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INVESTIGATION ON HUMAN FACTORS INFLUENCING HEALTH AND SAFETY PERFORMANCE IN THE CONSTRUCTION INDUSTRY

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Abstract

Occupational Health and Safety (OHS) legislation in India, particularly in the construction industry, relies heavily on the formal, differentiating evidence of working environment risks as the foundation for effective Safety Management. This is the case even though India has OHS legislation. The causal agent has to successfully traverse a difficult procedure. To suggest that both temporary employees and the persons who audit submitted approaches demand a reasonable comprehending of OHS enactments, it is necessary for both groups to possess such a comprehension. In order to demonstrate that they are capable of recognizing hazards in a formal archived manner, such as through an occupational safety investigation or safe work system's explanations that distinguish medium to high hazards in the working environment and framework for proper controls to remove or minimize hazard's study work, it is necessary to demonstrate that they are able to do so. One way to do this is through an occupational safety investigation. This study focuses on many aspects of human behavior in the construction sector that have the potential to influence occupational health and safety performance. The majority of the sample respondents whose information was utilized in this research were managerial staff members who managed building projects and were responsible for occupational health and safety. The information from the sample was gathered using a standardized interview schedule. Statistical methods were used to determine that a total of 212 participants would provide appropriate sample size. The statistical methods of factor analysis and confirmatory factor analysis by means of Structural Equation Modelling to examine the information we gathered. The research confirmed that there is a strong causal association between the numerous components that are ensuring an OHS framework in the construction industry.

Keywords: Construction sector, Occupational health, Safety standards, Managerial personnel; Casual relationship

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1. Introduction

Even though OHS legislation in India relies heavily on the formal, differentiating verification of workplace dangers as the foundation for effective Safety Management, this is not the case. Temporary employees must navigate a complicated process. In order to propose that both temporary workers and the individuals who audit submitted techniques require a sensible comprehension of OHS enactments, it is necessary to demonstrate that they are capable of recognizing hazards in a formal archived manner, such as through an occupational safety investigation or safe work system's explanations, that distinguish medium to high hazards in the working environment and framework for proper controls to remove or minimize hazard's study work (Mahmoudi et al. 2014; Taofeeg et al. 2020). These meetings directly include individuals in charge of the task and allow temporary employees to acquire a mind-boggling understanding of the assignment to assist them detect dangers and develop safe work habits. To do this, it's helpful to have contract employees in proximity so that they may use the interpersonal teamwork that planning meetings generate (Agumba and Haupt 2018; Fargnoli and Lombardi 2019; Abas et al. 2020).

When it comes to the success of the Malaysian economy, the construction sector is among the most important contributors. However, building is one of the sectors that will forever be linked to peril and danger. An important sector of the Malaysian economy is the construction sector. Still, building is one of those fields that will forever be linked to peril and danger (Wong and Soo 2019). Among the most lucrative in the Middle East, Saudi Arabia's construction sector is also one of the most perilous for its workforce. This research is vital since it will help lower construction industry risks, sources of danger, and fears for workers' safety. Data from the poll showed that almost everyone had a negative opinion of the many aspects of safety that were measured, with only very small percentages choosing positive valanced replies. By comparing the connections that make up the model to their relevance in terms of empirical data, a structural equation modeling method was utilized to examine the descriptive power of the model (Moosa and Oriet 2022). The construction business is often recognized as one of the most dangerous sectors of the economy, making the implementation of a safety program a top priority for companies looking to improve their safety record. This research examined the elements that make a difference in the level of safety practiced by Ghanaian craftsmen in the building sector. Findings indicated that management's dedication to and support of safety performance was the most important factor. Results from this research may be used to improve health and safety in the construction sector (Boakye et al. 2022). The issues that may affect building site safety are reviewed. Consideration is given to the connections between the site's historical, economic, psychological, technological, procedural, organizational, and environmental aspects and the state of safety on the premises. Background and traits, such as age and experience, are considered while evaluating the historical component. The monetary values related to safety, such as hazard pay, are what define the economic element (Rodrigues et al. 2015; Sawacha 1993). Employees, including managers, may be observed in the workplace and their safety-consciousness can be evaluated based on their actions. On-site training and the proper use of

safety equipment are used to evaluate the technical and procedural aspects (Sawacha et al. 1999).

Construction is both vital to the economy and very dangerous. In addition to human loss, construction site accidents may have a significant impact on project outcomes by delaying completion, increasing costs, decreasing quality, and decreasing productivity (Skeepers and Mbohwa 2015). The sheer number of variables means that poor safety performance is most often to blame for accidents at construction sites. There has to be a realignment and rebalancing of the priority allocated to elements impacting safety performance on construction projects if we are to achieve a considerable improvement in the safety performance objective (Khalid et al. 2021). Projects in both the developed and developing worlds have recently drawn attention to the problem of safety performance. Indeed, the building sector makes major contributions to both the economy and society. As a rule, the three dependent levels that most often result in harm are a close call, an incident, and an accident. First-level risk and hazard allocation denotes a near miss, therefore failure to detect these factors in good time results in an incident, and vice versa (Charehzehi and Ahankoob 2012). Methodology for categorizing human factors analysis The Human Factors Analysis and Prevention System (HFACS) is a broad human error framework designed to investigate and analyze the human causes of accidents in train, aviation, and offshore settings. This study presents the Human Factors in Construction Safety (HFACS) concept and the HEAT framework, both of which may be useful in the building sector. In this work, we offer a novel error analysis instructional and categorization tool for construction sector safety based on the HEAT methodology. The key distinction between HFACS and HEAT is the information's structure, substance, and presentation, which makes HFACS more useful for incident investigation and construction safety education and training (Garett and Teizer 2009). The building business in Saudi Arabia is plagued by a high rate of accidents. According to official statistics, more accidents occur in the Saudi Arabian construction industry than in any other sector of the economy. Scientists have identified many causes of workplace mishaps, including hazardous environments and employee negligence. In Saudi Arabia, accidents are often attributed to irresponsible behavior on the part of employees. Workers in the construction industry need to understand the relevance of H&S, which will ultimately prevent them from becoming victims in accidents (Azmat 2020). A growing number of facility managers must increasingly interact directly with smaller companies providing cleaning, maintenance, and other services related to the physical infrastructure. The manager's reputation is increasingly on the line when a company performs poorly, making it more important to comprehend how a small business function. The provision of a safe workplace for employees and contractors is a legal requirement for all businesses. Companies are understandably concerned about occupational health and safety (OHS) owing to the risk of legal repercussions. According to the findings, organization size, management commitment, and employee buy-in were the most important variables in determining safety outcomes (Lin and Mills 2001). Historically, 'lagging' indices of health and safety performance have been used in Australia's construction sector. Injury rates and other lagging indicators are not very informative since they are based on data collected after the fact and so represent an extremely unlikely

occurrence. An update on the creation of a multi-level measuring technique is presented, including the incorporation of 'leading' safety performance indicators and safety climate measurements. It has been proposed that leading performance indicators and climate metrics may provide a more all-encompassing assessment of the construction industry's health and safety record (Lingard 2013).

The construction industry is ever evolving which needs significant measures to ensure OHS standards and it's mandatory under various legislations in the country. The various measures taken by the government ensures the safety of manual labor working in the construction industry. The OHS standards must be satisfied by the construction industry in-order to operate projects. The regulations have put-forth significant measures to ensure labor safety but still there are numerous accidents that are taking place in the construction sector which is research gap that must be addressed. The dimensions that have an influence on the OHS standards must be measured at the ground level to understand the reality. Most of the reviews that has been presented in the literature and introduction part largely focused on international countries and studies are very limited at the national level. The human force in the construction industry will decline with the lack of OHS standards which makes it mandatory for this assessment. The various dimensions that have an influence on the OHS standards will be focus area of the research that has been identified based on the lack of research in the existing literature.

2. Materials and Methods

2.1 Design of the Study

The research will be carried out using the approach of descriptive surveying that was chosen. It is one of the most popular approaches of identifying and resolving problems with occupational health and safety in the construction businesses that has been chosen before. It is required to contact the employees and their management system in the chosen firms in Tamil Nadu to analyze the safety concerns that workers are facing in the selected companies in Tamil Nadu. The difficulties impact the workers. For the purposes of this study, the descriptive survey approach has shown to be highly relevant and helpful. Primary data is collected via interviews and other methods regulated by OHS management in many sectors of the construction industry. Primary data is useful for learning about safety and health approaches, worker knowledge, procedures, records, worker motivation, training, how effective these approaches were, if they existed at all, OHS delegate obligation to accident revolution, and hazards and risk assessment. Safety, health, and hygiene on the job site are everyone's responsibility, thus it's crucial that workers and local activists work together to ensure their protection. The OHS institution and audit of workplaces are crucial to ensuring conformity with safety and health requirements in the construction industry, and primary data gathering is a great way to evaluate worker safety and health in this sector.

2.2 Sample and Population

The study involves complex procedure in finding the population that is related to the OHS standards in the state of Tamil Nadu. The study focuses on the managerial personnel involved with the ensuring of the OHS in the construction industries operating in the state. The

role of the human personnel in implementing the various OHS standards forms the main focus of the study. The population frame of the study involves the various cadres of management professional who are entrusted with the working of OHS in their respective industries. The management professionals are playing significant role in the population frame of the study. The management professionals both operating in the private and public sector enterprises were part of the study which gives a wholesome view of the opinions towards the operation of OHS standards. The working of the OHS standards has to be ensured by these professionals and their opinion will give exact reality about the conditions in which the labors are working in the construction industry. The population frame will be significantly involving the lists obtained from the public and private sector enterprises working in the state of Tamil Nadu which involves the management personnel engaged in the OHS standards in construction industry.

2.3 Sampling and Data Collection

Managerial personnel in the public and commercial sectors who work to uphold OHS standards in Tamil Nadu make up the study's sample population. There are 38 districts in Tamil Nadu where building takes place and manual laborers are employed. The administrative staff of different commercial and public sector organizations constitutes the study's population frame. Based on the official and unofficial personnel rosters of businesses of all sizes, it is clear that the population was sizable. Obtaining the list was prohibited by construction industry standards, making random selection of participants very implausible. Non-random sampling methods may be used since the population frame was not set in stone. The researcher ran into an issue when trying to compile a list of construction sector managers responsible for OHS compliance. Because of the problems outlined above, the researcher had to use a non-random method to choose respondents from Tamil Nadu as their population. The management staff was selected from the community via judgment sampling, which proved to be quite effective in locating relevant viewpoints. 212 management people from various construction firms in Tamil Nadu were interviewed using the provided schedules. Priority has been given in the research to ensure that management professionals are chosen without too much prejudice in the selection process, which might increase the study's credibility.

2.4 Interview Schedule

The interview schedule was developed based on the dimensions of the OHS standards which are most prominent in the construction industry. The interview schedule was built based on the Likert five-point scale method and various elements are given as per Table 1. The following table clearly explains the building of interview schedule for the study based on OHS standards.

Table 1: Construction of interview schedule (Source: Index Constructs based on field investigation).

S. No	Constructs	Variables	Cronbach Alpha
1.		Recruitment matching the needs of the project	0.766

2. 3. 4.	Quality of Human Resources	Co-ordination among the work schedule of the workers Appropriate supervision based on field requirements Skill set of the selected workers in the field	
5. 6. 7. 8.	Safety Criteria	Protective gears and equipment for the workers Prescribed manual for operation of machines and equipment Periodic maintenance of the involved machines Scrutiny of the quality of machines and equipment at the workplace	0.896
9. 10. 11. 12.	Training Protocols	Periodic training for the workers involved in handling of machines Assessing the outcome of the training among the workers based on on-site evaluation Training the workers based on rotation policies to make them avoid accidents Implementing specialized branch for training and works allocation based on workers skills	0.857
13. 14. 15. 16.	Health Issues	Assessing the health issues over specialized health camps conducted Pre-calculating the organizational health hazards at the workplace Monetary backup for the workers in the form of insurance policies Checkpoints to assess the reasons behind health issues at workplace	0.805

2.5 Pilot Survey

The purpose of the pilot study is to get first-hand insight into the research challenges that will hopefully be resolved as a result of the main study. The pilot program included a reliability evaluation of the structured interview schedule by gathering feedback from a representative

sample of managers. The pilot study in Tamil Nadu comprised 46 managers with responsibilities in OHS regulations. The reliability of data collection tools built from the ground up for the research project will be examined. The consistency of the interview schedule was tested using Cronbach's alpha. Using a systematic interview schedule, such as the one shown in Table-1, it is possible to reliably gather data from managerial personnel involved in the implementation of OHS regulations in the construction industry. The research developed a credible interview schedule to gauge the perceptions of the management personnel and provide trustworthy results. Each section of the interview schedule used in the research has a Cronbach Alpha score over 0.70, indicating its reliability.

3. Results and Discussion

3.1 Results

The factor analysis was used for assessing the reliability of variables that were grouped under each factor. The exploratory factor analysis was used for grouping the variables based on each factor. The following table 2 helps to understand the validity of the factors involved in the study in assessing the OHS standards in the construction industry.

Table 2: KMO and Bartlett's test.

KMO test of sampling adequacy		**0.791**
Bartlett's Test	Approximate Chi-Square	2262.94
	dF	120
	Sig.	<0.001**

The test reveals the validity of the distribution based on which the factor analysis is carried out. The opinions given by the managerial personnel involved in the study are following normal distribution which has significant impact on the reliability of the outcome. The results in Table 2 reveal that the factors formed based on the analysis are reliable which is explained by the p-value suggesting the normality of the distribution

Table 3: Variance analysis.

Component	**Initial Eigen values**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	**Variance %**	**Cumulative %**	**Total**	**Variance %**	**Cumulative %**	**Total**	**Variance %**	**Cumulative %**
1	5.718	35.735	35.735	5.718	35.735	35.735	5.130	32.064	32.064
2	3.341	20.881	56.616	3.341	20.881	56.616	2.767	17.294	49.358
3	1.219	7.621	64.237	1.219	7.621	64.237	1.847	11.541	60.899

4	1.062	6.640	70.877	1.062	6.640	70.877	1.596	9.978	70.877
5	0.967	6.047	76.924						
6	0.725	4.529	81.453						
7	0.615	3.844	85.297						
8	0.539	3.371	88.668						
9	0.410	2.564	91.232						
10	0.325	2.030	93.262						
11	0.298	1.865	95.127						
12	0.230	1.439	96.566						
13	0.196	1.226	97.792						
14	0.143	0.894	98.686						
15	0.122	0.761	99.447						
16	0.088	0.553	100.000						

The variance table (Table 3) explains the overall results of the opinions given by the managerial personnel involved in the study in assessing the OHS standards in the construction industry. The variables and factors assessed have significant difference in the variances which guarantees the influence of these factors on the OHS standards. The variance explains that the factor analysis has reflected 70 percent of the opinions given by the managerial personnel involved in the study.

Table 4: Rotated factor matrix.

S. No	Constructs	Variables	Factor Loadings
1.	Quality of Human Resources	Recruitment matching the needs of the project	0.843
2.		Co-ordination among the work schedule of the workers	0.829
3.		Appropriate supervision based on field requirements	0.826
4.		Skill set of the selected workers in the field	0.815
5.	Safety Criteria	Protective gears and equipment for the workers	0.789

6.		Prescribed manual for operation of machines and equipment	0.782
7.		Periodic maintenance of the involved machines	0.755
8.		Scrutiny of the quality of machines and equipment at the workplace	0.623
9.	Training Protocols	Periodic training for the workers involved in handling of machines	0.888
10.		Assessing the outcome of the training among the workers based on on-site evaluation	0.861
11.		Training the workers based on rotation policies to make them avoid accidents	0.748
12.		Implementing specialized branch for training and works allocation based on workers skills	0.588
13.	Health Issues	Assessing the health issues over specialized health camps conducted	0.724
14.		Pre-calculating the organizational health hazards at the workplace	0.736
15.		Monetary backup for the workers in the form of insurance policies	0.688
16.		Checkpoints to assess the reasons behind health issues at workplace	0.472

The factor analysis reveals the major factors that are contributing for the OHS standards in the construction industry (Table 4). The major factors involved in the assessment and ensuring of the OHS standards are

- Prominent Area- I - Quality of Human Resources
- Prominent Area- II - Safety Criteria
- Prominent Area- III - Training Protocols
- Prominent Area- IV - Health Issues

These factors and variables used in assessing the OHS standards were analyzed using the confirmatory factor analysis based on analysis of movement structure. The analysis will help to confirm the validity of each factor and variables that are useful in the measurement of OHS standards in the construction industry (Figure 1). The variables were coded to simply the procedure and identify the relationship based on the name of the factor.

- Recruitment matching the needs of the project - QHS1
- Co-ordination among the work schedule of the workers - QHS2
- Appropriate supervision based on field requirements - QHS3

- Skill set of the selected workers in the field - QHS4
- Protective gears and equipment for the workers - SC1
- Prescribed manual for operation of machines and equipment - SC2
- Periodic maintenance of the involved machines - SC3
- Scrutiny of the quality of machines and equipment at the workplace - SC4
- Periodic training for the workers involved in handling of machines - TP1
- Assessing the outcome of the training among the workers based on onsite evaluation - TP2
- Training the workers based on rotation policies to make them avoid accidents - TP3
- Implementing specialized branch for training and works allocation based on workers skills - TP4
- Assessing the health issues over specialized health camps conducted - HI1
- Pre-calculating the organizational health hazards at the workplace - HI2
- Monetary backup for the workers in the form of insurance policies - HI3
- Checkpoints to assess the reasons behind health issues at workplace - HI4

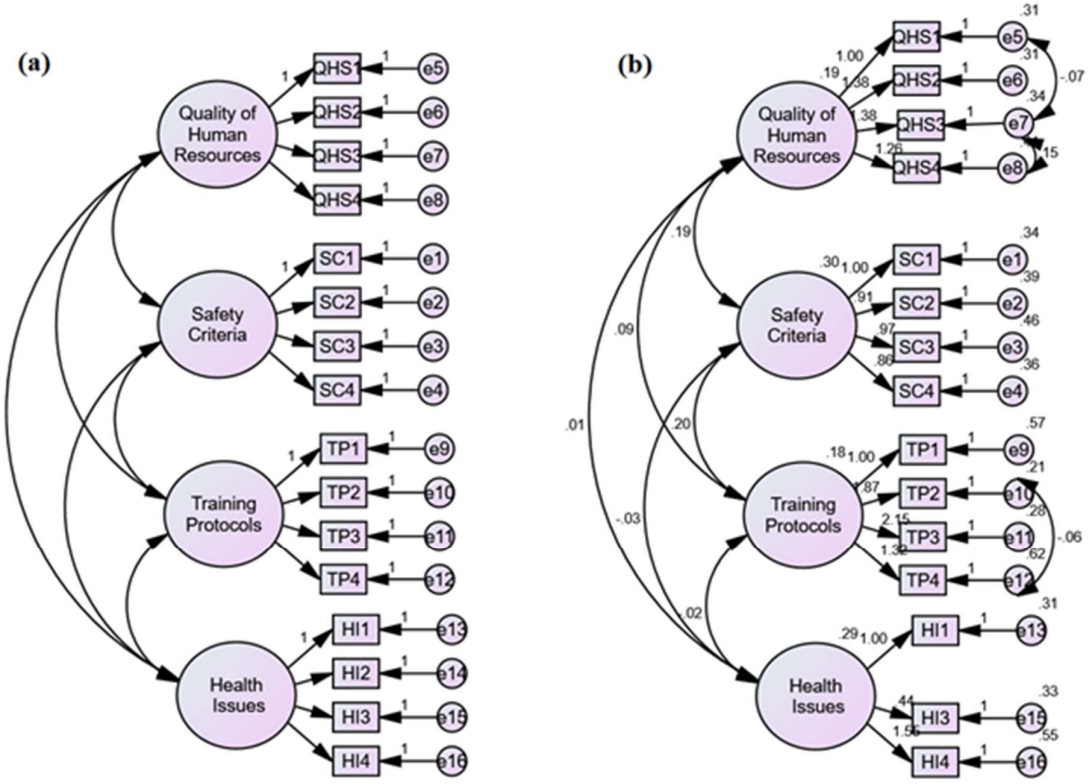

Figure 1: Modelling assessment of OHS standards in construction industry in Tamilnadu (a) Constructed model; (b) Fit model.

Table 5: Regression weights (Source: Compiled from AMOS output).

S.No	Dependent	Independent	Estimate	SE	CR	P-Value
1.	QHS1	Quality of Human Resources	1.000			***
2.	QHS2		0.915	0.112	8.145	***
3.	QHS3		0.974	0.121	8.075	***
4.	QHS4		0.858	0.107	8.054	***
5.	SC1	Safety Criteria	1.000			***
6.	SC2		1.381	0.186	7.410	***
7.	SC4		1.256	0.183	6.867	***
8.	SC3		1.384	0.202	6.841	***
9.	TI1	Training Issues	1.000			***
10.	TI2		1.874	0.262	7.158	***
11.	TI3		2.154	0.299	7.213	***
12.	TI4		1.324	0.225	5.877	***
13.	HP1	Health Protocols	1.000			***
14.	HP2		0.436	0.105	4.145	***
15.	HP3		1.547	0.364	4.245	***

Table 5 explains the beta estimate of the factors that are assessing the OHS standards in the construction industry and also its causal relationship among the variables that are involved in the assessment of each factor. The analysis has revealed significant relationship among each pair of factor and variables that is helpful in maintaining the OHS standards. The confirmatory factor analysis clearly explains that these areas are vital for ensuring OHS for employees working in the construction industry in the study area of Tamil Nadu.

Table 6: Overall model fit summary (Source: Compiled from AMOS output).

S. No	Measures	Literature value	Tested value
1.	CMIN	<5.00	3.283
2.	GFI	>0.080	0.866
3.	AGFI	>0.080	0.802
4.	NFI	>0.080	0.816

5.	CFI	>0.090	0.846
6.	RMR	<0.08	0.045
7.	RMSEA	<0.09	0.078

The overall model fit (Table 6) reveals that the model built by the study is valid and its highly helpful in measuring the overall opinions given by the managerial personnel in the area of OHS in construction industry.

4 Conclusion

The investigation looked at the factors that increase or decrease the likelihood of accidents happening during a building task. This research consolidated a framework view on accidents by focusing on the ways in which characteristics of the building creating framework lead to potentially dangerous situations and activities like these in the workplace. The study found that the features of the movement and environment, safety efforts to manage the conditions, and errand unconventionality determine the kind and frequency of hazardous work situations during a construction venture. The unavoidability of exposures and faults in building was acknowledged as a fundamental portion for assignment's capriciousness in producing unanticipated dangerous conditions. Noise, vibration, heat, cold, brightness, infrared, and ionizing radiation are all examples of physical risks. Substance dangers arise from the introduction of any of a wide range of compounds. The onset of illness may be instantaneous or it may take some time for symptoms to become apparent. The effect outlets are permanent at this time. Organic hazards may occur in the workplace when people in the construction industry consume contaminated food or become sick from exposed plants or bacteria, or when those who deal with animals eat improperly prepared meat or other foods. Diseases spread in this way might vary from ringworm among household laborer’s to infectious hepatitis in hospitals.

This work contributes to the existing body of knowledge in construction management by establishing structural equation models of occupational health and safety. These models analyze the causal link between many critical components that have quantitative values. The results of the research are significant for a number of reasons, including the fact that the analysis of components may result in improved outcomes for building projects and the identification of the underlying link among the major elements. The models instruct construction practitioners on what they need to do to increase performance in OHS-related construction projects. This is the practical meaning of the models. The value of this research to the field of construction practice is that it outlined the processes that can be used to use these models as management tools inside construction projects so that self-evaluation may be performed. Construction professionals may make accurate predictions about the maturity level of their companies in terms of occupational health and safety requirements using this approach. Using the findings of the self-assessment conducted using the model, businesses are able to build improvement plans in order to attain greater levels of occupational health and safety in the construction sector.

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