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Obstacles in Implementing Safety Management System in Nepalese Construction Projects

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Abstract

The rapid growth of construction activities in Nepal has led to an increase in accidents and fatalities. Construction projects are inherently risky due to the use of heavy equipment, power tools, and involvement of workers from various backgrounds. Safety management systems (SMS) help to mitigate these risks and hazards, which are in early stages in Nepal. The main purpose of the study is to find out the major obstacles in implementing SMS in construction projects. A total of 368 completely filled responses were collected and Principal Component Analysis (PCA) was used for analysis. Twenty-two obstacles were identified through an extensive review of the literature which were divided into five components using PCA. It was found that poor safety culture explained the most variation, accounting for 38.890% of the overall variance, with an Eigen value of 8.556. This study concludes that SMS are an essential tool in managing safety in construction projects, but their implementation requires careful planning, training and resources which will further help to improve SMS practices in similar projects.

Keywords: Construction Projects, Obstacles, Occupational Health and Safety, Principal component analysis, Safety Management System

Introduction

Construction safety means construction workers and tools are risk and accident free as work is performed. It checks how the construction worker's body, mind and social interactions are (Adhakari et al., 2020). Around the world, the construction industry is considered one of the most dangerous. Accidents are more common in the construction sector than in any other area (Elsebaei et al., 2020). Data from a number of developed countries shows that construction workers are much more likely to die on the job than workers in other industries (ILO, 2009). About one worker dies every ten minutes as a result of an industrial accident and about 60,000 accidents happen each year in the construction sector globally (Patel, 2021). It is predicted that 20,000 industrial accidents occur in Nepal every year which cause the deaths of 200 people (Gautam and Prasain, 2011).

Proper safety at work in construction relies on management techniques called construction safety management. The health of all workers and avoiding dangers or mishaps at the project depends on this being done right (Thanaraj and Priya, 2019). An OHS management system and a safety management system are basically the same concepts (Robson et al., 2007). SMS follows a planned system for safety management by requiring accountability, organizational structures, rules and procedures (ICAO, 2007).

The growth and development of Nepal largely depend on the construction industry. Nepal's construction industry has seen rapid growth because the government has made infrastructure

development a top priority. Nearly one-tenth of the country's GDP is generated by the construction industry which is the biggest non-agricultural employer and provides jobs for people facing seasonal unemployment, underemployment and unemployment (FCAN, 2022).

Nepal has made significant strides in enhancing safety management, evident through the establishment of key laws and regulations. The Occupational Health and Safety Act, 2074 (2017) and the National OSH Policy, 2019 both make it clear that the country values OSH. A crucial development is the creation of the National OSH profile, showcasing Nepal's dedication to aligning its OSH system with global standards, such as the intention to ratify the ILO Convention 155 on Occupational Safety and Health Convention, 1981. This reflects the government's progressive approach to strengthening national OSH measures in line with international norms. Nepal's government has created the Department of Labor and Occupational Safety (DLOS) within the Ministry of Labor, Employment, and Social Security. DLOS is entrusted with implementing and enforcing safety regulations in workplaces. Its responsibilities include monitoring workplaces for compliance, conducting safety inspections, and offering training and education in safety management. The Occupational Safety and Health Centre (OSHC) in Nepal supports and governs the safety and health of workers across the country. OSHC reaches its targets by writing, discussing and applying policies, standards and regulations that keep the workplace safe and healthy. The government has also implemented a National Building Code (NBC) 114 to ensure safety standards are met during construction. Overall, while progress has been made in improving safety management in Nepal, there is still work to be done to ensure that all workers are protected and that safety regulations are enforced effectively (ILO, 2022). Despite having various national and international safety policy, provisions and guidelines like National OSH policy 2076, labor law 2017, OSH guideline by Department of Local Infrastructure (DOLI), NBC 114, OSHA, ISO 45001:2018 etc., the majority of Nepalese construction companies currently face one of the biggest obstacles: incorporating OHS into everyday operations and decision-making. If the domestic enterprises are not ready and fail to establish health and safety benchmarks, they could lose their competitive advantage to foreign companies if they don't improve (Shrestha, 2018). Therefore, this study aims to assess the obstacles in implementing a safety management system (SMS) in Nepalese construction projects for improving safety management.

Literature Review

Developing countries deal with far more issues when it comes to making safety standards inclusive, unlike wealthy countries that have worked very hard to achieve this. There have been a lot of studies looking at the barriers countries experience when putting safety measures into place (Gibb and Bust, 2006). Employers' or organizations' unique cultural characteristics may be the source of implementation challenges and issues with SMS (Lappalainen, 2017).

A typical project team usually had a project manager, safety officer, safety supervisor, project engineer and foreman. Project team members, with the exception of safety officials, typically focused on the quantity and quality of work completed for some firms with comparatively weak safety cultures. As a result, the majority of the project team members delegated responsibility for safety to the safety officer or another qualified safety professional, and they gave safety a lower priority than other work obligations. Most construction companies have tight client-awarded work schedules, which makes it challenging to implement safety procedures. The project team may be resistant to change because they believe that the SMS's established procedures are sometimes redundant and unneeded. Moreover, having many staff members leave, subcontractors blocking progress, poor knowledge of OSH among the government and public, the client and the Labor Department not acting to improve OSH, focusing on minimum requirements instead of safety, lack of effort to foster ongoing improvements, absence of appropriate equipment for safe work practice could all stop SMS implementation in Hong Kong (Yiu et al., 2019, Yiu et al., 2018).

Previous research looked at the hindrances to the growth of health and safety management systems in Nigeria's construction sector and found the main reasons to be inefficient regulatory authorities which don't offer proper models and guidance on occupational health and safety management systems (OHSMS). A control structure is necessary for OHSMS because it will allow for a clear allocation of duties to various management levels and workplace units. It also gives management the ability to fully oversee its work processes. An organization's top management's leadership in health and safety is essential because it ultimately supports the use of resources and moderates' engagement with other key organizational concerns. Absent or ineffective communication among the stakeholders were also identified as a barrier in implementing SMS (Kamoli et al., 2021).

Past study highlighted the problems with introducing SMS in the Indian construction industry and found that businesses are less likely to invest in health and safety because of budgetary limitations. Safety training takes a lot of time, which has a significant impact on work flow and raises injury rates. The project team's lack of adequate safety knowledge or risk concepts, strict project timeline, absence of a safety officer or supervisor, insufficient dedication to OSH, safety concerns are not known to high management. Another factor cited as a barrier to SMS implementation was the failure to maintain accident records (Murugasamy et al., 2020).

OHSAS 18001 was less effective in places with poor safety culture and it is commonly believed that bad safety culture can develop from a society that does not highly value OHS or from managers who have poor concerns for safety (Ghahramani, 2016).

Methodology

The research targeted obstacles in adopting SMS in construction projects in Nepal, through quantitative research and a cross-sectional approach. From the previous literature review, we listed 22 obstacles in implementing SMS. Both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used in the questionnaire's formulation. In order to assure content validity, a pretest survey comprising five academic experts was also carried out to verify the clarity of the questions and based on their feedback received, the questions were then adjusted. The front-line employees and managers of construction projects (i.e., project/contract manager, contractor, safety officer, project engineer, site engineer, overseer, supervisor, etc.) with better safety knowledge throughout Nepal were the study group that was targeted. Out of 400 questionnaires distributed, 368 responses were received. A Google form, private emails, face-to-face interviews, and telephone interviews were among the methods utilized to gather data. The questionnaire was mainly based on Likert's scale of five ordinal measures (5= strongly agree; 4=agree; 3=No opinion; Disagree= 2; strongly disagree=1).

The participants were requested to arrange the reasons for slow adoption of SMS in construction projects by measuring their frequency of occurrence, based on their personal experience. After completion of data collection: processing, cleaning and preparing of data was carried out for analysis. PCA on SPSS was used to find out the obstacles in implementing SMS in Nepalese construction projects.

Result and Discussion

PCA analysis was performed. The analysis for this study started by making sure the data was suitable, then pulling out the factors using the maximum value method and ended by rotating and interpreting the factors.

a) Assessment of the Suitability of the Data for obstacles in implementing SMS

Factor analysis uses KMO to evaluate how suitable a data set is for the analysis. In the same way, a determinant score, a correlation matrix and the Bartlett’s test are produced to check whether factor analysis will work with the available data (Shrestha, 2021, Acharya et al., 2024).

Table 1 KMO and Bartlett's Test for obstacles in implementing SMS

Kaiser-Meyer-Olkin Sampling Adequacy Measure		0.879
Bartlett's Sphericity Test	Approx. Chi-Square	2147.253
	df	231
	Sig.	0.000

Researchers can use the KMO test to find out if the data are right for factor analysis. In other words, it evaluates whether the sample size is sufficient. Bartlett's Test of Sphericity was applied to check if the PCA is valid. Good sampling is shown by a KMO value between 0.8 and 1.0, moderate by a value of 0.70 to 0.79 and mediocre by 0.6 to 0.69. Should KMO be less than 0.6 because of poor sampling, corrective action is necessary. With sample sizes of between 100 and 200, the average value ought to remain between 0.5 and 0.6, while samples of less than 100 should have an average above 0.6 (Shrestha, 2021, Acharya et al., 2024).

Several variables in the correlation matrix are strongly correlated as shown by the very significant result ($p < 0.001$) from the Bartlett’s test of sphericity. This time, significance is less than 0.0001 and the test value is recorded as 2147.253. The set of data could be studied using factor analysis since the value is less than 0.05 (Shrestha, 2021, Acharya et al., 2024). It was determined that the factor number is, KMO value 0.879; Bartlett value $\chi^2 = 2147.253$; $df = 231$ ($p = 0.00$) in the scale consisting of 22 items. Table 1 shows that the KMO statistics value is equal to $0.879 > 0.7$, indicating that the factor analysis and sample are suitable for the data.

b) Factor Extraction for obstacles in implementing SMS

Scree Test and Kaiser’s Criterion (Eigen Value) are both applied in this study to decide how many factors should be kept. A result concerning the question, “What are the obstacles in implementing SMS in Nepalese construction projects?”, is presented here. For this reason, the 22 challenges in executing SMS at construction sites were added to the PCA analysis. Only the parts of the data with eigenvalues that are 1.0 and higher were preserved in this case. Varimax was applied to reduce the number of substantial factors and raise the amount of variance in the model. A scree plot displays the values of factors or principal components from a multivariate statistics study as a line of data. A scree plot was utilized to decide on how many factors or principal components to hold in an FA or PCA. According to figure 1 of the scree plot, five latent variables have an Eigen value that is above 1.

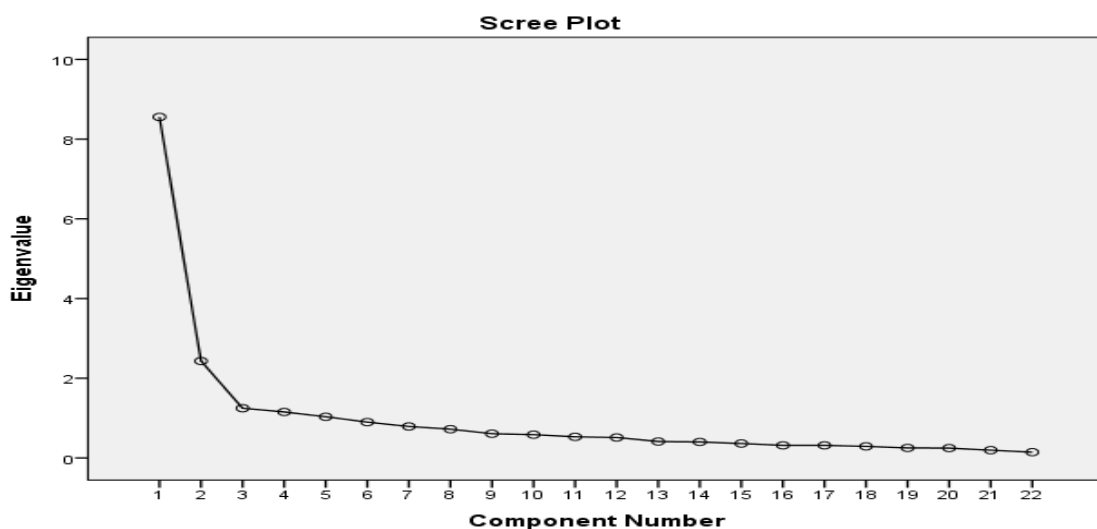


Fig 1: Scree plot for obstacles in implementing SMS in Construction projects

In Figure 1, eigenvalues were plotted on the y-axis and the twenty-two extracted component numbers are plotted on the x-axis in the order they were pulled out. Eigenvalues get bigger when started to retrieve them, with larger factors appearing first. Knowing which factors to keep is done by examining the scree plot. Most of the variation in the data can be linked to five components, where each has an eigenvalue above one. The last elements are regarded as not very significant because their contribution to total variability is tiny (Shrestha, 2021, Acharya et al., 2024).

Table 2 Eigen values (EV) and Total Variance Explained Extraction Method: Principal Component Analysis for obstacles in implementing SMS

Compon ents	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.556	38.890	38.890	8.556	38.890	38.890	4.955	22.523	22.523
2	2.432	11.053	49.943	2.432	11.053	49.943	2.922	13.284	35.806
3	1.247	5.669	55.612	1.247	5.669	55.612	2.850	12.954	48.760
4	1.153	5.241	60.854	1.153	5.241	60.854	2.326	10.573	59.333
5	1.033	4.694	65.548	1.033	4.694	65.548	1.367	6.215	65.548
6	0.898	4.084	69.632						
7	0.789	3.587	73.218						
8	0.722	3.280	76.499						
9	0.609	2.766	79.265						
10	0.585	2.657	81.922						
11	0.530	2.407	84.329						
12	0.513	2.332	86.661						
13	0.411	1.869	88.530						
14	0.401	1.821	90.351						
15	0.362	1.646	91.997						
16	0.316	1.436	93.433						
17	0.316	1.436	94.869						
18	.290	1.320	96.189						
19	.251	1.143	97.331						
20	.247	1.124	98.455						
21	.195	0.887	99.342						
22	.145	0.658	100.000						

Extraction Method: Principal Component Analysis.

Total variance explained and eigenvalue values are shown in Table 2. In this study, principal component analysis was used to extract factors in the data. In this investigation, principal component analysis was used which is the factor analysis method. 22 linear components are recognized in the data set before extraction takes place. The data set with an eigenvalue greater than one includes five different linear components after being extracted and rotated. The five factors together explain 65.548% of the overall variance found. It is suggested that at least half (50%) of the total variance in the data should be accounted for by the chosen factors.

The outcome demonstrates that five factors account for 65.548% of the common variance among twenty-two variables. As the KMO value (0.879) supports, factor analysis is a valid choice for analyzing these variables. The first idea is that the final solution will only find up to five components. Five factors were found to have an eigenvalue greater than one within the study's scope. Factor one explains 38.890% of the variation, with Eigen value 8.556; factor two explains 11.053%, with Eigen

value 2.432; factor three 5.669%, with Eigen value 1.247; factor four 5.241%, with Eigen value 1.153; and factor five 4.694%, with Eigen value 1.033.

c) Factor Rotation and Interpretation for obstacles in implementing SMS

Rotation Method: Varimax with Kaiser Normalization

Rotation converged in 9 iterations

Table 3 Extraction Method: Principal Component Analysis for obstacles in implementing SMS

Obstacles in implementing SMS	Components				
	Poor safety culture	Lack of Resources	Poor project management and leadership	Lack of knowledge and awareness	Inadequate government support
Putting a low priority on safety	0.819				
Inadequate training	0.743				
Absent or ineffective communication among the stakeholders	0.732				
Inadequate commitment to OSH	0.678				
Poor OSH attitude of the project team	0.638				
Lack of maintenance of records of accidents	0.633				
Lack of investment on OSH		0.725			
Tight project schedule		0.684			
No safety officer/in charge		0.638			
high rate of employee turnover			0.757		
Subcontractor obstruction			0.681		
Lack of maintenance and availability of construction equipment			0.650		
Government and society have poor understanding of occupational safety				0.848	
Inadequate safety knowledge or risk concepts for the project team				0.691	
High management is not aware of safety issues				0.670	
A lack of professional support from the Labor Department and client in promoting OSH at the frontline level					0.641
Inefficient regulatory authorities					0.617

According to the findings, only 17 obstacles in implementing SMS were identified as major critical out of 22 obstacles in implementing SMS. All of these obstacles were subdivided into 5 components as shown in table 3 above.

Table 4 Cronbach's alpha for second order component analysis for obstacles in implementing SMS

Component	Cronbach's Alpha
Poor safety culture	0.857
Lack of resources	0.704
Poor project management and leadership	0.818
Lack of knowledge and awareness	0.714
Inadequate government support	0.702

Internal consistency was checked for all factors by calculating Cronbach's alpha (α). Cronbach's alpha should be over 0.7 in order to be considered adequate (Baggio and Klobas, 2011). In Table 4, the component Poor safety culture, Lack of resources, Poor project management and leadership, Lack of knowledge and awareness, Inadequate government support have Cronbach's alpha values 0.857, 0.704, 0.818, 0.714 and 0.702 respectively, which attested to the statistical techniques' high degree of reliability. It demonstrates that the variables are internally consistent because they show a correlation with the grouping of their components.

Component 1: Poor safety culture

Poor safety culture is marked as component one and is considered a major challenge in introducing SMS in construction projects which contains six items that strives for putting a low priority on safety, inadequate training, absent or ineffective communication among the stakeholders, inadequate commitment to OSH, poor OSH attitude of the project team, lack of maintenance of records of accidents and have a correlation of 0.819, 0.743, 0.732, 0.678, 0.638, 0.633 correspondingly with component 1. The variable 'Poor safety culture' accounted for 38.890% of the variation in scores, with an Eigen value of 8.556. In this component, six items had the strongest average positive agreement, because their total variance and Eigen value were high. According to Ghahramani (2016), the system's effectiveness was reduced by a poor safety culture. and it is asserted that poor safety culture may result from societal attitudes that place a low priority on OHS, manager's poor attitudes towards safety. Many other past studies also proved that inadequate commitment to OSH, putting a low priority on safety, absent or ineffective communication among the stakeholders, inadequate training, poor OSH attitude of the project team, lack of maintenance of records of accidents hinders the implementation of SMS in construction projects (Kamoli et al., 2021, Yiu et al., 2019, Murugasamy et al., 2020).

Component 2: Lack of resources

In addition, the second component called 'Lack of resources' identified as a significant hurdle to executing SMS in construction projects, accountable for 11.053% variance with an Eigen value of 2.432. This component had three different items including lack of investment on OSH, tight project schedule, no safety officer/in charge and had correlation of 0.725, 0.684, 0.638 correspondingly with component 2. According to Yiu et al. (2018) potential difficulties were identified based on the state-of-the-practice review and structured interviews and insufficient resources; tight work schedules were found as the key challenges to the effective SMS implementation. It is the job of management to secure enough resources such as skilled workers, time, finances, proper work methods, facilities, tools and machinery, to ensure a SMS is carried out in construction projects (Murugasamy et al., 2020, Yiu et al., 2018).

Component 3: Poor project management and leadership

The component 3 is marked as the third critical obstacle named 'poor project management and leadership' in implementing SMS in construction projects. It contains three items namely high rate of employee turnover, subcontractor obstruction, lack of maintenance and availability of construction equipment which have a correlation of 0.757, 0.68, 0.650 correspondingly with component 3. This component explained 5.669 % of the total variance and had an Eigen value of 1.247. Yiu et al. (2019) classified poor project management and leadership as an obstacle in implementing SMS and identified that high rate of employee turnover, subcontractor obstruction as top obstacles to implementing SMS

in the construction industry. Additionally, past study show that unavailability of suitable construction equipment for site work as an obstacle in implementing SMS in the construction industry (Yiu et al., 2018).

Component 4: Lack of knowledge and awareness

Component 4 is regarded as the fourth crucial obstacle and is identified as ‘Lack of knowledge and awareness’ in implementing SMS in construction projects. It contains three items namely Government and society have poor understanding of Occupational safety, inadequate safety knowledge or risk concepts for the project team, High management is not aware of safety issues and have a correlation of 0.848, 0.691, 0.670 correspondingly with component 4. This component was explained with total variance 5.241 % and Eigen value 1.153. Sánchez et al. (2017) identifies poor safety awareness and knowledge of stakeholders involved as the major challenges in implementing SMS in construction projects. Another past study by Murugasamy et al. (2020) found that lack of knowledge about safety at a top level lowers the organization’s capacity to understand and manage risks. A lack of awareness about OSH by both government officials and the public was stated as a challenge to implementing SMS (Yiu et al., 2019).

Component 5: Inadequate government support

The component 5 is marked as the fifth critical obstacle named as ‘Inadequate government support’ in implementing SMS in construction projects. It contains two items namely lack of professional support from the Labor Department and client in promoting OSH at the frontline level, and inefficient regulatory authority has a correlation of 0.641, 0.617 correspondingly with component 5. It explains 4.694% of the total variance and has Eigen value 1.003. Yiu et al. (2018) and Kamoli et al. (2021), also shows that lack of professional support from the Labor Department and client in promoting OSH at the frontline level, Inefficient regulatory authority makes difficult in implementing SMS.

Conclusion

The obstacles in implementing SMS in construction projects were identified and divided into five components i.e., poor safety culture, lack of resources, poor project management and leadership, lack of knowledge and awareness, inadequate government support. Results have shown that the “poor safety culture” component has been ranked in the first position as obstacles in implementing SMS in construction projects. This indicates that “poor safety culture” by construction professionals and government organizations will lead to obstacles in implementing SMS. Hence for the SMS to be implemented properly, careful planning, teamwork, stakeholder involvement, adequate training, and enough resource allocation is needed.

Practical Implications

Better understanding of the obstacles associated with SMS implementation in construction projects is the goal of this study. Future research on construction site safety will be motivated by this work. With proper concentration on these identified obstacles, each construction project or organization can upgrade their SMS implementation practice, mainly in underdeveloped countries like Nepal. Safety should be considered as everyone’s responsibility, cooperative efforts and stakeholder involvement in safety programs and awareness-raising are necessary for the system's successful development and implementation. Appropriate models and guidelines for SMS should be provided by policy makers or governmental regulatory bodies, and sufficient monitoring and auditing should be carried out to ensure the system is continuously improved.

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