***ISSN** (E): 2959-3921*
(P): 2959-393X
***DOI:** https://doi.org/10.59122/194EFE11*
Ethiopian International Journal of Engineering and Technology (EIJET)
Volume 4, Issue 1, 2026

Key Determinants of Health and Safety Management in Building Construction Projects in SWEPR, Ethiopia

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Abstract

Construction workers are often victims of accidents, causing physical suffering and financial losses due to the multifaceted nature of construction tasks. Moreover, due to inadequate site management that results in poor health and safety management practices, a higher incidence of accidents and injuries occurs among workers. This research identified key factors influencing HSM in building construction projects in the area and how they influence project outcomes. A mixed-methods approach incorporating both quantitative and qualitative techniques was utilized. The systematic random sampling technique was used to select samples from a building construction site, employing a 95% confidence level and a 5% margin of error. Descriptive statistics was used to summarize the survey responses, and rankings were assigned based on the relative importance index (RII). The findings reveal that the top factors affecting HSM are implementation of safety protocols and procedures (RIR=0.910), compliance with safety regulations and standards (0.851), worker training and awareness programs (0.789), adequacy of safety training provided to workers (0.787), and implementation of risk assessment and management procedures (0.754). Lack of regular safety inspections and absence of designated safety personnel exacerbate the safety concerns. The most prevalent impact is increased accidents and injuries. The findings put forward that ensuring compliance with safety regulations, providing adequate safety training, implementing effective safety protocols, and addressing cultural and language barriers are perceived as key priorities for achieving positive project outcomes, particularly in terms of worker safety, project timelines, and overall quality. In general, the findings provide actionable insights for contractors and policymakers to enhance safety standards in the region.

Keywords: Building construction project, health and safety management, factors affecting health and safety, occupational safety, construction risk management, mixed-method study

***Received**: August 27, 2025; **Revised**: November 9, 2025; **Accepted:** November 25, 2025; **Published:** December 6, 2025*
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I. INTRODUCTION

The construction industry is renowned for its hazardous working conditions with high frequency of accidents, illnesses, and fatalities [1, 2]. The sector's unique environment makes it one of the most dangerous in terms of workplace safety [3]. Moreover, the impact of inclement weather on construction sites presents additional challenges, exposing workers to adverse conditions that can harm their physical and mental well-being [4]. Construction workers often have to contend with extreme temperatures and strong winds, which can compromise safety and reduce productivity. Unfortunately, this also makes them more susceptible to accidents, leading to physical suffering and financial losses due to the multifaceted nature of construction tasks [5].

This issue is not limited to Ethiopia; other regions, such as Palestine, also face significant safety challenges [6]. The construction sector's fatality rate in Europe is 3.4 times the median rate, further highlighting its life-threatening nature [7]. The pressing need to ensure workplace safety for construction personnel is a global concern, as an alarming 85% lack access to Health and Safety (HS) services [8]. These issues have led to a growing concern for construction workers' Occupational Health and Safety (OHS) [9].

Effective safety management is a major concern in the construction industry, particularly for large-scale projects [10]. To address the aforementioned issues and eliminate potential hazards, continuous monitoring of construction sites is crucial [9]. In recent times, safety management theories have evolved, shifting the focus from individual influences to the organization as a whole [11]. Placing emphasis on OHS training can significantly reduce construction hazards [12], and implementing lean construction practices can decrease the number of accidents [13]. Adopting a sociotechnical perspective can enhance safety by valuing workers and recognizing their contributions [14]. It is essential for legal control measures. They need to be balanced with collaborative efforts to foster trust and cooperation [15].

Research findings support the development of mitigation plans to reduce fatalities and injuries in the construction sector [16]. Regrettably, construction organizations often employ low-level Health and Safety Management (HSM) practices, resulting in frequent work absences and early retirements due to accidents and uncomfortable working conditions [17]. As per Aasonaa's study

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in 2023, there is a lack of safety and health management at all stages of construction, stemming from poor attitudes towards safety, inadequate regulations, and a lack of attention from primary contractors [18].

According to Feleke et al. [19] building construction's HS issues are a key worldwide concern and have an impact on labor force longevity, project timeliness, project cost, and project quality. However, the level of Occupational Safety and Health (OSH) execution is notably low in Ethiopia [19], even if the compulsory legal and policy frameworks have been adopted [20]. Providing occupational HS services is still insufficient to meet the increasing demands placed on worker health [21].

In Ethiopia, there is a dearth of research on safety considerations during construction [19]. Understanding the deficiencies and requirements for occupational health services in Ethiopian workplaces is limited due to insufficient information. Detailed evaluations of occupational exposures are challenging due to the scarcity of information. Unfortunately, there is limited knowledge about the deficiencies and requirements for occupational health care in Ethiopian workplaces [21]. Furthermore, numerous occupational injuries frequently occur, leading to a prolonged loss of productive working days.

According to a study conducted by Tadesse and Israel [22] in Addis Ababa, Ethiopia, 38.3% of building construction employees experienced an injury. Despite the building industry's critical role in the growth and development of urban regions in Ethiopia, several challenges hinder progress. These challenges include insufficient regulatory enforcement, corruption, inadequate training and awareness, limited investment in safety equipment, and the lack of management commitment [2]. Another study identified key problems in Addis Ababa using the relative importance index, which included the non-availability of a clear company HS policy, inadequate enforcement of existing building rules and regulations, and insufficient safety awareness among top management [19].

As Sefara [20] noted, low enforcement can be attributed to a lack of awareness of Occupational Safety and Health (OSH) among employers and workers, inadequate inspection services, insufficient safety equipment, and inadequate enforcement of minimum standards by relevant

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governmental authorities. Belachew's [23] study highlights the need for top management commitment and support for HSM in the construction sector.

Ethiopia's construction industry has experienced considerable growth due to factors such as urbanization, economic expansion, and an increase in infrastructure projects [2]. However, this progress has also led to a rise in HS issues in construction sites.

South West Ethiopia People Region (SWEPR) is a newly formed region. There is limited empirical evidence on the determinants of Health and Safety Management (HSM) in the SWEPR construction sector. Conducting such research in this region can help significantly to understand and improve HSM in building construction projects.

The research efforts made were focused on answering is question was what are the key factors influencing Health and Safety Management (HSM) in building construction projects in South West Ethiopia People Region (SWEPR), Ethiopia, and how do they impact project outcomes? To answer the main research question, the following objectives were set to align the intermediate activities.

1. Identify the key factors affecting HSM in building construction projects in SWEPR, Ethiopia.
2. Assess the current practices and policies related to HSM within the building construction projects in SWEPR, Ethiopia.
3. Investigate the relationship between identified factors and their impact on project outcomes such as worker safety, project timelines, and overall quality.
4. Propose recommendations and strategies for improving HSM practices in building construction projects in SWEPR, Ethiopia, to enhance overall project performance and reduce risks to workers.

II. MATERIAL AND METHODS

2.1. Study Period and Area

The research was conducted from 15 January 2024 to 21 December 2024 in the Southwest Ethiopia Peoples Region (SWEPR). As presented in Fig. 1, the Southwest Ethiopia Peoples Regional State Government Communication Affairs Bureau, the Southwest Ethiopia Peoples Region is the eleventh region of the country, which was established on November 21, 2021. The region

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encompasses 6 zonal administrations, 41 district (Woreda) administrations, 16 town administrations, and 900 Kebele administrations. The estimated land area of the region is 39,061.4 square kilometers or 3.91 million hectares. The topography of the region lies between 348 and 3346 meters above sea level. The region incorporates West Omo, Bench Sheko, Kefa, Dawuro, Sheka, and Konta zones. The region has four capital cities which are Bonga, Tercha, Mizan Aman, and Tepi.

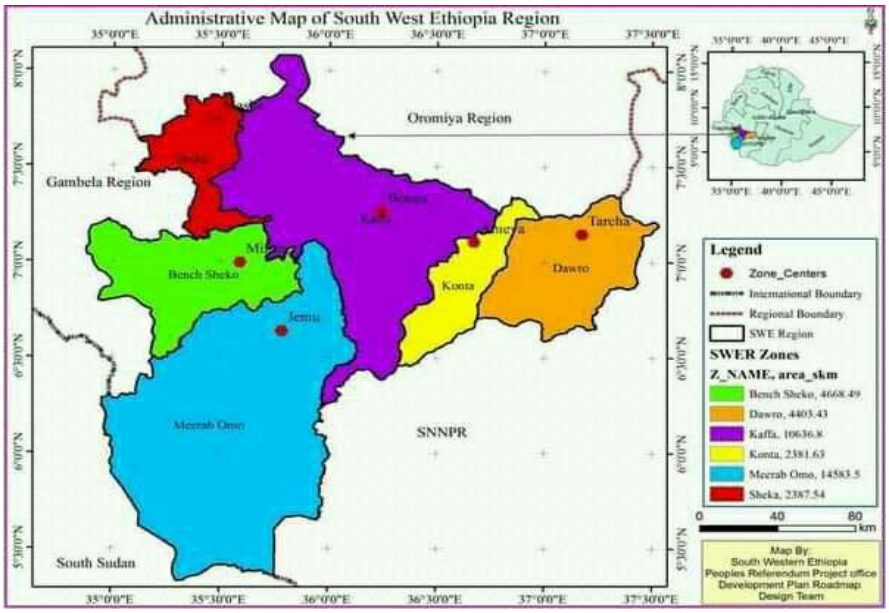

Fig. 1: Southwest Ethiopia people's region map (Source: Southwest Ethiopia Peoples Regional State Government Communication Affairs Bureau)

2.2. Research Design

To accomplish the objectives of this research, a mixed-methods approach which incorporated both quantitative and qualitative techniques [2] to evaluate the factors affecting HSM was utilized. To achieve the objectives of this research through a literature review, 85 determinants influencing HSM were selected and assessed in the context of building construction.

2.3. Study Population, Sampling Technique, and Sample Size Determination

The population of the study were 1200 building construction projects. They vary from single-story to multiple-story under construction. Systematic random sampling was utilized to select samples that represented the population, employing a 95% confidence level and a 5% margin of error using Yamane's formula [24].

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$$n=\frac{N}{1+N(e)^2} \quad (1)$$

Where,

N= population size

n = Sample size.

e = Level of precision.

The no of population is 1200 with a 95% confidence level and 5% Precision

$$n=\frac{1200}{1+1200(0.05)^2}=300 \quad (2)$$

For 1200 populations, and 5% precision, the sample size becomes 300 samples

2.4. Data Collection Methods, Research Process, and Data Analysis

2.4.1. Data collection methods: The data collection method utilized a pre-tested, structured questionnaire.

2.4.2. Research Process: The research commenced by evaluating factors influencing HSM based on prior experience and research findings. Subsequently, a comprehensive literature review was conducted to align with the research objectives. To undertake an in-depth examination of the current HSM practices in construction projects in SWEPR, a rating scale questionnaire was formulated by screening and comprehending the relevant literature in the field of HS practice in building construction and targeting individuals such as contractors, clients, and consultants [19]. 546 questionnaires were distributed at 300 construction sites to clients, contractors, and consultants. Moreover, an open-ended section was included to accommodate additional participant variables. The participants were asked to rate the factors based on their determinant influence on HSM by using the Likert scale to assess the current practices and policies related to HSM, to investigate the relationship between identified factors and their impact on project outcomes, and to propose recommendations and strategies for improving HSM practices in building construction projects in SWEPR, Ethiopia.

2.4.3. Pilot Study: To assess the reliability and validity of the questions and ensure their suitability for data analysis, the questionnaires were distributed to building construction project experts actively working in the field. The returned questionnaires were revised based on the feedback received, and the modified questionnaires were then administered to the research participants.

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2.4.4. Data Analysis: The collected data from the survey were analyzed using appropriate statistical methods. The raw data were first validated, sorted, and prepared for analysis. The data were then interpreted and discussed, and conclusions were drawn. Descriptive statistics were employed to summarize the survey responses, and rankings were assigned based on the relative importance index (RII). The qualitative data were coded, categorized, and themes were identified to provide insights into the underlying factors affecting HSM in construction projects in SWEPR, Ethiopia.

2.5. Inferential Statistics

Spearman's rank correlation coefficient was used to measure the association between two groups of respondents' rankings for various variables. The correlation coefficient was classified into different categories: 0.00-0.19 (zero correlation or very low correlation), 0.20-0.39 (low correlation), 0.40-0.59 (medium correlation), 0.60-0.79 (high correlation), and 0.80-1.00 (very high or strong correlation) **Error! Reference source not found.**The Spearman's rank correlation coefficient was calculated using the following formula:

$$rs = 1 - \frac{(6*\sum {d_i}^2)}{N*(N^2-1))} \quad (3)$$

Where:

r_s = Spearman's rank correlation coefficient

d_i = Difference between the ranks given by any two groups of respondents for an individual cause

N = Number of causes (variables)

A maximum correlation coefficient of +1 indicates a perfect linear correlation, while a minimum value of -1 indicates a negative correlation. A value of 0 indicates no correlation.

III. RESULTS ANALYSIS AND DISCUSSION

3.1. Participant's information

By using systematic random sampling techniques, 300 construction sites were selected from 1200 building construction projects. A total of 546 questionnaires were sent out to gather data from construction project stakeholders. From 546 questionnaires, 399 valid questionnaires were returned and analyzed. The percentage of returned questionnaires was 73%.

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Table I: Participant's information

Demographic Information		
1. Gender:	**count**	**Percent**
Male	305	76%
Female	94	24%
Total	399	100%
2. Age:		
Under 25	106	27%
25-35	95	24%
36-45	145	36%
46-55	35	9%
Over 55	18	5%
3. Years of experience in the construction of building construction projects	Count	Percent
Less than 1 year	19	5%
1-5 years	59	15%
6-10 years	127	32%
11-15 years	172	43%
More than 15 years	22	6%
4. Position/Role in the construction project	count	Percent
Project Managers	92	23%
Site Supervisors	55	14%
Construction Worker	80	20%
Site Engineers	70	18%
Regulatory bodies	20	5%
Health and Safety Officer	45	11%
Other	37	9%

As presented in Table I, this section of the research provides valuable insights into the demographic composition of individuals involved in the survey, specifically focusing on gender, age, years of experience, and position/role within construction projects.

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Gender Distribution: The majority of respondents were male, constituting 76% of the sample, while females accounted for 24%. This indicates a significant gender imbalance within the building construction projects, with males being disproportionately represented.

Age Distribution: The age distribution shows a diverse range of respondents, with the largest proportion falling within the age group of 36-45, comprising 36% of the sample. This suggests that individuals in their mid to late thirties and early forties are actively involved in building construction projects. Notably, there is a relatively low representation of individuals over the age of 55, comprising only 5% of the sample. This may indicate challenges in retaining older workers within the industry or a lower participation rate of older individuals.

Years of Experience: The distribution of years of experience in the building construction projects reveals a broad spectrum of expertise. The majority of respondents (75%) have more than 5 years of experience, with 43% having 11-15 years of experience. This suggests a considerable level of experience and expertise among the respondents, which could positively impact the quality and efficiency of construction projects.

Position/Role Distribution: The distribution of roles within construction projects reflects the diverse functions and responsibilities within the industry. Project managers constitute the largest proportion at 23%, followed by construction workers (20%), site engineers (18%), and site supervisors (14%). These roles are crucial for the successful execution and management of construction projects. Additionally, roles such as regulatory bodies (5%) and HS officers (11%) demonstrate the importance placed on compliance and safety within the building construction projects. The presence of individuals in 'other' roles (9%) underscores the multifaceted nature of construction projects, which may involve various specialized functions not captured by the listed categories.

Overall, this analysis highlights the demographic diversity and professional expertise within the building construction projects. Understanding these demographics is essential for developing targeted strategies to address challenges, promote diversity and inclusion, and optimize project management practices within the sector.

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3.2. Factors affecting Health and Safety Management practice in construction projects

The survey involved 399 participants and aimed to identify and rank various HS factors that affect management practices.

3.2.1. Low Awareness of Safety Regulations

The research results provide valuable insights into the awareness and understanding of HS regulations among workers in the building construction projects in SWEPR, Ethiopia, as well as the most common hazards encountered in building construction projects in the country.

Table II: Awareness and understanding of Health and Safety regulations and common hazards

Awareness and most common hazard		
2.1. How would you rate the awareness and understanding of HS regulations among workers in the building construction projects in SWEPR, Ethiopia?	Number of respondents (N=399)	Percentage
Poor	297	74.44%
Fair	78	19.55%
Good	22	5.51%
Excellent	2	0.50%
2.2. What are the most common hazards encountered in building construction projects in SWEPR, Ethiopia? (Select all that apply)?		
Falls from height	171	42.86%
Electrical hazards	42	10.53%
Hazardous materials exposure	33	8.27%
Scaffolding collapses	61	15.29%
Earth excavation collapses	80	20.05%
Others	12	3.01%

Awareness and Understanding of HS Regulations: *Over 70% of workers demonstrated limited awareness* and understanding *of* HS regulations. Only a small proportion rated it as "Fair" (19.55%), "Good" (5.51%), or "Excellent" (0.50%). The high percentage of respondents rating their awareness as "Poor" indicates a significant gap in knowledge and understanding of HS regulations among workers in the building construction projects in SWEPR, Ethiopia. The low percentages of respondents rating their awareness as "Good" or "Excellent" suggest that there is a

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need for improved training and education initiatives to enhance awareness and understanding of HS regulations among construction workers.

Most Common Hazards Encountered in Building Construction Projects: Falls from height (42.86%) were identified as the most common hazard. Other common hazards included earth excavation collapses (20.05%), scaffolding collapses (15.29%), electrical hazards (10.53%), and hazardous materials exposure (8.27%). The high percentage of respondents identifying falls from height as a common hazard highlights the importance of implementing measures to prevent falls, such as proper scaffolding, guardrails, and fall arrest systems. The significant percentages of earth excavation and scaffolding collapses indicate the need for improved structural stability and safety protocols in construction projects. The presence of electrical hazards and hazardous materials exposure underscores the importance of proper training, personal protective equipment (PPE), and adherence to safety regulations in handling such risks.

Overall Implications: The findings suggest a pressing need for comprehensive interventions to improve awareness and understanding of HS regulations among construction workers in SWEPR, Ethiopia. Addressing the identified common hazards requires a multi-faceted approach, including enhanced training, stricter enforcement of safety regulations, provision of appropriate safety equipment, and regular inspections to ensure compliance with safety standards. In conclusion, the research results underscore the urgency of prioritizing HS initiatives in the building construction projects in SWEPR of Ethiopia to mitigate risks, enhance worker safety, and prevent accidents and injuries.

3.2.2. Key determinants influencing Health and Safety Management in building construction

The Relative Importance Index (RII) value was used to rank various factors influencing safety and health management and presented in Table III. The result is presented below.

Table III: Key Factors Affecting Health and Safety Management

Code	Factors	w	RII	Rank
12	Implementation of safety protocols and procedures	1724	0.910	1
3	Compliance with Safety Regulations and Standards	1697	0.851	2
4	Worker Training and Awareness Programs	1575	0.789	3

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10	Adequacy of safety training provided to workers	1570	0.787	4
2	Implementation of risk assessment and management procedures	1504	0.754	5
9	Worker Involvement in Safety Decision-Making	1440	0.722	6
11	Availability of Personal Protective Equipment (PPE)	1420	0.712	7
8	Incentives for Safe Practices	1415	0.709	8
6	Communication of Safety Procedures and Policies	1400	0.702	9
15	Cultural and language considerations in safety communication	1400	0.702	9
7	Risk Assessment and Hazard Identification Processes	1371	0.687	11
5	Site Supervision and Monitoring	1361	0.682	12
13	Communication of safety information and instructions	1360	0.682	13
1	Management of hazardous materials and waste disposal	1251	0.627	14
14	Supervision and monitoring of safety practices	1188	0.595	15

Based on the result presented in Table III, the top five factors are the following: -

1) Implementation of safety protocols and procedures**:** This factor ranks highest, indicating its importance in ensuring safety within the environment under study. It suggests that having robust safety protocols and procedures in place is essential for mitigating risks and preventing accidents.

2) Compliance with safety regulations and standards**:** Compliance with established safety regulations and standards is the second most influential factor. This finding emphasizes the importance of adhering to legal requirements and industry standards to maintain a safe working environment.

3) Worker training and awareness programs**:** The presence of comprehensive worker training and awareness programs ranks third, highlighting the significance of educating employees about safety procedures and hazards to minimize accidents.

4) Adequacy of safety training provided to workers**:** This factor closely follows the previous one, indicating that the quality and adequacy of safety training provided to workers significantly impact safety outcomes.

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5) Implementation of risk assessment and management procedures**:** Effective risk assessment and management procedures are crucial for identifying and mitigating potential hazards, placing this factor in fifth position.

Overall, these findings highlight the multifaceted nature of safety management, emphasizing the importance of comprehensive strategies that encompass protocols, compliance, training, risk assessment, employee involvement, communication, and cultural awareness. Addressing these factors holistically can lead to a safer and healthier work environment.

3.2.3. Current Practices and Policies

To assess the current practices and policies related to HSM within the building construction projects in SWEPR, Ethiopia. The respondents were asked to rate the following statements based on their perception of the current practices and policies related to HSM within the building construction project in SWEPR, Ethiopia. The results are shown below.

Table IV: Current Practices and Policies

Current Practices and Policies	Frequency distribution of respondents (N=399)				
	1	2	3	4	5
The current safety regulations and policies are adequate to ensure worker safety	18	14	78	289	
Safety training programs for construction workers are comprehensive and well-implemented	315	46	27	9	2
There is effective enforcement of safety regulations on construction sites	297	59	35	5	3
Technology adoption for safety monitoring and enforcement	301	92	3	3	
Safety regulations and standards are effectively enforced on construction sites.	325	43	31		
Risk assessment and hazard identification processes are regularly conducted.	299	88	10	2	

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The building construction projects in SWEPR Ethiopia prioritize worker safety.	309	22	54	9	5
Stakeholder engagement and consultation	251	100	25	15	8
There are adequate training programs for workers on HS practices	315	55	15	9	5
There is clear communication of safety procedures and policies to all workers.	303	74	15	2	5

Based on the results shown on Table IV the current safety regulations and policies are adequate to ensure worker safety**:** This statement was agreed to by the majority of respondents (289) supporting that the current safety regulations and policies are adequate. However, a significant portion of respondents (32) disagreed or strongly disagreed, suggesting that there may be some gaps or inadequacies perceived in the existing regulations and policies. The statement: - **'**safety training programs for construction workers are comprehensive and well-implemented**'**, received a notably low rating, with a vast majority of respondents (315) disagreeing or strongly disagreeing that safety training programs are not comprehensive and not well-implemented. This indicates a critical area for improvement in ensuring the safety and well-being of construction workers in SWEPR, Ethiopia.

The statement 'there is effective enforcement of safety regulations on construction sites**'** similarly recorded considerable dissatisfaction among respondents regarding the enforcement of safety regulations on construction sites, with the majority (297) out of 399 strongly disagreeing with the effectiveness of enforcement. This highlights a significant concern regarding the actual implementation and enforcement of safety regulations in building construction projects. The statement 'technology adoption for safety monitoring and enforcement**'** received a clear response, with a large number of respondents (301) strongly disagreeing with the adoption of technology for safety monitoring and enforcement and limitations in technology adoption within the industry. The majority of respondents (325) strongly disagree to the statement that safety regulations and standards are effectively enforced, indicating some discrepancy in perceptions regarding the enforcement of safety regulations on construction sites.

The statement 'risk assessment and hazard identification processes are regularly conducted**'** received a response, with a significant number of respondents (299) strongly disagreeing that risk

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assessment and hazard identification processes are not regularly conducted. The majority of respondents (309) strongly disagree that the building construction projects do not prioritizes worker safety. Similar to previous statements about training programs, there is a significant dissatisfaction among respondents regarding the adequacy of training programs for workers on HS practices, with the vast majority (370) disagreeing or strongly disagreeing. This underscores the critical need for improvement in this area. The statement 'there is clear communication of safety procedures and policies to all workers' received a strong disagreement from the majority of respondents (303) who believe that safety procedures and policies are not clearly communicated to all workers. This suggests potential communication gaps that need to be addressed to ensure the effective implementation of safety measures.

In summary, the analysis of these results highlights several areas of concern within the building construction projects in SWEPR Ethiopia regarding HSM practices and policies. These include inadequacies in safety training programs, enforcement of safety regulations, technology adoption, stakeholder engagement, and communication of safety procedures. Addressing these concerns will be crucial in improving worker safety and well-being within the building construction projects in SWEPR, Ethiopia.

3.3. Safety Inspections Frequency and Designated Safety Personnel

The research results offer insights into safety inspections and personnel responsible for overseeing HS on construction sites in SWEPR, Ethiopia. The responses to the question 'how often are safety inspections conducted on construction sites in SWEPR, Ethiopia?' are presented below.

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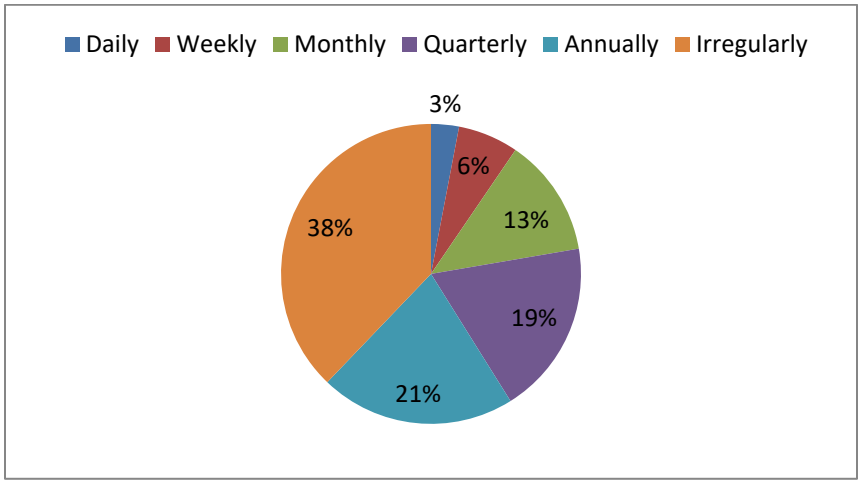

Fig. 2: Frequency of inspection

As presented in Fig. 2, the findings show that the majority of safety inspections are conducted either annually (21.05%) or irregularly (37.84%). This indicates a significant portion of construction sites may not have regular safety checks, posing potential risks to workers. Monthly and quarterly inspections, which are considered more frequent, constitute a lower percentage compared to annual or irregular inspections.

The research participants were asked if there are designated safety officers, and their responses are presented below.

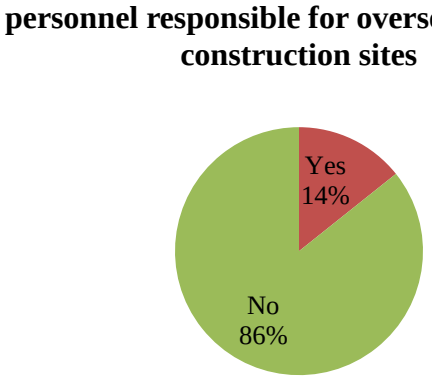

Fig. 3: Assigned safety officer

Designated Safety Personnel: As shown in Fig. 3, a significant majority (86%) of construction sites lack designated safety officers or personnel responsible for overseeing Health and Safety.

Received*: August 27, 2025;* ***Revised****: November 9, 2025;* ***Accepted:*** *November 25, 2025;* ***Published:*** *December 6, 2025*
Corresponding author- ***Kibremoges Tesfaye***

ISSN (E): 2959-3921
(P): 2959-393X
DOI: *https://doi.org/10.59122/194EFE11*
Ethiopian International Journal of Engineering and Technology (EIJET)
Volume 4, Issue 1, 2026

This absence of dedicated personnel could lead to inadequate safety measures and increased risks for workers. Overall, we can conclude the following:

- The findings suggest a concerning lack of regular safety inspections on construction sites in SWEPR, Ethiopia, with inspections often occurring either annually or irregularly.
- The absence of designated safety personnel further exacerbates the safety concerns, as there may not be individuals specifically tasked with monitoring and ensuring safety standards are met.
- These findings highlight a potential gap in safety regulations or enforcement in the building construction projects in SWEPR, Ethiopia, indicating a need for stronger safety protocols and oversight mechanisms to protect workers' well-being.

3.4. Relationship between Factors and Project Outcomes

This section of the research presents findings on the relationship between various factors and their impact on project outcomes such as worker safety, project timelines, and overall quality. The respondents rated these factors based on their perception of their influence using a scale from 1 to 5, ranging from "No Impact" to "Very High Impact." The Relative Importance Index (RII) was calculated to determine the relative importance of each factor. The findings are presented as follows:

Table V: Relationship Between Factors and Project Outcomes

Code	**Factors and Project Outcomes**	W	RII	RANK
4	Compliance with Safety Regulations and Standards	1243	0.623	1
1	The adequacy of safety training provided to workers impacts worker safety	1228	0.616	2
7	Worker Training and Awareness Programs	1221	0.612	3
14	Supervision and monitoring of safety practices	1214	0.609	4
3	Implementation of safety protocols and procedures impacts overall project quality	1213	0.608	5
15	Cultural and language considerations in safety communication	1210	0.607	6
5	Implementation of risk assessment and management procedures	1205	0.604	7
13	Communication of safety information and instructions	1200	0.602	8

Received*: August 27, 2025;* ***Revised****: November 9, 2025;* ***Accepted:*** *November 25, 2025;* ***Published:*** *December 6, 2025*
Corresponding author- ***Kibremoges Tesfaye***

ISSN *(E): 2959-3921*
(P): 2959-393X
DOI: *https://doi.org/10.59122/194EFE11*

Ethiopian International Journal of Engineering and Technology (EIJET)
Volume 4, Issue 1, 2026

10	Risk Assessment and Hazard Identification Processes	1194	0.598	9
2	Availability of Personal Protective Equipment (PPE) impacts project timelines	1192	0.597	10
8	Site Supervision and Monitoring	1190	0.596	11
9	Communication of Safety Procedures and Policies	1159	0.581	12
11	Incentives for Safe Practices	1152	0.577	13
6	Management of hazardous materials and waste disposal	1150	0.576	14
12	Worker Involvement in Safety Decision-Making	1137	0.570	15

The research results presented in Table V provide valuable insights into the relationship between various factors and their impact on project outcomes such as worker safety, project timelines, and overall quality. The Relative Importance Index (RII) is used to quantify the perceived impact of each factor, with higher RII values indicating a stronger perceived impact.

1. Compliance with Safety Regulations and Standards received the highest RII score (0.623) and was ranked first. This indicates that respondents perceived compliance with safety regulations and standards as having the most significant impact on project outcomes, particularly worker safety, project timelines, and overall quality.
2. Adequacy of safety training provided to workers impacts worker safety was ranked second, with a slightly lower RII score of 0.616. This suggests that the adequacy of safety training is considered highly influential but slightly less so than compliance with safety regulations.
3. Worker Training and Awareness Programs and Supervision and monitoring of safety practices followed closely behind, indicating that these factors are also perceived as crucial for ensuring worker safety and overall project success.
4. The statement ‘Implementation of safety protocols and procedures impacts overall project quality’ was ranked fifth, suggesting that while important, its impact may be slightly less immediate compared to factors directly related to worker safety.
5. Cultural and language considerations in safety communication and Implementation of risk assessment and management procedures were also ranked relatively high, indicating that addressing cultural and language barriers and implementing effective risk assessment and management procedures are perceived as important for project success.

***Received**: August 27, 2025; **Revised**: November 9, 2025; **Accepted:** November 25, 2025; **Published:** December 6, 2025*
*Corresponding author- **Kibremoges Tesfaye***

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(P): 2959-393X
***DOI:** https://doi.org/10.59122/194EFE11*
Ethiopian International Journal of Engineering and Technology (EIJET)
Volume 4, Issue 1, 2026

6. 'Communication of safety information and instructions', 'Risk Assessment and Hazard Identification Processes', and 'Availability of Personal Protective Equipment (PPE) impacts project timeliness' were also ranked within the top 10, highlighting their significance in ensuring both worker safety and project efficiency.
7. Factors such as Site Supervision and Monitoring, Communication of Safety Procedures and Policies, and Incentives for Safe Practices were ranked lower, suggesting that while still important, they are perceived to have a slightly lesser impact compared to other factors.
8. Management of hazardous materials and waste disposal, and Worker Involvement in Safety Decision-Making received the lowest RII scores. It was ranked last, indicating that they may be perceived as having a comparatively smaller impact on project outcomes.

Overall, the findings suggest that ensuring compliance with safety regulations, providing adequate safety training, implementing effective safety protocols, and addressing cultural and language barriers are perceived as key priorities for achieving positive project outcomes, particularly in terms of worker safety, project timelines, and overall quality. These results can provide valuable insights for project managers and stakeholders in prioritizing resources and interventions to enhance project success.

3.5. Impacts of Poor Health and Safety Management Practices

This research result indicates that poor HSM practices have significant impacts on various aspects of project outcomes.

Table VI: Poor Health and Safety management practices impact

Poor HSM practices impact ***4.1. In your experience, how do poor HSM practices impact project outcomes such as worker safety, project timelines, and overall quality?***	count	percent
Increased accidents and injuries	235	58.90%
Delays in project completion	35	8.77%
Compromised quality of work	22	5.51%
increased project cost	107	26.82%

***Received**: August 27, 2025; **Revised**: November 9, 2025; **Accepted:** November 25, 2025; **Published:** December 6, 2025*
*Corresponding author- **Kibremoges Tesfaye***

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(P): 2959-393X
DOI: *https://doi.org/10.59122/194EFE11*
Ethiopian International Journal of Engineering and Technology (EIJET)
Volume 4, Issue 1, 2026

The findings are presented below in Table VI.

1) **Increased accidents and injuries (58.90%):** This is the most prevalent impact reported by the respondents. Poor HSM practices lead to a higher incidence of accidents and injuries among workers. This not only affects the well-being of the workers but also has implications for productivity and morale.
2) **Delays in project completion (8.77%):** While not as commonly reported as increased accidents and injuries, delays in project completion are still a notable consequence of poor HSM practices. This suggests that issues related to HS can disrupt the workflow and schedule of projects, potentially leading to increased costs and client dissatisfaction.
3) **Compromised quality of work (5.51%):** Poor HSM practices also have an impact on the quality of work produced. When workers are not adequately protected or trained in safety procedures, they may be more prone to errors or inefficiencies, resulting in substandard work quality.
4) **Increased project cost (26.82%):** A significant portion of respondents identified increased project costs as a consequence of poor HSM practices. This can be attributed to various factors, including expenses related to treating injuries, implementing corrective measures, or addressing delays caused by safety-related issues.

These findings highlight the importance of effective HSM practices in construction projects. Addressing and mitigating these issues not only improves worker safety and well-being but also contributes to smoother project execution, higher-quality outcomes, and reduced financial burden. Organizations should prioritize investing in robust HS protocols to minimize these negative impacts and promote a culture of safety within the workplace.

3.6. Recommendations and Strategies

The research participants were questioned based on their experience and what measures they suggested for improving HSM practices in building construction projects in SWEPR, Ethiopia. The result presented the recommendations and strategies for enhancing HSM practices in building construction projects in SWEPR, Ethiopia. The data presented in Table VII outlines the opinions of the research participants regarding the feasibility and potential effectiveness of various strategies.

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ISSN (E): 2959-3921
(P): 2959-393X
DOI: *https://doi.org/10.59122/194EFE11*

Table VII: Recommendations and Strategies

	Recommendations and Strategies	W	RII	RANK
3	Strengthening regulatory enforcement of safety regulations on construction sites	1305	0.654	1
4	Improve access to high-quality Personal Protective Equipment (PPE)	1222	0.613	2
1	Implementing advanced safety technologies	1211	0.607	3
2	Increase investment in safety training programs for construction workers	1191	0.597	4
6	Effective HSM practices contribute to meeting project timelines.	1182	0.592	5
7	Ensuring HS standards enhances the overall quality of construction projects.	1181	0.592	6
5	Adherence to HS protocols improves worker safety.	1173	0.588	7

The research results, as presented in Table VII, indicate the opinions of respondents regarding various strategies for improving HSM practices in building construction projects in SWEPR, Ethiopia.

1. **Strengthening regulatory enforcement of safety regulations on construction sites (Rank: 1)**: This recommendation received the highest ranking in terms of feasibility and potential effectiveness. It underscores the importance of enforcing existing safety regulations rigorously. Strengthening regulatory enforcement can significantly enhance compliance with safety standards, ultimately reducing risks to workers and improving overall project performance.
2. **Improve access to high-quality Personal Protective Equipment (PPE) (Rank: 2)**: The high ranking of this recommendation indicates a recognition of the critical role of PPE in ensuring worker safety. By providing high-quality PPE and ensuring its accessibility, construction companies can mitigate various hazards present on construction sites, thereby reducing the incidence of workplace accidents and injuries.
3. **Implementing advanced safety technologies (Rank: 3)**: While this recommendation ranks slightly lower than others, it still signifies recognition of the potential benefits of adopting advanced safety technologies in construction projects. Integrating technologies such as IoT sensors, drones, and wearable devices can enhance real-time monitoring of safety conditions, identify potential hazards, and prompt timely interventions to prevent accidents.

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DOI: *https://doi.org/10.59122/194EFE11*

4. **Increase investment in safety training programs for construction workers (Rank: 4)**: Investing in safety training programs is crucial for equipping construction workers with the necessary knowledge and skills to identify hazards, follow safety protocols, and respond effectively to emergencies. While ranking fourth, it remains an important aspect of enhancing HS practices on construction sites.
5. **Effective HSM practices contribute to meeting project timelines (Rank: 5)**: This statement highlights the interconnectedness between HSM and project timelines. By prioritizing HS, construction projects are less likely to experience delays due to accidents or incidents, ultimately contributing to improved project efficiency and completion within stipulated timelines.
6. **Ensuring HS standards enhance the overall quality of construction projects (Rank: 6)**: The ranking of this recommendation suggests an acknowledgment of the correlation between adherence to HS standards and the overall quality of construction projects. By prioritizing safety standards, construction companies can enhance the structural integrity and longevity of buildings, resulting in higher-quality outcomes.
7. **Adherence to HS protocols improves worker safety (Rank: 7)**: While ranking last among the recommendations, the importance of adhering to HS protocols cannot be understated. Consistent adherence to established protocols is essential for minimizing risks and ensuring the well-being of construction workers throughout the project lifecycle.

In conclusion, the research findings emphasize the significance of regulatory enforcement, access to quality Personal Protective Equipment (PPE), adoption of advanced technologies, investment in training programs, and the integration of HS considerations into project management practices for improving HSM in building construction projects in SWEPR, Ethiopia. These recommendations, if implemented effectively, have the potential to enhance overall project performance and reduce risks to workers significantly.

3.7. Inferential Statistics result

To analyze the agreement in the ranking by employers, consultants, and contractors, the Spearman correlation coefficient was used. As presented in Tables VIII, IX and X, the Spearman (rs) rank correlation coefficient was used to show the differences in ranking between two groups of

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(P): 2959-393X
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Ethiopian International Journal of Engineering and Technology (EIJET)
Volume 4, Issue 1, 2026

respondents scoring for various variables. The higher the correlation coefficient, the stronger the relationship in the ranking

3.7.1. Agreement analysis of the ranking: Key determinants influencing HSM in building construction

The Spearman correlations are categorized: 0.00-0.19 (zero correlation or very low correlation), 0.20-0.39 (low correlation), 0.40-0.59 (medium correlation), 0.60-0.79 (high correlation), and 0.80-1.00 (very high or strong correlation) [13]. The result of the Agreement analysis of the ranking Key determinants influencing HSM in building construction between employers, consultants, and contractors showed strong correlations, indicating the consistency of perceptions among the different stakeholders.

Table VIII: Spearman correlation rank order on Key determinants influencing HSM in building construction projects

Spearman (rs) rank correlation coefficient	Employers Vs consultants	Employers Vs contractors	Consultants Vs contractors
	0.89	0.91	0.82

3.7.2. Agreement analysis of the ranking Relationship between Factors and Project Outcomes

Agreement analysis of the ranking Relationship between Factors and Project Outcomes between employers, consultants, and contractors showed strong to high correlations, indicating the consistency of perceptions among the different stakeholders.

Table IX: Spearman correlation rank order on the Relationship between Factors and Project Outcomes

Spearman (rs) rank correlation coefficient	Employers Vs consultants	Employers Vs contractors	Consultants Vs contractors
	0.68	0.87	0.94

3.7.3. Agreement analysis of the ranking Recommendations and Strategies

Agreement analysis of the ranking Recommendations and Strategies between employers, consultants, and contractors showed high to strong correlations, indicating the consistency of perceptions among the different stakeholders.

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ISSN (E): 2959-3921
(P): 2959-393X
***DOI:** https://doi.org/10.59122/194EFE11*

Table X: Spearman correlation rank order on Recommendations and Strategies

Spearman (rs) rank correlation coefficient	Employers Vs consultants	Employers Vs contractors	Consultants Vs contractors
	0.75	0.96	0.88

IV. CONCLUSION

Based on the extensive research findings presented, a number of crucial conclusions can be drawn with regard to HSM in the building construction projects in SWEPR Ethiopia: The research has revealed a substantial gap in awareness and comprehension of HS regulations among workers in the building construction projects. The majority of respondents rated their awareness as inadequate, indicating an urgent need for enhanced training and educational initiatives. Falls from height were identified as the most prevalent hazard, followed by earth excavation, scaffolding collapses, electrical hazards, and exposure to hazardous materials. These findings underline the importance of implementing preventive measures to address these hazards and safeguard worker safety. Factors such as the implementation of safety protocols, compliance with safety regulations, and worker training programs were identified as having a significant impact on ensuring worker safety and overall project success. These factors emphasize the importance of adopting comprehensive safety management strategies. There are significant concerns regarding the adequacy of current safety regulations, enforcement practices, training programs, and communication of safety procedures. Addressing these concerns is essential for improving HSM in building construction projects. Poor HSM practices have significant negative consequences, including increased accidents and injuries, project delays, compromised work quality, and higher project costs. These consequences underscore the urgent need for improvement in HS practices. Strengthening regulatory enforcement, improving access to quality personal protective equipment (PPE), implementing advanced safety technologies, investing in training programs, and incorporating HS considerations into project management practices are recommended strategies for enhancing HSM in construction projects.

In conclusion, the research highlights the urgent need for comprehensive interventions to improve HSM practices in the building construction projects in SWEPR, Ethiopia. Addressing the identified gaps and implementing recommended strategies can significantly enhance worker safety, mitigate risks, and improve overall project outcomes.

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DOI: *https://doi.org/10.59122/194EFE11*

Recommendations and Implications

The findings of this research provide valuable insights into the HS problems faced by construction workers in SWEPR, Ethiopia. Based on the research outcomes, recommendations are formulated to contribute to the body of knowledge regarding HSM in building construction projects in Ethiopia.

- Implementing stricter regulations mandating regular safety inspections, preferably on a weekly or monthly basis, could help mitigate risks and improve overall safety standards.
- Encouraging or enforcing the appointment of designated safety officers at construction sites could ensure continuous monitoring and enforcement of safety protocols.
- Providing training and resources to enhance safety awareness among construction workers and management could further contribute to a safer work environment.

These results are based on self-reported data and are limited to SWEPR, building construction projects only.

Statements and Declarations

Funding: The researchers received no funding for this study.

Conflicts of Interest: The authors declare no conflicts of interest

AI-Assistance Declaration :

The authors used the ChatGPT tool (OpenAI) solely for grammar checking, refinement, language polishing, and sentence formatting. No part of the conceptualization, research design, data analysis, interpretation of results, or creation of original scientific content was generated by the AI tool. All scholarly contributions, ideas, and conclusions are entirely those of the authors.

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Received*: August 27, 2025;* ***Revised****: November 9, 2025;* ***Accepted:*** *November 25, 2025;* ***Published:*** *December 6, 2025*
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***Received**: August 27, 2025; **Revised**: November 9, 2025; **Accepted:** November 25, 2025; **Published:** December 6, 2025*
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***Received**: August 27, 2025; **Revised**: November 9, 2025; **Accepted:** November 25, 2025; **Published:** December 6, 2025*
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