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Journal of Construction Engineering, Management & Innovation

Journal homepage: www.goldenlightpublish.com/journals/2/jcemi

Critical factors affecting construction safety and health performance: A case study on construction projects in Addis Ababa, Ethiopia

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https://doi.org/10.31462/jcemi.2026.616

Received 13 October 2025; Revised 31 January 2026; Accepted 5 February 2026; Available online 27 March 2026

Keywords

Building construction
Critical factors
Performance
Safety and health
Ethiopia

Abstract

The construction industry in Ethiopia is the backbone of the economy and contributes a big chunk to the GDP. But the sector is also plagued by high rates of injuries and fatalities on construction sites which is a big concern for both industry and national level. This study aims to identify and analyze the critical factors that affect the safety and health performance of building construction projects. Through literature review and interviews with engineers 47 potential factors that affect safety and health were identified. These factors were then incorporated into a structured questionnaire which was distributed to consultants and contractors in Addis Ababa to assess and rank their importance. Stepwise multiple regression analysis revealed that two factors – inadequate provision of personal protective equipment (PPE) ($B = -0.33$, $\beta = -0.57$, $t = -10.09$, $p < 0.001$) and absence of clear company safety and health policy ($B = -0.32$, $\beta = -0.58$, $t = -10.29$, $p < 0.001$) have the most negative impact on safety and health performance in construction projects. The regression model accounted for 62% of the variance in safety and health performance ($R^2 = 0.62$; adjusted $R^2 = 0.61$), indicating strong explanatory power. The findings of this study will be useful for both researchers and practitioners to understand the critical drivers of safety performance and to implement proactive measures to ensure workplace safety in Ethiopian construction sector.

1. Introduction

Ethiopia one of the fastest growing country in the Horn of Africa has gone through significant development and construction sector is playing vital economic and social role. This rapid growth is reflected in the numerous construction projects going on especially in building construction. However construction industry is globally recognized as one of the most complex and high risk sector. It is associated with big risks, accidents and injuries resulting in huge losses for individuals, organizations and society as a whole. As a result the industry has negative reputation regarding safety practices. But safety should be seen not as a luxury but as a necessity that prevents property loss, injury and fatalities [1]. Health and safety management involves identifying, assessing and controlling potential risks in the workplace. It also involves employee competence and training to mitigate risks [2]. The challenges and effectiveness of implementing safety measures depends on many factors such as work environment, community and nature of activities. Therefore health and safety efforts aim to recognize and evaluate hazards in the workplace and implement control strategies to minimize or eliminate associated risks and improve safety performance. Construction safety and health performance (SHP) has got global attention. Many studies in different countries have investigated the factors that affect SHP [3-5]. Occupational safety and health (OSH) is the foundation for preventive strategies and enforcement of safety standards at construction sites [6]. Research also emphasizes the importance of consistent supervision and implementation of basic OSH services to promote safe working environment [7].

In developing countries construction sector is more hazardous than developed nations. The fatality rate in construction is reportedly five times higher than in the manufacturing sector, with construction sites accounting for around 30% of all workplace-related deaths [8]. Due in large part to hazardous working conditions, there is a growing trend of occupational injuries in Ethiopia's construction industry, according to scant research. Back pain (9.7%), hand injuries (11.3%), and puncture wounds (21%) are the most common causes of injuries.

Approximately 67.7% of construction workers have been injured at least once a year, according to studies [9]. However, the lack of complete data makes it difficult to determine the actual severity of these injuries. Improving working conditions and industry safety procedures requires figuring out the underlying causes of these kinds of incidents. Traditional (lagging) safety indicators, which only show results after accidents occur, have been the main focus of Ethiopian research to date.Reactive in nature, lagging indicators include reported injuries and fatalities. Leading indicators, on the other hand, are proactive tools that can be used to anticipate and stop subpar safety performance. Finding proactive health and safety management techniques that can affect workplace safety outcomes is the main goal of this study [10]. Inadequate safety and health procedures are usually the cause of construction-related accidents. Such risks can be caused by a variety of factors, and the methods used to measure and enforce health and safety standards throughout the construction process have a significant impact on how well a project performs in terms of safety [11].

About 67.7% of workers in the construction industry in Ethiopia suffer injuries on an annual basis [9]; building construction workers in particular are more prone to injury, with a statistic of approximately 38.3% of them suffering from an injury in 2015 [12]. These numbers indicate that the current methods of measuring the health and safety of workers in the construction industry are ineffective in preventing injuries in the workplace. There is a need for the creation and implementation of enhanced strategies to resolve the safety challenges being faced by this industry. Without the implementation of appropriate and efficient interventions concerning workplace injuries, illnesses, sickness absenteeism and productivity losses associated with workplace-related accidents and fatalities, these challenges will continue to be significant issues within the Ethiopian construction industry. In order to alleviate these issues and improve both occupational health and safety performance, it is essential to define what are the most critical factors affecting both health and safety of construction workers engaged in a building construction project. Furthermore, any strategies developed for improving worker safety must be affordable and practicable and have the ability to adapt to the environment within the Ethiopian construction industry. Therefore, this investigation has as its purpose, the identification of the critical factors which determine the safety performance of construction projects in Ethiopia. While international research on the performance of construction safety is growing, there is a gap in the data from developing countries such as Ethiopia, where the management and regulatory frameworks used for the management of safety in construction are still evolving. This research will fill this gap by identifying and examining the elements that affect the performance of safety and health on building construction projects located in Addis Ababa. This research is distinctive because it studies an evolving environment of construction, it combines conceptual research with empirical studies by using expert interviews and quantitative data analysis, and it focuses on those elements that are both statistically significant and practically important. This study will provide information and examples of empirical work that will increase the knowledge of safety in construction in Africa as well as provide the ability to make sound data-based decisions related to improving safety performance.

2. Literature Review

Recent research reveals that safety and health in construction are highly correlated with the achievement of global sustainability goals such as the well, being of workers and improved organizational performance. Such outcomes are indeed attributed to safety culture, management commitment, and human resource practices, therefore, understanding how these and other factors affect safety performance in a developing country situation like Ethiopia become vitally important. In line with this, the literature review that first of all recaps the major findings on construction safety, and then through the emerging connections between construction safety and sustainability, it sets the stage for the recognition of the key factors in the present study.

2.1. Relevance of OHS sustainability

Occupational health and safety (OHS) sustainability aspects and their relation to the social, environmental, and economic paths have been the focus of a significant number of studies in recent times. One of such research studies [13] argues that safety and health at work can be a tool for corporate sustainability through, firstly, employee affective commitment, and secondly, the positive outcome in economic, social, and environmental factors. Simply put, the arguments vary and basically, one way of thinking is that strong OHS systems are necessary for workers' safety and well, being which at the same time lead to higher efficiency for the organizations.

On the other hand, studies also prove that OHS programs help employees directly in terms of both productivity and well, being, which is why safety management should be considered a key component of the sustainable organizational performance framework [14]. Similarly, a key element which creates a safety culture and helps in achieving safe working conditions is the managers visible engagement in occupational safety and health, and this has been pointed out to be the major factor among others at the management level [15]. Hence, these experiences in the area suggest the significance of OHS implementation along with the wider sustainability schemes which holds true especially for the construction sector where there is a high level of both social and economic risks.

2.2. Construction safety and health performance

Compared to many other industries, the construction sector experiences more accidents and injuries worldwide [16].

A number of Occupational Health and Safety (OHS) issues are common in the construction industry, according to [17]. These include the low priority given to safety, the unfavorable attitudes of contractors and employees toward OHS procedures, the lack of qualified staff to enforce safety laws, the poor promotion of safety awareness, and generally inadequate health and safety management systems; however,Even though some studies have looked into job safety and health in Ethiopia, there are not many published works focusing on how building construction projects actually perform in these areas. Moreover, in Addis Ababa, construction companies need licenses from the city's Housing and Construction Authority, and they have to meet certain standards to get them but these standards usually don't cover things like workplace safety and cleanliness.

This presents an anomaly because Ethiopia's Labour Law (Proclamation No. 377/06), especially Article 92, clearly states that employers are supposed to do everything needed to make workplaces safe, healthy, and free from anything that could harm workers. Many Sub-Saharan African countries, including Ethiopia, have not had adequate studies performed on work related injuries to assess their impact on workers and the economy. The lack of research regarding work related injuries can lead to both direct costs such as lost wages, the costs of workers' compensation benefits, and the costs of retraining employees and indirect costs that extend beyond the individual worker to families, communities, and even the government [12].

2.3. Measuring construction safety and health performance

Throughout the course of the project, ongoing measurement is necessary to evaluate the safety and health performance of construction projects. These metrics are used by organizations to efficiently manage and lower risks and to guarantee adherence to safety obligations.

Lagging and leading indicators are the two primary categories into which safety and health performance indicators are typically divided. Metrics like accident rates, missed work time, and property damage are examples of lagging indicators that show historical performance. Leading indicators, also known as positive performance indicators (PPIs), on the other hand, concentrate on proactive elements such the organization's safety atmosphere [18] and safety culture [11]. PPIs are just beginning to gain traction in the Construction Industry, specifically in Safety Management Environments, on a larger scale. Although PPIs have the potential to improve Safety Management, many construction companies rely heavily on traditional lagging indicators (accident records, workers' compensation, etc.) that react to an incident after the fact and provide little to no support for preventing incidents from occurring [19].

2.4. Enhance safety and health performance on construction sites

Strong management commitment, safe working environment, and the cultivation of safe work habits are all necessary for the successful implementation of safety programs on construction sites, according to [20]. The active participation and commitment of management and employees in developing policies and setting up feedback systems that encourage continuous improvement are critical to the success of a safety program.

In a similar vein, [2] identifies a number of fundamental components necessary for successful safety and health initiatives in the construction industry.

Such things that are mentioned include: management leadership, employees' participation in work, related matters, identification and assessment of potential hazards, implementation of prevention and control measures, education and training of personnel, continuous program evaluation and improvement, and effective coordination and communication, especially in multiemployer worksites. Furthermore, carrying out effective safety management systems in construction is of great importance as [6] argues, still, statistical data reveal that safety is often neglected in many developing countries. Conduct a study and find out that management and organization, allocation of resources, site supervision, workplace conditions, and labor issues are the five major difficulties that the local construction industry is facing. It underlined that in order to improve safety performance on project sites, senior construction professionals, including government officials and top management, must take on more responsibilities.

Additionally, [21] suggested that frequent toolbox meetings be held prior to the start of work as an efficient means of informing employees about potential risks and safety information. Increasing the quantity of safety indicators on the premises also helps guarantee that employees and guests are aware of the dangers in particular locations or circumstances, hence enhancing overall safety awareness.

2.5. Factors affecting safety and health performance in construction projects

Despite being essential to a nation's economic growth, the construction industry is nonetheless among the riskiest because of its high accident rate. Poor worker safety performance, which frequently stems from a combination of contributing variables, is one of the main causes of these incidents [21]. Falls from heights are among the most frequent kinds of accidents. Workers' awareness levels, lack of knowledge, age and experience differences, and the lack of safety briefings or toolbox meetings are important factors that affect safety performance.

Contractors believe that on-site management activities have the biggest influence on safety performance, followed by staff, procedures, policies, technical factors, and

incentives [22]. The top three particular components found were (1) safety inspections, (2) robust on-site management commitment to safety, and (3) enforcement of safety regulations.

Likewise, research on large construction companies in Egypt revealed that regular safety inspections carried out by supervisors, project managers, and top management have a highly significant impact on safety performance.

Not much research on construction safety and health performance has been conducted in Ethiopia. For example, [9] researched occupational risks and injuries in the sector but also highlighted that the lack of data on workplace injuries is an issue to be concerned about. To make worker safety and conditions better, there needs to be an understanding of the factors associated with work, related injuries. This points to the crucial need for the investigation that will help find the root cause of the below average safety and health performance that leads to accidents and injuries in Ethiopian construction projects. A thorough analysis of pertinent literature and expert advice served as the foundation for the identification of the 47 safety and health factors. This approach employed ten professionals; all of them had more than fifteen years of professional expertise in the building industry. Project managers, site engineers, safety officials, consultants, and academics with a wealth of building construction project experience were among the specialists. Semi-structured interviews were used to gather expert perspectives, enabling participants to evaluate the completeness, relevance, and clarity of the factors found in the literature. Thematic analysis was used to examine and code the qualitative data from the interviews in order to find recurrent themes and validate the final collection of elements.

The factors identified from the literature and expert opinions were grouped into thematic categories based on their conceptual similarities and the way they are commonly classified in previous construction safety and health studies as shown in Table 1 below. These categories help to organize the factors into coherent groups for clearer analysis and discussion.

3. Research Methodology

488 consultants and 1576 contractors engaged in construction projects made up the study's populations. A random selection technique was used to get a representative sample from these groups, making use of the concepts of randomness to guarantee that every person had an equal chance of being chosen. This method increases the generalization of the study results and reduces the sampling biases. Furthermore, the combination of population control data and random sampling method, which were based on the official register obtained from the Ministry of Urban Development and Infrastructure (FDRE), resulted in unbiased respondent selection and hence, the validity of the study results was enhanced.

The Yamane formula, which is known for successfully balancing between precision and feasibility in survey research, was utilized to accurately determine the sample sizes of 85 consultants and 95 contractors.This method is ideal for large group studies since it calculates the optimum sample size that minimizes the error, at the same time it takes into account the whole population.

Data was collected through a systematic questionnaire survey of closed, ended questions which facilitated the coding and examination of the responses. Google Forms were used to distribute and gather the surveys due to its accessibility and convenience of use. Participants received links to the survey through professional networking sites like LinkedIn and direct emails. Two surveys were rejected for being incomplete, leaving 134 valid replies for analysis, even though 136 out of 180 online surveys were received (74% response rate). Every questionnaire was checked for missing responses, conflicting ratings, and incomplete sections in order to filter the data. For the statistical analysis, only surveys that met these requirements and were fully completed were kept.

Table 1. Summary of groups of factors affecting safety and health performance

No.	Group Factors	Literature
1	Administrative and management related	[6, 23]
2	Role of government and engineering societies	[24, 25]
3	Project nature	[26,27]
4	Historic, human and psychological climate	[21]
5	Safety and health inspections	[22,28]
6	Safety and health meetings, accident records and reports	[21,23, 30, 31]
7	Safety and health incentive and penal	[25, 29]
8	Safety and health educating and training	[28,29]
9	Medical facilities	[24]
10	Safety and health awareness	[3]
11	Economic investment/ safety and health resource	[2]
12	Environmental factors	[32, 33]
13	Personal protective equipment	[34,35]

The responses were examined using IBM SPSS statistical software. The Relative Importance Index (RII), which provides a precise, quantifiable index that evaluates the ratings given to each item, highlighting their perceived relevance, was used to rate the relative importance of distinct criteria. This approach is especially helpful in studies that aim to ascertain the relative significance of various components since it generates accurate rankings that aid in the development of policies and decision-making. Multiple regression analyses were carried out as well to investigate the linear correlations between dependent variables (DV) and independent variables (IV). To ensure a comprehensive methodology, multiple regression analysis and RII were merged. While RII gives a relative assessment of the importance of variables, regression analysis explains the relationships between DV and IV. This dual approach, which also allows for more complex interpretations of how the data can be used to improve safety and health performance in building construction, thus significantly contributes to the analytical standpoint of the study. The survey was designed in such a way that its two parts were to serve the purpose of quantitatively assessing how the respondents perceived safety and health performance in Ethiopian building projects. Cronbach's alpha, an index of internal consistency, was used to assess the reliability of the instrument. Mat Nawi et al. [36] state that a Cronbach's alpha score between 0.6 and 0.8 indicates sufficient dependability. Whereas a score greater than 0.8 denotes high reliability. The reliability of the research tool in evaluating the safety and health performance in Ethiopian building projects was confirmed by the study's Cronbach's alpha value of 0.93.

4. Results and Discussion

4.1. Respondent's demographic profile

An analysis of the demographic characteristics of the respondents using descriptive statistics was presented in Table 2. Among participants, from contractors companies 25% of the respondents' experience was 1-5 years, 53% (5-10 years), 29% (10-15 years) and 20% of the respondents' experience was more than 15 years. And from the consultant's companies, 17% of the respondents' experience was for 1-5 years, 32 %(5-10 years), 16 %(10-15 years) and 13% of respondents were having experience more than 15 years.

4.2. Desk study results

A desk study was carried out in order to gather and analyze existing information to examine accidents (considered lagging indicators) as a measure of safety performance in construction. By understanding how these accidents occurred, the overall state of safety performance could be assessed. The findings revealed that construction-related accidents were happening at an alarming rate each year. The maximum death occurred during the year of 2020/21 that was 47 % (43 people). (Table 3)

Furthermore, the result of the desk study revealed the causes for these accidents as shown in Table 4. Accordingly, falling from height was the topmost causing accidents at construction sites in each year. This result has a parallel meaning with the inadequate of PPE at the worksite.

Table 2. Respondents experiences

Years	Respondents experiences			
	From contractors Organization		From Consultants Organization	
	Frequency	Percent	Frequency	Percent
1-5 years	15	25%	13	17%
5-10 years	31	53%	24	32%
10-15 years	17	29%	12	16%
> 15 years	12	20%	10	13%
Total	75	100%	59	100%

Table 3. Number of fatal and non-fatal injuries recorded during the last 6 years

Years	Number of Fatal work injuries recorded	Percent	Number of Non-fatal injuries recorded	Percent
2022/23	23	25%	570	34%
2020/21	43	47%	434	26%
2018/19	25	27%	665	40%
Totals	91	100%	1669	100%

Source: Ministry of labor and social affairs Ethiopia, 2023

Table 4. Causes of accidents in construction sites during the last 6 years

Causes	2022/23	Percent	2020/21	percent	2018/19	Present
Falls	211	35%	170	35%	149	22%
Electrocutions	12	2%	6	1%	2	0%
Mishandling	80	13%	38	8%	67	10%
Machine	60	10%	30	6%	26	4%
Hand tools	105	18%	90	18%	57	8%
Collision	48	8%	38	8%	127	19%
Slides	14	2%	11	2%	14	2%
Splinter	43	7%	71	14%	66	10%
Falling objects	11	2%	17	3%	140	21%
Transportation	12	2%	20	4%	25	4%
Totals	596	100%	491	100%	673	100%

Source: Ministry of labor and social affairs Ethiopia, 2023

4.3. Identify the factors affecting safety and health performance in building construction projects

The ranking of factors affecting safety and health performance based on overall relative importance index is given in Table 5 below.

According to [37] implementation of Personal Protective Equipment (PPE) is one of the highest among evaluated factors influencing contractor safety performance. They concluded that without adequate attention to PPE implementation, safety performance suffers significantly on construction sites. Studies consistently highlight that weak or missing on-site safety and health inspection/enforcement processes are major contributors to poor safety performance in building construction projects [38, 39]. Study by [40] shows that OHS management systems are inconsistently used and construction firms often lack formal risk assessment policies, undermining implementation of safety measures lead to poor safety performance in building construction projects.

4.4. Determining the critical factors affecting SHP using Regression analysis

To assess how significantly each of these factors influences safety and health performance, multiple regression analysis was used. This statistical method is generally employed to understand the relationship between several independent (or explanatory) variables and a single dependent (or response) variable.

The regression model takes the form of the following equation:

$$Y = a0 + a1x1 + a2x2 + a3x3 + \cdots anxn + \mathcal{E} \quad (1)$$

Where: Y is the dependent variable, Xi (i = 1, 2 … n) are the independent variables, ai (i = 0, 1 … n) are the parameters to be estimated and e is the error term.

This study considers the responses regarding the project's safety and health performance as the dependent variable, while the top 10 ranked factors identified through analysis serve as the independent variables.

The impact of the ten most important factors, listed in Table 6, on safety and health performance was investigated using a stepwise multiple regression analysis. A probability of F-to enter criterion of $p < 0.05$ was used to add variables to the model, while a probability of F-to remove criterion of $p \geq 0.10$ was used to remove variables. The overall F-statistic ($F = 35.701$, $p < 0.001$) showed that the final regression model was statistically significant. Variance inflation factor (VIF) values were used to measure multicollinearity; all of these values were below the generally accepted threshold of 5, suggesting that there was no significant multicollinearity among the independent variables. The conditions of linearity, normality, and homoscedasticity were shown to be reasonably satisfied by using basic residual diagnostics, such as standardized residuals and normal probability plots. A single item indicator was used to measure safety and health performance. Respondents were asked to rank their project's overall performance in terms of safety and health. A five-point Likert scale, with 1 representing "very low" and 5 representing "very high," was used to record responses. Better performance in terms of safety and health is indicated by higher scores. the use of a single item measure was judged appropriate, because it captures respondents' overall professional judgment of project level safety and health performance and is frequently used in management and safety research when a comprehensive assessment is necessary [41, 42].

Table 7 shows the stepwise multiple regression results, when ‘safety and health performance’ is treated as a dependent variable and the top significant factors discussed above as independent variables. In this case, ‘Non-availability of clear company safety and health policy’ and ‘Inadequate PPE at work site’ were found to be significant at $p < 0.05$ for safety and health performance of building construction projects. These factors are the most critical when aiming to achieve strong safety and health performance.

Table 5. Ranking of factors affecting safety and health performance in building construction projects

No	Factors	RII		Over all RII	S.D.	Rank
		Contractor	Consultant			
G_1	Managements related Factors					
1	Lack of safety awareness of the company's top management	0.491	0.566	0.529	1.40	45
2	Non-availability a clear company safety and health policy	0.869	0.825	0.847	0.93	4
3	Absence of safety and health committee	0.693	0.661	0.677	0.96	27
4	Inadequate PPE at work site	0.853	0.858	0.856	1.38	1
5	Lack of implementation of safety and health management system in accordance with legislation	0.752	0.746	0.749	1.12	10
6	Lack of technical guidance(workplace safety notes)	0.691	0.569	0.630	1.26	34
7	Lack of management commitment to safety and health programs	0.752	0.769	0.761	1.10	7
8	Lack of emergency plan and procedures	0.709	0.580	0.645	1.47	31
9	Risk assessment is not practicable at workplace	0.843	0.854	0.849	1.35	3
G_2	Role of Government and Engineering Societies Related Factors					
10	Issuing of safety laws, standards, regulations, and legislation	0.640	0.644	0.642	1.08	33
11	Ineffectiveness of current safety policy	0.509	0.590	0.550	1.40	44
12	Lack of workers compensation insurance	0.747	0.753	0.750	1.33	9
13	Poor safety legislation, codes, and standards	0.659	0.698	0.679	1.36	26
G_3	Project Nature Related Factors					
14	Poor planning and organizing the site (layout) - work environment	0.632	0.597	0.615	1.20	36
15	Design complexity	0.573	0.515	0.544	1.29	46
16	Lack application of new technology in construction	0.624	0.583	0.604	0.87	39
17	Type of owner	0.509	0.641	0.575	1.40	42
G_4	Historic, Human and Psychological Climate Related Factors					
18	Employee experience in safety and health issues	0.741	0.546	0.644	1.35	32
19	Employee education	0.765	0.614	0.690	1.34	20
20	Employee safety and health training received	0.624	0.536	0.580	0.87	40
21	Lack of skilled labor	0.712	0.736	0.724	1.06	13
G_5	Safety and Health Inspection Related Factors					
22	Lack of safety and health inspection by government authorities	0.733	0.708	0.721	1.35	14
23	Lack of safety and health inspection by management	0.749	0.725	0.737	1.34	11
24	Lack of safety and health inspection by the safety supervisor	0.677	0.685	0.681	0.94	24
25	Lack of safety and health inspection procedures onsite	0.835	0.864	0.850	1.06	2
G_6	Safety and Health Meetings, Records and Reports Related Factors					
26	Lack of conducting safety and health meeting before each activity begins	0.659	0.695	0.677	1.36	28
27	Lack of attendance of safety and health meetings by management	0.760	0.749	0.755	1.09	8
28	Poor recording and reporting of daily safety and health issues	0.824	0.861	0.843	1.49	5
29	Poor accident record keeping and reporting system	0.832	0.800	0.816	1.46	6

Table 5. Cont'd

G_7	Safety and Health Incentive and Penal Related Factors					
30	Lack of implementation of safety rewards	0.624	0.759	0.692	1.40	19
31	Lack of implementation of disciplinary actions	0.659	0.580	0.620	1.36	37
G_8	Safety and Health Educating, Training Related Factors					
32	Lack of provision and conducting safety and health training	0.733	0.702	0.718	1.35	15
33	Lack of issuing of safety booklets	0.509	0.522	0.516	1.40	47
34	Lack of displaying safety posters	0.704	0.654	0.679	0.94	25
35	Lack of training for first aid for all employees	0.724	0.637	0.731	1.06	12
G_9	Medical Facilities Related Factors					
36	Lack of availability of medical advice	0.584	0.529	0.557	1.49	43
37	Lack of adequate facilities for first aid treatment	0.659	0.593	0.626	1.35	35
G_{10}	Safety and Health Awareness Related Factors					
38	Not well educated	0.725	0.586	0.656	1.34	30
39	No safety and health briefing/toolbox meeting	0.728	0.647	0.688	1.23	21
40	Lack of safety and health signage board	0.723	0.624	0.674	1.14	29
41	Unwilling to wear personal protective equipment	0.744	0.678	0.711	1.09	17
G_{11}	Economic Investment/ Safety and health resource					
42	No budget allocated for safety	0.731	0.675	0.703	1.35	18
43	Poor safety investment on (PPE)	0.603	0.553	0.578	1.07	41
44	Lack of insuring with insurance companies	0.704	0.664	0.684	0.95	22
G_{12}	Environmental Related Factors					
45	Poor weather condition	0.717	0.651	0.684	1.07	23
46	Lack of safe construction environment	0.659	0.563	0.611	1.35	38
47	Waste materials in site	0.752	0.681	0.717	1.35	16

Table 6. The top 10 factors affecting safety and health performance in building construction projects

Group No.	Factors	RII	S.D.	Rank
G_1	Inadequate PPE at work site	0.857	1.38	1
G_5	Lack of safety and health inspection procedures onsite	0.850	1.06	2
G_1	Risk assessment is not practicable at workplace	0.848	1.35	3
G_1	Non-availability a clear company safety and health policy	0.846	0.93	4
G_6	Poor recording and reporting of daily safety and health issues	0.843	1.49	5
G_6	Poor accident record keeping and reporting system	0.816	1.46	6
G_1	Lack of management commitment to safety and health programs	0.761	1.1	7
G_6	Lack of attendance of safety and health meetings by management	0.755	1.09	8
G_2	Lack of workers compensation insurance	0.750	1.33	9
G_1	Lack of implementation of safety and health management system in accordance with legislation	0.749	1.12	10

Table 7. Stepwise multiple regression results for safety and health performance

Independent Variables	B	σ	β	t-value	p-value
Dependent variable: Safety and health performance;R^2=0.62, adjusted , R^2 = 0.61					
Constant	4.45	0.19	NA	23.63	0.00
Non availability of a clear company safety and health policy	-0.32	0.03	-0.58	-10.29	0.00
Inadequate PPE at work site	-0.33	0.03	-0.57	-10.09	0.00

The results of this study demonstrate that the most important factors influencing safety and health performance in building construction projects in Addis Ababa are the lack of explicit business safety and health policies and the

insufficient supply of personal protective equipment (PPE). Similar findings have been documented in other developing nations, where construction accidents have been linked to inadequate PPE, inadequate organizational safety policies, and inadequate safety planning [43-45]. Similar findings have also been documented in research papers, which show that resource limitations, a lack of formal safety procedures, and inefficient safety management systems continue to be major obstacles in the construction sector in developing nations [46].

Studies from nations with more robust regulatory frameworks and enforcement mechanisms, on the other hand, typically find that worker behavior, safety attitudes, and safety culture are more important determinants of safety performance [47, 48]. Therefore, Ethiopia's contextual conditions limited regulatory enforcement, inadequate safety training, financial constraints among contractors, and the relatively low institutionalization of safety culture within the construction sector are responsible for the prominence of organizational and resource-related factors in the current study. The parallels and differences between this study and relevant international research can be explained by these contextual factors.

Without availability of a clear company safety and health policy companies may inadvertently violate occupational health and safety laws. For an effective safety and health performance in building construction projects availability of a clear company safety and health policy is required [40, 49]. Inadequate PPE at work site, whether due to unavailability, discomfort, poor fit, or lack of training, significantly affects safety and health performance in construction environments [50-53].

4.5. Interviews result

As part of this study, interviews were carried out with 20 professionals involved in building construction projects to evaluate the state of safety and health performance in the industry. These 20 professionals, who were from different functions of the construction teams, gave valuable input derived from their work experiences. The prime purpose of the interviews was only to understand the existing safety and health standards and how these contribute to creating safer work environments at construction sites.

Table 8 clearly highlights serious gaps in the company's occupational safety and health management systems. The majority of respondents consistently reported a lack of key safety components, such as planning, supervision, training, management involvement, and policy implementation. Overall, the company seems to have a reactive rather than proactive approach to construction safety, which could lead to frequent workplace accidents, legal consequences, and low worker morale.

Beginning with internal validity, the study's findings are supported by the relationship between the regression model and respondents' rankings of the importance of different variables. This provides both statistical validation and support through the industry that the major drivers are significant. The two critical factors identified as insufficient PPE supply and the absence of a clear safety and health policy repeat global research that highlights the need for organizations to demonstrate commitment to safety, and to properly allocate resources for safety. While this particular study focuses on Addis Ababa, the methodology employed to collect data, and the results achieved may be transferable to other developing countries that face similar constraints and barriers to improving safety culture in their construction sectors; such as regulatory issues and safety culture issues. Therefore, the methodology used in this study, may serve as a framework for comparative studies to identify common themes and differences in approaches to improving safety culture across different geographic locations and/or industries.

4.6. Future directions and limitations

Construction firms are thus urged to put safety and health measures at the top of their agenda and not just talk about them but actually do those measures for their workers' and the environment's sake. They can start by establishing a safety and health committee to be responsible for all safety and health activities of the company.

Table 8. Interview results

No.	Interview Questions	Yes	%	No	%
1	Does your Company have construction site safety and health plan to improve accident reduction?	4	20	16	80
2	Does your company have site safety and health regular supervision at least once in a day?	3	15	17	85
3	Does your company have safety and health meeting program or attendance to improve its workers health and safety at site?	4	20	16	80
4	Does your company have safety and health training personal for all workers?	5	25	15	75
5	Does your company top management members involve in safety and health committee to manage and control risk that results accidents?	4	20	16	80
6	Does your company have organizational safety and health policy?	7	35	13	65
7	Is there manual checklist at your site to investigate and accident recording and reporting?	8	40	12	60

Safety and health activities ought to be planned, managed, and monitored through this committee. People who work on the construction site need training and continuous education, especially with the frequent changes and introduction of new safety and health measures and procedures. By means of a structured and regular field safety inspection procedure, noncompliance and potential hazards can be identified and corrected. It will also ensure that the safety and health measures being undertaken are effective. Hence, safety equipment must be provided to the workers and enforced in the usage at all times. A daily safety and health report should be the norm in every construction site. An accident reporting system must be established to ensure that safety lessons are learned and that those responsible are held accountable.

These steps should be a fundamental part of business operations, demonstrating a strong dedication to worker safety and legal compliance. Additionally, during project planning, monitoring, and execution, consultants working on building construction projects ought to give safety and health considerations additional weight. They are urged to frequently monitor site conditions to guarantee adherence to safety requirements, integrate safety and health assessments into project design and review procedures, and advise and assist contractors in putting best practices for occupational safety and health into effect.

For Future Studies: Extensive research should be done in other areas of Ethiopia beyond Addis Ababa. This will shed light on the differences in safety and health issues between urban and rural construction sites. More participants such as clients, regulatory bodies, and health and safety officers should be included in future studies to gain comprehensive insights regarding the challenges and safety implementation gaps from multiple perspectives.

Limitations of the Study: This study is subjected to the following limitations that should be acknowledged. The study focused only on building construction projects in Addis Ababa. Hence, the results may not entirely depict safety and health situations or practices in other parts of Ethiopia, especially in rural or less urbanized areas. Moreover the views of the study are mainly those of the contractors and the consultants. The study does not include the perspectives of other important stakeholders such as the government regulators and the clients whose contributions could give a more comprehensive understanding of safety and health performance.

5. Conclusions

This study delivers a comprehensive review of the factors that affecting safety and health performance in building construction projects in Addis Ababa.

This study included three phases: (1) identification of factors affecting safety and health performance, (2) determining critical factors affecting safety and health performance, and (3) assessing current status of safety and health performance in building construction projects. Accordingly, 47 factors having a strong effect on safety and health performance of the projects were identified through an extensive literature review and interview with professionals. The identified factors were grouped into twelve categories. Using RII, a critical assessment was conducted to rank and identify the top 10 factors based on their anticipated influence on safety and health performance. Furthermore, stepwise multiple regression analysis was used to assess how significantly each of the top 10 factors influences safety and health performance. Accordingly, the factors, non-availability of clear company safety and health policy and inadequate personal protective equipment (PPE) at worksites are found to be the most critical factors influencing safety and health performance of building construction projects in Addis Ababa. The result of interview also revealed that workers are being subjected to poor work conditions, conditions which continually endanger their life.

Finally, the study makes valuable contributions to the world of construction safety management, both in theory and practice. From a theoretical perspective, this study adds new empirical evidence from a region where there has been little input into the international dialogue concerning safety and health performance. From a practical standpoint, the study identifies two key factors related to company provision of personal protective equipment (PPE) and development of a clear safety and health policy as having a significant impact on safety outcomes for workers at construction site work locations. These findings should provide value to contractors, consultants, and policymakers who are seeking to improve safety performance, to develop effective training programs for improving worker safety, and to establish regulations and policies that promote improved safety culture and performance in the construction industry. Future studies may seek to build upon the findings of this study, by examining additional geographic regions, or sectors, to further validate and refine the relationships identified in this study.

Declaration

Funding

This research received no external funding.

Author Contributions

E. G. Sinesilassie: Resource, Data curation, Methodology, Supervision, Validation, Writing- Reviewing and Editing.

M. A. Deressa: Conceptualization, Data curation, Writing-Original draft preparation, Visualization, Investigation.

Acknowledgments

We would like to thank Ministry of labor and social affairs, Ethiopia, for its remarkable contributions to this stud.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Ethics Committee Permission

The authors acquired ethics committee permission for surveys implemented in this paper from Arba Minch University Faculty of Civil Engineering Research Ethics Committee (Date. 15.03.2023; No. 1570).

Conflict of Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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