighted that the main objective of safety culture is to strategise a body of knowledge, social norms, roles, and technological and behavioural practices aimed at reducing the likelihood that management, staff, clients, and the general public would be exposed to hazardous or harmful situations. Another study by Fernández-Muñiz et al (2007), highlighted that members in the organisation share a standard set of safety-related values, perceptions, attitudes, and behavioural patterns. They also implement policies, practices, and procedures at all organisational levels that reduce employees' exposure to occupational risks and demonstrate a strong commitment to preventing illnesses and accidents.

Construction is globally recognised as one of the most hazardous industries, with a notably poor safety record (Zhang et al., 2019). Ensuring safety in construction has been a significant concern for industry practitioners and researchers (Tam et al., 2004; Lee et al., 2020). Despite employing around 7 percent of the world's workforce, the construction sector is responsible for nearly 30-40 percent of the total fatalities (Khan et al., 2023). In Great Britain, the construction sector recorded the highest number of fatal injuries between 2022 and 2023 with 45 fatalities (HSE, 2023). In the United States of America, the construction industry reported 971 fatalities in 2017, indicating a fatality rate of 9.5 per 100, 000 full-time workers, which is almost 2.7 times greater than the average fatality rate across all occupations (Choe et al., 2020). The fatality and incident rates in the construction industry are extensively higher than the averages of all the industries in most countries (Trinh & Feng, 2020), and the Namibian construction industry is no exception. According to Nghitanwa (2016), the Namibian construction industry has the highest injuries across all industries. Nghitanwa & Lindiwe (2017) found that between April 2011 and March 2016, the Namibian construction industry recorded 37 accidents, among which 59.5 percent were severe, 13.5 percent minor, and 27 percent fatal in Windhoek alone. However, the accident and fatality statistics in the Namibian construction sector could be much worse in reality. As Nghitanwa & Lindiwe (2017) stated that occupational accidents and injuries in the Namibian construction industry are under-recorded and reported. As a result, safety remains a critical issue in the Namibian construction sector (Amweelo, 2001).

However, limited previous studies investigated and concluded the relationships between safety management communications, behavioural safety, perceived working

environment, and safety culture in the Namibian construction industry. Therefore, this study aims to investigate the overall impact of safety management communications, behavioural safety, perceived working environment, and safety culture in the Namibian construction industry by employing the total safety culture model.

Total Safety Culture Model

The total safety culture model proposed by Geller (1994), emphasises behaviour and safety culture, aiming to achieve what is known as the Safety Triad. This model seeks to empower construction employees to develop standardised data sets to reduce risks and adopt behaviour factors that help establish necessary actions to prevent incidents at construction sites (Choudhry et al., 2009; Al-Bayati, 2021). The core concept of the total safety culture model is based on three domains: behavioural factors, environmental factors, and personal factors (Cooper, 2002). These three factors form a triangle shape called the Safety Triad, which provides the narrative structure of a dynamic safety culture (Choudhry et al., 2009; Al-Bayati, 2021). Geller (1994), outlined ten fundamental principles for maintaining a total safety culture at a construction site, including worker driven safety rules and procedures; a behaviour-based strategy; focusing on safety processes rather than outcomes; viewing behaviour as directed by activators and motivated by consequences; aiming for success, rather than merely avoiding failure; observing and providing feedback on labour practices; offering effective feedback via behaviour-based coaching; recognising observation and coaching as critical activities; emphasising self-esteem, belonging, and empowerment; and treat safety as a priority instead of a value. The safety triad model acknowledges the dynamic and interactive relationships between the person (construction workers), the environment, and behaviour (Junaid et al., 2020).

The total safety culture model is built on the premise that fostering a strong safety culture within the construction industry can significantly reduce workplace risks and incidents. By focusing on the behaviour of employees, the environment in which they work, and individual personal factors, this model seeks to create a holistic approach to safety. The safety triad, a vital element of this model, illustrates the interconnectedness of these three domains. Behaviour factors include the actions and practices of workers that contribute to safety. Environmental factors encompass the physical and organisational settings where construction activities occur. Personal factors involve the individual characteristics and attitudes of the workers. The safety triad offers a comprehensive framework for understanding and improving safety culture by addressing all three areas.

Previous studies have highlighted the critical role of behavioural, environmental, and personal factors in shaping safety culture. Behavioural safety, supported by strong management commitment, has been shown to enhance safety performance on construction sites, thereby reducing accidents and associated costs (Mohammadi & Tavakolan, 2020). Environmental factors also play a significant role in contributing to accidents (Zhang et al., 2020). Hence, construction companies must implement adequate safety systems to create a safe and productive working environment, enhancing the safety culture (Williams et al., 2018). Additionally, personal factors can influence practices or conditions that lead to accidents (Xu, Zhang, & Hou, 2019). Choudhry et al. (2009) emphasised that safety culture results from the interaction between psychological, behavioural, and situational or environmental aspects within a construction company. Therefore, this study acknowledges

the importance of adopting all three factors — behavioural, environmental, and personal — to cultivate a comprehensive safety culture in the construction industry.

Literature Review and Hypotheses Development

Safety Management Communications and Safety Culture

Elving et al (2012), define communications management as the systematic planning, implementation, monitoring, and revision of all communication channels within a construction company, including the organisation and dissemination of new communication directives related to the company, network, or communications technology. According to PMI (2017), communications management encompasses planning communications management, managing communications, and monitoring communications. Effective communication involves delivering information and ensuring it is understandable, received, and comprehended (Eyre, 1979). Safety managers play a crucial role by communicating and enforcing all safety protocols. They organise safety training programs to align construction workers' behaviours with the working environment (Benjaoran & Bhokha, 2010). In some instances, Occupational Safety, Health, and Environment (OSHE) professionals directly communicate with and monitor each construction worker to ensure safe task execution. Misnan & Mohammed (2007) emphasise that safety managers must continuously transfer and exchange extensive safety information throughout the construction project life cycle for a productive working environment. Li et al (2015), highlights that dynamic management forces within a construction company are vital to the success of construction projects, contributing to lower injuries and incidents. Therefore, we formulated the following hypothesis.

H1: Safety management communications significantly impact safety culture.

Safety Management Communications and Behavioural Safety

Effective communication management with all levels of stakeholders, as identified in project management bodies of knowledge, is a critical area of project management and a crucial success factor for any construction project (Bust et al., 2008; PMI, 2017). Additionally, management is vital in motivating and educating construction workers on-site to follow safety protocols and maintain a safe working environment. Li et al. (2015) emphasised that management needs to understand the behaviour of construction workers within the work environment and provide training accordingly. Management officials are also responsible for making follow-ups and motivating workers to achieve organisational goals on time. Samsudin et al. (2020) found that safety management significantly impacts behavioural safety practices; further, they stated that communication is essential for fostering quality relationships, trust, and cooperation among construction project teams. However, limited studies shed light on the relationship between safety management communications and behavioural safety in Namibia's construction industry. Thus, the following hypothesis was formulated.

H2: Safety management communications significantly impact behavioural safety

Safety Management Communications and Perceived Working Environment

The perceived working environment encompasses a range of elements, including indicators, principles, traits, characteristics, components, dimensions, and attributes (De Castro, 2013). Management professionals play a crucial role in developing safety measures at all levels by understanding construction workers' behaviour and attitudes towards

maintaining a safety culture (Saenko et al., 2011). Glendon (2006), identified a set of stable and standard safety culture dimensions that significantly influence the perceived working environment. Pirzadeh et al (2020), argue that poor communication by safety personnel can lead to accidents at construction sites. Similarly, Zamani et al (2020), discuss that safety managers who design protocols without understanding construction workers' behaviours and the working environment increase risk levels and reduce performance. Practical analysis and understanding of the working environment help train construction workers for better outcomes. Therefore, safety managers must understand the behaviours of construction workers, recognising that they come from diverse educational backgrounds, skills, genders, and ages (Ahmed et al., 2020). While the influence of safety managers' values on the perceived working environment and understanding of behavioural safety and personal priorities have been extensively studied in other industries such as healthcare (Man et al., 2020), aviation (Ciucă et al., 2020), and manufacturing (Suhanyiova et al., 2020), there is a lack of research exploring these factors within the construction industry. Moreover, the impact of OSHE professionals on predicting the working environment, behavioural safety, and personal priorities toward safety culture remains unclear in the context of the construction industry. To address these gaps, this study formulated the following hypothesis.

H3: Safety management communications significantly impact the perceived working environment.

Behavioural Safety and Safety Culture

The construction industry is known for having poor safety cultures, and efforts to improve safety records will not be fully effective until behavioural safety is addressed (Ehiaguina & Moda, 2020). Despite this, there is a substantial body of research on behavioural safety and safety culture concepts within the construction industry. Behavioural safety factors, which involve construction workers' actions toward safety culture, can be measured through peer observations and the implementation and design of appropriate safety training and monitoring (Choudhry et al., 2009). In the construction industry, a behavioural safety assessment survey was conducted to evaluate participants' willingness and project site conditions, highlighting the core weaknesses of construction workers during work hours (Li et al., 2015). Behavioural safety factors pertain to the systematic study of human behaviour on work sites, focusing on critical safety behaviours and assessing whether construction workers adhere to safety protocols. In such situations, safety managers monitor workers and encourage the maintenance of a safety culture on-site (Saenko et al., 2011). Attention to behavioural safety is directed at specific safety aspects performed by individual construction workers (Kang et al., 2020). Han (2010) notes that while behavioural safety factors have been studied in various fields, such as sales, security, and consumer relations, there is limited research on their impact on safety culture within the construction industry. Therefore, this study formulated the following hypothesis.

H4: Behavioural safety significantly impacts safety culture.

Perceived Working Environment and Safety Culture

The working environment is a crucial variable in the safety culture model, frequently used to examine the safety culture of the physical working environment. It encompasses equipment, tools, machines, housekeeping, temperature control, and standard operating

procedures in construction projects (Akan et al., 2020). Luque-Vílchez (2019), found that the conditions of the working environment directly influence safety culture among construction workers. Other studies have also indicated a significant relationship between safety culture factors and construction workers' outcomes, suggesting that improved safety can enhance worker performance and reduce healthcare costs (Pandit et al., 2019). Zhang et al. (2019) recommend maintaining a strong safety culture by improving the working environment to reduce risks and incidents by safety personnel. Numerous studies have investigated the impact of the perceived working environment on safety culture across various industries, including manufacturing, courier services, and offshore companies (Suhanyiova et al., 2020). However, few studies have focused on the construction industry and how the working environment affects safety culture. Lee (2020) highlighted that the working environment, whether directly or indirectly, influences construction workers' perceptions, behaviours, and safety culture factors on-site. To address these research gaps, this study formulated the following hypothesis to explore within the Namibian construction industry.

H5: Perceived working environment significantly impacts safety culture.

Mediating Role of Perceived Working Environment and Behavioural Safety

H6: Behavioural safety mediates the relationship between safety management communications and safety culture.

H7: Perceived working environment mediates the relationship between safety management communications and safety culture.

Research Method

A quantitative research method was employed to investigate the proposed hypotheses of the present study. To collect data from construction sites, a questionnaire survey was developed using a five-point Likert scale (from 1= "strongly disagree" to 5= "strongly agree"). Thereby, the measurement items for the present study were adapted from past studies, such as the items for safety management communications (Mohamed, 2002), behavioural safety (Fung et al., 2005), perceived working environment (Cox & Cheyne, 2000), and safety culture (Al-Bayati, 2021). However, some items were slightly modified to reflect the construction industry's thoughts. In addition, to ensure measurement reliability and validity, a draft questionnaire was pretested on two academicians and a construction safety manager. Their feedback was used to refine the questionnaire. "Structural equation modelling" (SEM) via Smart PLS software was applied to test the hypothetical relationship between the constructs in the present study.

Demographic Data

Despite the survey's initial distribution to 400 construction workers via face-to-face interactions, only 367 (91.75%) responses were considered for analysis (Heberlein and Baumgartner, 1978). This discrepancy may be attributed to non-participation or incomplete submissions, influencing the study's scope and findings. Table 1 shows an overview of the demographic data of the participants in this study.

Table 1

Demographic Characteristics

	Category	Frequency	Percent
Gender	Male	362	98.6
	Female	5	1.4
Age	Less than 20 years		
	21-30 years	115	31.3
	31-40 years	156	42.5
	41-50 years	86	23.4
	51 years and above	10	2.7
Position in the organisation	Occupational Safety, Health and Environment (OSHE) Manager	2	0.5
	Occupational Safety, Health and Environment (OSHE) Officer	16	4.4
	Occupational Safety, Health and Environment (OSHE) Supervisor	8	2.2
	Skilled Construction Worker	300	81.7
	Semi-Skilled Construction Worker	30	8.2
	Unskilled Construction Worker	11	3.0
Highest level of education	No school attended	89	24.3
	Primary	57	15.5
	Secondary	170	46.3
	Certificate	30	8.2
	Diploma	20	5.4
	Bachelor's degree	1	0.3
	Doctorate		
How long have you been working in the construction industry?	Less than 1 year	22	6.0
	1-3 years	83	22.6
	4-6 years	101	27.5
	7-9 years	73	19.9
	10 years and above	88	24.0
How many construction projects have you been involved in?	1-3 projects	131	35.7
	4-6 projects	107	29.2
	7-9 projects	44	12.0
	10 projects and above	85	23.2
	N\$ < 150K		
	150K – 250K		

What is the total cost of the project you are currently involved in?	250K – 350K		
	350K – 450K		
	450K – 550K	1	0.3
	550K – 650K	3	0.8
	> 650 000 N\$	76	20.7
	I do not know	287	78.2
How do you rate your current Occupational Safety, Health and Environment (OSHE) knowledge at construction sites?	Very poor	2	0.5
	Poor	2	0.5
	Neither poor nor good	60	16.3
	Good	279	76.0
	Excellent	24	6.5
Have you ever had injuries at the construction site?	Never	122	33.2
	rarely	155	42.2
	Sometimes	81	22.1
	Often	7	1.9
	Always	2	0.5
Have you ever violated the Occupational Safety, Health and Environment (OSHE) procedures at work?	Never	152	41.4
	Rarely	151	41.1
	Sometimes	56	15.3
	Often	4	1.1
	Always	4	1.1
Total		367	100.0

Table 1 provides a comprehensive overview of the respondents' demographic data. The results revealed that the majority of participants were male, comprising 98.6 percent compared to 1.4 percent of females. This gender imbalance is rooted in traditional stereotypes, societal expectations, or barriers to entry for women in the industry. Most of the construction workers were from the age group between 31 to 40 years with 42.5 percent, followed by 21 to 30 years (31.3 percent), 41-50 years (23.4 percent), and 51 years and above (2.7 percent), respectively. The predominant age group of construction workers in the survey falls between 31 to 40 years, comprising 42.5 percent. This suggests a significant concentration of mid-career professionals in the industry. The following age brackets, 21 to 30 years (31.3 percent) and 41 to 50 years (23.4 percent), indicate a diverse workforce. The smaller percentage of workers aged 51 and above (2.7 percent) implies a lesser presence of older individuals in the construction sector, potentially indicating challenges or attrition in retaining experienced workers.

Data Analysis

The research hypotheses were tested using structural equation modeling (SEM), a statistical tool commonly used by sociologists and psychologists but underutilised in construction engineering and management despite its clear advantages (Molenaar et al., 2000). SEM is a multivariate methodology that allows for the simultaneous examination of relationships among independent and dependent constructs within a theoretical model (Al-Bayati, 2021). For analysis of the hypotheses for this study, this study utilised the partial least squares (PLS) technique (Saleem et al., 2022). PLS estimates parameters for the connections between measures and their respective constructs (loadings) and the connections between

different constructs (path coefficients). Loadings can be interpreted as factor loadings, while path coefficients are standardised regression coefficients. The assessment of the model is presented in Table 2-4 and Figure 1.

Table 2
Measurement Items

Safety Management				
Communications		0.927	0.941	0.696
CM1	0.847			
CM2	0.87			
CM3	0.848			
CM4	0.818			
CM5	0.866			
CM6	0.768			
CM7	0.818			
Behavioural Safety		0.791	0.865	0.619
BS1	0.851			
BS2	0.884			
BS3	0.765			
BS5	0.621			
Perceived Working Environment		0.808	0.883	0.717
PWE4	0.734			
PWE5	0.912			
PWE6	0.883			
Safety Culture		0.699	0.816	0.529
SC1	0.652			
SC2	0.621			
SC3	0.843			
SC4	0.772			

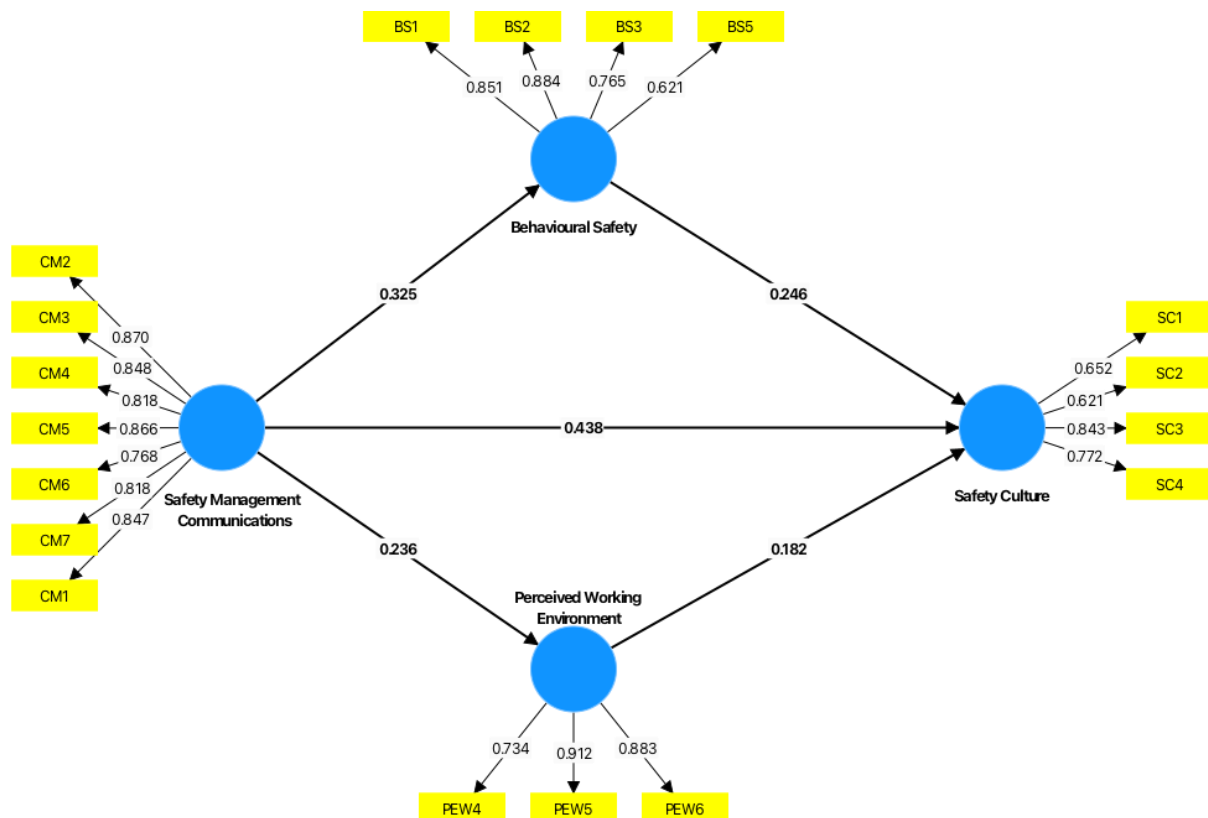


Figure 1. Assessment of Structural Model

Table 3

The Heterotrait-Monotrait ratio of correlations

	BS	PWE	SC	CM
Behavioural Safety	1			
Perceived Working Environment	0.396	1		
Safety Culture	0.572	0.456	1	
Safety Management Communications	0.372	0.254	0.679	1

Table 4

Forner-Larcker criterion

	BS	PWE	SC	CM
Behavioural Safety	0.787			
Perceived Working Environment	0.288	0.847		
Safety Culture	0.441	0.357	0.728	
Safety Management Communications	0.325	0.236	0.561	0.834

Hypotheses Testing

This section presents the results of testing the research hypotheses. The effectiveness of any given PLS model in achieving its objectives can be determined by examining the R-square values for the dependent construct(s). Path analysis was used to assess the model. A higher path coefficient indicates a more substantial effect of one variable on another. Figure 2 shows the estimated path coefficients, while Table 5 summarises the hypotheses, path coefficients from PLS analysis, the t-values, and the associated significance levels for each

path. All paths were in the hypothesised direction. The regression of the independent constructs on the safety culture construct resulted in an R-square of 0.74, indicating that the model explains about 74% of the variance in safety culture for the sampled data.

Table 5
Direct Hypotheses

	β	t-value	p-values
Safety Management Communications -> Perceived Working Environment	0.236	4.158	0.000
Safety Management Communications -> Behavioural Safety	0.325	5.175	0.000
Safety Management Communications -> Safety Culture	0.438	6.536	0.000
Behavioural Safety -> Safety Culture	0.246	3.636	0.000
Perceived Working Environment -> Safety Culture	0.182	2.837	0.005

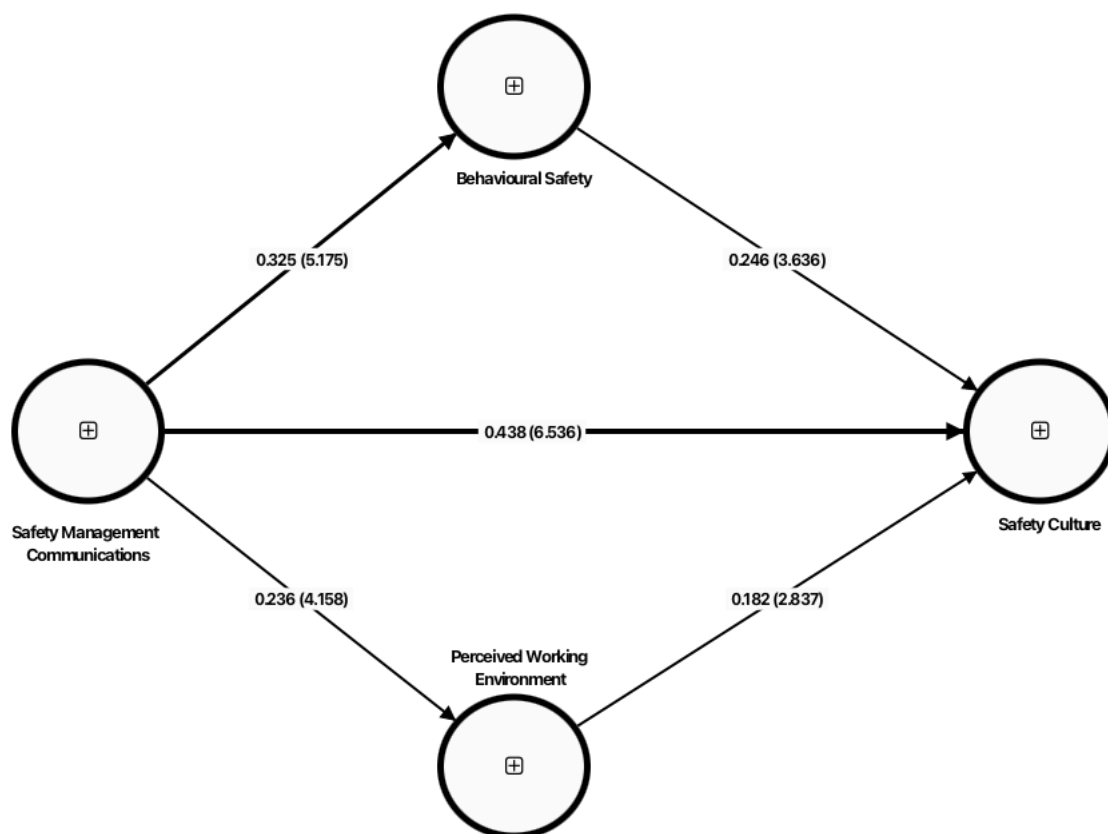


Figure 2. Structural Model

The results from the structural equation modeling highlight the critical role of safety management communications in influencing both behavioural safety and the perceived working environment, which in turn affects the overall safety culture. Specifically, the most substantial direct effect on safety culture comes from safety management communications ($\beta = 0.438$), indicating that effective communication strategies are paramount in building a robust safety culture. Behavioural safety also significantly contributes to safety culture ($\beta =$

0.246), suggesting that fostering safe employee behaviours is essential for a positive safety culture. Similarly, the perceived working environment impacts safety culture ($\beta = 0.182$), though to a lesser extent, indicating that employees' perceptions of their work conditions are important but secondary to direct communication and behavioural interventions. The direct influence of safety management communications on behavioural safety ($\beta = 0.325$) and the perceived working environment ($\beta = 0.236$) further underscores the importance of effective communication in promoting safe practices and enhancing the work environment.

Mediating Hypotheses

The results from the structural equation modeling highlight the significant indirect effects of safety management communications on safety culture through the perceived working environment and behavioural safety. While the direct impacts of safety management communications on safety culture were previously shown to be strong, these indirect paths further emphasise the multifaceted implications of effective communication in fostering a positive safety culture. First, behavioural safety mediates the relationship between safety management communications and safety culture. The path coefficient of 0.08, which is significant, suggests that improving safety communications leads to safer behaviours among workers, enhancing the safety culture. This highlights the importance of behaviour as a mediating factor and reinforces the need for communication strategies specifically targeting behavioural changes.

Second, the perceived working environment mediates the relationship between safety management communications and safety culture. The path coefficient of 0.043, while modest, is statistically significant. This indicates that safety management communications contribute to a better safety culture by positively influencing employees' perception of their working environment. Even though the effect size is small, it shows that employees' perceptions are essential in translating communication into a safety culture. Therefore, the statistical results are presented in Table 6.

Table 6

Mediating Hypotheses

	β	t-value	p-values
Safety Management Communications -> Behavioural Safety -> Safety Culture	0.08	2.598	0.009
Safety Management Communications -> Perceived Working Environment -> Safety Culture	0.043	2.414	0.016

Discussion

The overall findings from this study underscore the crucial role of safety management communications in shaping a positive safety culture on construction sites. These communications' direct and indirect effects on safety culture, mediated through the perceived working environment and behavioural safety, highlight a multifaceted approach to improving workplace safety. The direct influence of safety management communications on safety culture was found to be significant ($\beta = 0.438$, t-value = 6.536, p-value = 0.000), aligning with Mohamed (2002), who emphasised that effective safety communication can significantly enhance employees' safety perceptions and behaviours, thereby strengthening the overall

safety culture. This underscores the importance of clear, consistent, and practical safety communication strategies in fostering a robust safety culture.

Behavioural safety also showed a significant positive effect on safety culture ($\beta = 0.246$, t -value = 3.636, p -value = 0.000), consistent with Neal & Griffin (2006), who suggest that safe behaviours are critical components of a strong safety culture. Workers engaging in safe practices reduces the likelihood of accidents and reinforces the importance of safety within the organisational culture. This highlights the need for behaviour-based safety programs that reward safe practices and provide feedback on unsafe behaviours.

The perceived working environment significantly affected safety culture ($\beta = 0.182$, t -value = 2.837, p -value = 0.005), in line with Zohar (2000), who found that employees' perceptions of their work environment significantly influenced their attitudes towards safety. A positive working environment fosters a sense of well-being and security, which is integral to maintaining a safety culture. This suggests that efforts to enhance the physical and psychological aspects of the work environment can lead to better safety outcomes.

The study also revealed significant indirect effects of safety management communications on safety culture through both perceived working environment ($\beta = 0.043$, t -value = 2.414, p -value = 0.016) and behavioural safety ($\beta = 0.08$, t -value = 2.598, p -value = 0.009). These findings align with Geller (2001), who emphasised that comprehensive safety programs must address multiple dimensions, including communication, environment, and behaviour, to be effective. This suggests that communication strategies directly impact and improve safety culture by enhancing workers' perceptions and behaviours.

Management commitment and the appraisal of work hazards were identified as significant factors influencing the safety environment and affecting safe work behaviour. This supports the conclusions of Fernandez-Muniz et al. (2007), who argued that management's visible commitment to safety and proactive hazard assessments are critical in developing a positive safety culture. This finding highlights the need for organisations to demonstrate visible management commitment to safety through regular site inspections, safety audits, and leadership engagement in safety initiatives.

In conclusion, the study's findings emphasise the vital role of safety management communications in fostering a robust safety culture on construction sites. Effective communication has a direct impact, enhances the perceived working environment, and promotes safer behaviours among employees. These results align with existing literature, underscoring the multifaceted nature of safety culture and the need for comprehensive safety management strategies. Organisations aiming to improve their safety culture should prioritise effective communication strategies, promote safety behaviours, and enhance the working environment to create a safer and more productive workplace.

Practical Implications

The findings of this study offer several practical implications for improving safety culture on construction sites. Organisations can leverage these insights to develop more effective safety management strategies that enhance workplace safety. Given the substantial direct and indirect effects of safety management communications on safety culture,

organisations should prioritise creating and implementing clear, consistent, and practical safety communication strategies. Regular safety briefings, clear signage, and comprehensive safety training programs can significantly enhance safety culture. Utilising various communication channels (e.g., posters, meetings, and toolbox talks) ensures safety messages reach all employees. Mohamed (2002), emphasises that effective safety communication can significantly enhance employees' safety perceptions and behaviours, strengthening the overall safety culture. Since behavioural safety significantly impacts safety culture, fostering safe behaviours among workers is crucial. Developing behaviour-based safety programmes that reward safe practices and provide effective feedback on unsafe behaviors can promote safer behaviours. Engaging employees in safety discussions and involving them in developing safety protocols can also enhance safety culture.

Neal & Griffin (2006), suggest that safe behaviours are critical components of a strong safety culture, as they reduce the likelihood of accidents and reinforce the importance of safety within the organisation. Improving employees' perceptions of their working environment can also positively impact safety culture. Efforts to enhance the physical and psychological aspects of the work environment, such as ensuring well-maintained facilities, providing necessary safety equipment, and fostering a supportive and inclusive work atmosphere, can lead to better safety outcomes. Zohar (2000) found that employees' perceptions of their work environment significantly influence their attitudes toward safety, highlighting the importance of a positive working environment in fostering a safety culture. Management commitment and proactive hazard assessment play significant roles in shaping a positive safety environment and influencing safe work behaviour. Organisations should demonstrate visible management commitment to safety through regular site inspections, open communication, safety audits, and leadership engagement in safety initiatives. Proactive hazard assessments and timely mitigation of identified risks can further strengthen safety culture. Fernandez-Muniz et al (2007), argue that management's visible commitment to safety and proactive hazard assessments are critical in developing a positive safety culture.

The study's findings suggest that organisations aiming to improve their safety culture should adopt comprehensive safety management strategies that address communication, behaviour, and environment. By doing so, they can create a safer and more productive workplace, ultimately reducing the incidence of accidents and improving overall safety performance.

Limitations

While providing valuable insights into the factors influencing safety culture on construction sites, this study has several limitations that should be acknowledged. First, the study was conducted in a specific geographical region, namely Windhoek, Namibia. This geographic limitation may affect the generalisability of the findings to other areas or countries with different safety regulations, cultural norms, and construction practices.

Second, the sample size, though adequate for the statistical analyses performed, was relatively small and confined to 19 construction sites. A larger sample size across more diverse sites would increase the robustness and generalisability of the results. Additionally, the reliance on self-reported data from questionnaires introduces the potential for response bias, where participants may provide socially desirable answers rather than truthful responses.

Third, the study's cross-sectional design captures a snapshot in time and does not account for changes in safety culture or behaviours over time. Longitudinal studies would more effectively examine how safety culture evolves and the long-term impacts of safety management interventions.

Fourth, while the study used Partial Least Squares (PLS) for structural equation modeling, this method, despite its strengths, has limitations in estimating complex models with many constructs and indicators. The choice of PLS over other SEM techniques may affect the precision and interpretability of the path coefficients and relationships among variables.

Fifth, the study primarily focused on the perceptions and behaviours of workers at construction sites. It did not profoundly explore the perspectives of management or other stakeholders, whose views and actions are also critical in shaping a safety culture. Incorporating a broader range of perspectives would provide a more comprehensive understanding of the factors influencing safety culture.

Finally, the study did not extensively account for external factors such as economic conditions, regulatory changes, or technological advancements that might influence safety culture and behaviours. These external factors can have significant impacts and should be considered in future research.

Conclusions

In conclusion, this study has provided valuable insights into the factors influencing safety culture on construction sites, highlighting the critical roles of safety management communications, behavioural safety, and the perceived working environment. The findings underscore the importance of effective communication strategies in enhancing safety culture, as evidenced by the significant direct and indirect effects of safety management communications on workers' perceptions and behaviours related to safety. This aligns with existing literature emphasising the pivotal role of clear, consistent communication in fostering a robust safety environment (Mohamed, 2002). Moreover, the study reinforces the significance of behavioural safety programs in promoting safe practices among workers. The positive impact of behavioural safety on safety culture suggests that interventions focusing on reinforcing safe behaviours can contribute substantially to overall workplace safety (Neal & Griffin, 2006).

Additionally, the perceived working environment emerged as a crucial factor influencing safety culture, highlighting the importance of creating a supportive and safe workplace environment to enhance employees' safety perceptions and attitudes (Zohar, 2000). While the study contributes valuable findings, it is essential to acknowledge its limitations, including its geographical focus, sample size, reliance on self-reported data, and cross-sectional design. These factors may limit the generalisability and depth of the findings. Future research could address these limitations by conducting longitudinal studies across diverse geographical regions and industries, incorporating multiple perspectives, and examining the impact of external factors on safety culture dynamics. Overall, this study provides actionable insights for organisations seeking to improve safety culture in construction and similar high-risk industries. Organisations can foster a safer and more productive workplace environment by prioritising effective communication strategies,

promoting behavioural safety initiatives, and enhancing employees' perceptions regarding their working environment, ultimately reducing accidents and improving overall safety performance.

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