

A Comparative Analysis of Occupational Health and Safety Practice Implementation in Public and Private Construction Sectors: A Policy Harmonization Case Study

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ABSTRACT

The construction sector is a high-risk industry for Occupational Health and Safety (OHS). The rapid pace of construction has raised questions about the efficacy of OHS at public- and private-sector project sites. This study compares OHS practices, hazard types, and accidents across construction sites operated by public- and private-sector organizations. Data were collected through a comparative, cross-sectional survey of 422 construction workers, supervisors, and managers working at public- and private-sector construction sites in the Kurdistan Region of Iraq, using a structured questionnaire. The questionnaire covered key OHS domains, including safety training, use of Personal Protective Equipment (PPE), accident-reporting processes, and general safety culture. The data were then examined using descriptive statistics and comparison tests (chi-square tests and t-tests) to report differences across sectors. The results indicate that compliance with OHS practices, including safety training, the availability of PPE, and the implementation of formal accident-reporting systems, was higher at public-sector construction sites. Private sector facilities, despite having some strengths, were found to have more variability and lower overall adherence to OHS practices. There are significant disparities ($p < 0.05$) in OHS between public and private sector construction sites in the Kurdistan Region of Iraq. To address these disparities and enhance Health and Safety (HS) outcomes for construction workers, the study proposes increased regulation and targeted policy interventions, particularly for the private sector.

Keywords-comparative study; construction sector; occupational health and safety; private sector; public sector; hazards and accidents

I. INTRODUCTION

The construction industry is one of the most dangerous industries, where workers are constantly exposed to different workplace hazards [1, 2]. Consequently, construction industries have a significant interest in Occupational Health and Safety (OHS), especially in emerging countries with high infrastructure development rates [3]. In addition, the rapid

growth in construction activities provides an opportunity to evaluate the advances and limitations of OHS practices [4].

The general and specific safety standards are well established at both international and national levels; however, their enforcement significantly differs between the public and private construction enterprises [5]. This research explores this difference by examining and comparing OHS practices on

construction sites operated by both the public and private sectors in the Kurdistan Region. The findings of this study provide feedback for policymakers, industry stakeholders, and safety professionals to improve the status of work safety in the region [6]. The following research questions are addressed in this study:

- To what extent are the principles of OHS applied within public and private construction sites in the Kurdistan Region of Iraq?
- What are the differences between public and private construction safety practices?

II. LITERATURE REVIEW

A. OHS in Construction

The construction industry has a very high level of risk with its own unique challenges, leading to high rates of accidents and deaths at the workplace [7]. These hazards include slips, trips, and falls; being struck by vehicles or moving objects; contact with dangerous machinery; and exposure to hazardous substances [1]. Work-related accidents are significantly higher in developing countries, lacking regulatory measures and implementation [8].

B. OHS Practices: Global and Regional Perspectives

The effectiveness of OHS in construction is influenced by numerous factors, including the regulatory environment, safety culture, and training and management commitment [9, 10]. A complete safety program, frequent training, and supply of Personal Protective Equipment (PPE) can considerably decrease the accident rate [11, 12]. Several safety concerns have been documented in the Middle East, including a lack of awareness, inadequate training, and noncompliance with safety regulations [13]. Evidence from other countries suggests that government projects are more compliant with safety standards compared to privately managed sites [14].

C. Public versus Private Sector OHS Performance

Comparative research suggests that stricter regulations and greater resource availability in public sector projects result in better safety performance [15]. In contrast, the private sector exhibits more innovation; however, it faces resource and cost challenges [16]. Additionally, safety culture and management commitment are important for OHS performance in both sectors [17].

D. OHS in Developing Countries

The limited literature available on construction safety from the Kurdistan Region suggests that the region faces similar challenges to those faced by other developing countries [3, 18]. The region lacks uniform OHS standard implementation with limited investment in training, awareness, and regulation [8].

E. Theoretical Framework: Institutional Theory

The present study applies Institutional Theory to address differences in the implementation of OHS in public and private sectors. To achieve legitimacy, organizations respond to coercive as well as normative pressures [19]. In developing countries, policy is sometimes decoupled from practice due to

"institutional void" [20]. In the Kurdistan Region, "decoupling" is frequently exhibited by the private sector, where formal safety policies are described as a "myth and ceremony" to fulfil the legal obligations [21] but are not embedded into project site activities [22]. This theoretical perspective explains why policy efficacy may remain low despite the existence of formal policies in the private sector.

F. Research Gap

Although OHS is significant in the construction industry, few studies compare the practices of public and private sector sites. This research aims to fill this gap by offering evidence from the field that supports the improvement of policy and practice. Studies from developed economies indicate that the private sector's capacity to innovate enhances safety systems [22], while studies from developing and post-conflict regions demonstrate that the private sector often prioritizes profit over safety [21]. In addition, OHS compliance in the public sector is affected by bureaucratic 'red tape' and funding insecurity. Building upon these global conclusions, the present study hypothesizes that the construction industry in the Kurdistan Region exhibits similar trends, with the private sector prioritizing profit and the public sector struggling with bureaucracy and limited resources. The current study fills the literature gap by empirically assessing this hypothesis in a regional setting where public and private security frameworks are not fully aligned.

III. METHODOLOGY

The study conducts a comparative, cross-sectional analysis to assess OHS practices at construction sites in the Kurdistan Region of Iraq. This approach can be used for understanding sectoral variations in the implementation of OHS practices [23].

A. Analytical Integration and Variable Clustering

To present a cohesive analysis of the broad OHS landscape in the Kurdistan Region, the study focuses on three crucial aspects:

- Institutional framework: The institutional framework includes policy existence, formal regulations, and barriers to systems.
- Operational execution: Operational execution includes policy effectiveness, management priority, and resource investment.
- Human and safety outcomes: Human and safety outcomes involve worker quality, and exposure to hazards and accidents.

By analyzing these aspects, the research extends beyond descriptive work and provides an integrated examination of how institutional voids have direct implications for safety at work and for human outcomes in both public and private organizations.

B. Study Population and Sample

The research focused on the workforce of public and private sector construction firms in the region. The list of projects used in the study was based on a census released in

2024 by the Ministry of Labor and Social Affairs and the Ministry of Construction and Housing, which identified 205 ongoing construction projects (64 government projects and 141 private projects). All levels of employees, including local workers, site supervisors, and managers, were purposively sampled from the two sectors, and 422 respondents were selected, of which 306 were from the private sector and 116 were from the public sector.

C. Sampling Strategy and Participant Selection

The study employs a purposive sampling technique to collect rich, detailed data from professionals and stakeholders with OHS implementation experience. Instead of selecting a random sample of construction workers, the participants were selected from the project manager, safety officer, and site engineer classes. This strategy helps identify the gap between formal policy and site execution.

To reduce the likelihood of a sampling bias and account for the numerical difference between public (n_1) and private sector (n_2), participants with a diverse set of experience in residential, commercial, or infrastructure projects were selected. As the private sector sample size was larger, indicative of higher private-led construction activities in the Kurdistan Region, the application of chi-square (χ^2) tests on categorical variables provides a valid comparison between the two groups despite unequal group sizes. This technique ensures that the results are particular to the region, but it also indicates a high internal judgment of professional OHS practices.

D. Data Collection

Data were collected using a structured questionnaire, which included demographic information, knowledge and education on OHS, availability of PPE, experience with accident reporting, and perceptions of the safety climate. The questionnaire was reviewed by experts before administration [24]. The survey was conducted from September 2024 to December 2024. The responses were collected in hard-copy or web-based questionnaires. Participation was voluntary and confidential. Full forms were checked for completeness before analysis.

E. Data Analysis

All data were analyzed with the help of SPSS Statistics software. Respondent characteristics and OHS practices were reported by category, followed by a comparison between public/private sector responses using inferential tests (chi-square/t-test).

F. Statistical Approach and Analytical Justification

The study applied a statistical approach to evaluate OHS implementation differences between the public and private sectors. Bivariate analysis (chi-square) was used because of the nature of the categorical variables. OHS implementation is influenced by factors such as project size and experience of individual workers; however, the present study focuses only on the institutional-level differences within the sector. This leads to a confounding effect, which is addressed by using a large and diverse sample size ($N = 422$) and providing a reference comparison for sectoral safety culture in Kurdistan Region.

G. Validity and Reliability of the Instrument

Validation and reliability tests were conducted to ensure the robustness of the survey instrument. Content validity was achieved with the initial questionnaire review by a panel consisting of five experts, including three academic researchers in construction management and two senior OHS practitioners. This panel assessed whether the questionnaire really captured regional safety challenges for construction

Internal consistency was measured using Cronbach's alpha. Reliability analysis yielded an overall instrument score of 0.82, and subscale scores (Policy, Hazard Exposure, and Management Priority) ranging from 0.78 to 0.85. All coefficients exceeded the recognized standard of 0.70, demonstrating that the questionnaire yields reliable and stable measurements for the public sector and private sector.

IV. DATA ANALYSIS

A. Demographics and Employment Characteristics

Table I presents the composition of workers and their methods of employment within the construction sector. The sex disparity reveals that males are predominant in both sectors, accounting for 265 participants (86.6%) in the private sector and 50 participants (43.1%) in the public sector. This is a statistically significant difference ($p < 0.000$, $\chi^2 = 84.088$), and indicates that safety considerations need to be gender specific. In terms of age, most private sector employees are younger than 44 years (< 35: 127 (41.5%); 35–44: 120 (39.2%)), whereas the public sector employees are evenly distributed across the age groups ($\chi^2 = 18.083$, $p = 0.001$), although employees above the age of 55 are rare in both sectors. Younger staff in particular would need extra safety training, since they are less experienced.

With respect to qualifications, a larger percentage of employees in the public sector have BSc degrees as their highest qualification (92 (79.3%)), while similar percentages in both sectors hold an MSc or PhD, but more employees in the private sector reported 'other' qualifications, which might include professional certifications, or non-traditional educational backgrounds ($\chi^2 = 36.942$, $p = 0.000$). This implies that educational level should be taken into account in safety training programs to ensure understanding, especially in the public sector.

In terms of work type, engineers dominate both sectors (private: 194 (63.4%), public: 105 (90.5%)), followed by laborers (private: 35 (11.4%), public: 3 (2.6%)) ($\chi^2 = 31.987$, $p = 0.000$). Given the large number of engineers, technical safety training is essential. The specialization data also reveal that there are greater numbers of civil engineers (private: 128 (41.8%), public: 37 (31.9%)) ($\chi^2 = 62.012$, $p = 0.000$). This number varies largely from sector to sector, and the hazard mitigation efforts should focus more on technicians than on general laborers.

Regarding project types, residential building 43.1% (132), is the predominant project type in the private sector, while in the public sector most projects are related to infrastructure development 8.5% (36) and other (56 (48.3%)), including school, hospital, or local municipal maintenance ($\chi^2 = 102.146$,

$p = 0.000$). These projects constitute different safety hazards and therefore need different levels of precautionary safety measures. The regional distribution also varies significantly: the largest group of workers is from Erbil (private: 133 (43.5%); public: 56 (48.3%)), indicating a need for regional safety policies. The data on duration of employment indicate

that long-term employees (≥ 16 years) are more prevalent in the public sector (67, 57.8%) compared to the private sector (1-5 years: 154 (50.3%), $\chi^2 = 123.805$, $p = 0.000$). High turnover and intake of new employees highlight the importance of providing regular HS training in the private sector for a higher level of OHS awareness.

TABLE I. WORKFORCE DISTRIBUTION AND CHI-SQUARE ANALYSIS FOR SAFETY PROGRAM DEVELOPMENT IN THE KURDISTAN CONSTRUCTION INDUSTRY

Variable	Classification	Private sector, $n = 306$ (%)	Public sector $n = 116$ (%)	χ^2	p-value	Degrees of freedom
Gender	Male	265 (86.6%)	50 (43.1%)	84.088	0.000**	1
	Female	41 (13.4%)	66 (56.9%)			
Age	<35	127 (41.5%)	26 (22.4%)	18.083	0.001**	4
	35-44	120 (39.2%)	55 (47.4%)			
	45-54	43 (14.1%)	31 (26.7%)			
	55-64	12 (3.9%)	3 (2.6%)			
	≥ 65	4 (1.3%)	1 (0.9%)			
Qualifications	Diploma	48 (15.7%)	1 (0.9%)	36.942	0.000**	5
	BSc	159 (52.0%)	92 (79.3%)			
	High school diploma	11 (3.6%)	5 (4.3%)			
	MSc	36 (11.8%)	12 (10.3%)			
	PhD	9 (2.9%)	3 (2.6%)			
Type of work	Other	43 (14.1%)	3 (2.6%)	31.987	0.000**	6
	Engineer	194 (63.4%)	105 (90.5%)			
	Electrician	14 (4.6%)	1 (0.9%)			
	Technician	21 (6.9%)	5 (4.3%)			
	Foreman	18 (5.9%)	1 (0.9%)			
	Skilled laborer	11 (3.6%)	0 (0.0%)			
	Laborer	35 (11.4%)	3 (2.6%)			
Specialization	Other	13 (4.2%)	1 (0.9%)	62.012	0.000**	7
	Architecture	24 (7.8%)	20 (17.2%)			
	Civil engineering	128 (41.8%)	37 (31.9%)			
	Electrical engineering	66 (21.6%)	14 (12.1%)			
	Software engineering	4 (1.3%)	10 (8.6%)			
	Water resources engineering	5 (1.6%)	7 (6.0%)			
	Geomatics (surveying)	6 (2.0%)	3 (2.6%)			
Role in project	Mechanical engineering	12 (3.9%)	19 (16.4%)	64.26	0.000**	5
	Other	61 (19.9%)	6 (5.2%)			
	Engineer	125 (40.8%)	96 (82.8%)			
	Client	8 (2.6%)	3 (2.6%)			
	Contractor	22 (7.2%)	0 (0.0%)			
	Owner	21 (6.9%)	1 (0.9%)			
Construction project	Project manager	28 (9.2%)	7 (6.0%)	102.146	0.000**	4
	Other	102 (33.3%)	9 (7.8%)			
	Residential houses	132 (43.1%)	19 (16.4%)			
	High-rise buildings	79 (25.8%)	3 (2.6%)			
	Oil industry projects	16 (5.2%)	2 (1.7%)			
Region	Infrastructure project	29 (9.5%)	36 (31.0%)	11.462	0.022*	4
	Other	50 (16.3%)	56 (48.3%)			
	Erbil	133 (43.5%)	56 (48.3%)			
	Duhok	58 (19.0%)	26 (22.4%)			
	Sulaymaniyah	77 (25.2%)	14 (12.1%)			
Employment duration (current employer)	Halabja	28 (9.2%)	18 (15.5%)	123.805	0.000**	3
	Other	10 (3.3%)	2 (1.7%)			
	1-5 years	154 (50.3%)	10 (8.6%)			
	6-10 years	81 (26.5%)	15 (12.9%)			
Employment duration (construction industry)	11-15 years	36 (11.8%)	24 (20.7%)	35.07	0.000**	3
	≥ 16 years	35 (11.4%)	67 (57.8%)			
	1-5 years	69 (22.5%)	6 (5.2%)			
	6-10 years	72 (23.5%)	16 (13.8%)			
	11-15 years	57 (18.6%)	19 (16.4%)			
	≥ 16 years	108 (35.3%)	75 (64.7%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

B. Association Between Company Type and OHS Practices

Table II presents the results of chi-square tests, which indicate significant relationships between the type of construction company (private versus public) and some aspects of OHS implementation. In Table II, a significant association was found between the provision of OHS documents at workplaces ($\chi^2= 9.547, p = 0.008$) and the private sector, confirming better availability of OHS documents in the private sector. OHS policy accessibility, however, showed no significant association ($\chi^2= 1.323, p = 0.516$), suggesting a shared weakness across both sectors. A statistically significant association was found between receiving OHS training ($\chi^2= 8.016, p = 0.005$) and the private sector (104; 34.0%). A higher number of private sector employees (23; 19.8%) reported receiving OHS training. There was a significant association

between the presence of a safety engineer and the sector type. Specifically, 26.1% of private companies had a safety engineer compared to only 5.2% of public companies ($\chi^2 = 29.465, p < 0.001$). Collaboration with a safety engineer also showed an association with the sector type ($\chi^2= 19.512, p < 0.001$), with the private sector having higher collaborations compared to the public sector. First aid regulation was not significantly associated with sector ($\chi^2 = 4.445, p = 0.108$), but it was more common in the private sector than in the public sector (35.6%, 25.0%, respectively). These results indicate that although awareness of OHS is higher in the private sector for some items, both sectors need to strengthen this to ensure accessibility, cooperation, and emergency response mechanisms.

TABLE II. ASSOCIATION BETWEEN COMPANY TYPE AND OHS PRACTICES IN THE KURDISTAN CONSTRUCTION INDUSTRY – CHI-SQUARE TEST RESULTS

Variable	Classification	Private sector n = 306 (%)	Public sector n = 116 (%)	χ^2	p-value	Degree of freedom
Includes OHS documents	Yes	151 (49.3%)	44 (37.9%)	9.547	0.008**	2
	No	84 (27.5%)	50 (43.1%)			
	Not sure	71 (23.2%)	22 (19.0%)			
OHS policies accessible	Yes	56 (18.3%)	21 (18.1%)	1.323	0.516	2
	No	221 (72.2%)	88 (75.9%)			
	Not sure	29 (9.5%)	7 (6.0%)			
Received OHS training	Yes	104 (34.0%)	23 (19.8%)	8.016	0.005**	1
	No	202 (66.0%)	93 (80.2%)			
Safety Engineer at the workplace	Yes	80 (26.1%)	6 (5.2%)	29.465	<0.001**	2
	No	193 (63.1%)	104 (89.7%)			
	Not sure	33 (10.8%)	6 (5.2%)			
Cooperation with a safety engineer	Yes	63 (20.6%)	4 (3.4%)	19.512	<0.001**	2
	No	203 (66.3%)	98 (84.5%)			
	Not sure	40 (13.1%)	14 (12.1%)			
First aid regulations	Yes	109 (35.6%)	29 (25.0%)	4.445	0.108	2
	No	169 (55.2%)	76 (65.5%)			
	Not sure	28 (9.2%)	11 (9.5%)			

Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

TABLE III. ASSOCIATION BETWEEN COMPANY TYPE AND IMPLEMENTATION OF HS COMPONENTS

Variable	Response	Private sector n = 306 (%)	Public sector n = 116 (%)	χ^2	p-value	Degree of freedom
HS policy	Yes	141 (46.1%)	41 (35.3%)	15.273	0.000**	2
	No	94 (30.7%)	59 (50.9%)			
	Not sure	71 (23.2%)	16 (13.8%)			
HS procedures	Yes	102 (33.3%)	24 (20.7%)	13.511	0.001**	2
	No	150 (49.0%)	80 (69.0%)			
	Not sure	54 (17.6%)	12 (10.3%)			
HS programmer	Yes	84 (27.5%)	17 (14.7%)	13.848	0.001**	2
	No	158 (51.6%)	83 (71.6%)			
	Not sure	64 (20.9%)	16 (13.8%)			
HS meeting	Yes	112 (36.6%)	15 (12.9%)	22.47	0.000**	2
	No	171 (55.9%)	90 (77.6%)			
	Not sure	23 (7.5%)	11 (9.5%)			
Documenting and reporting procedures	Yes	80 (26.1%)	28 (24.1%)	7.016	0.030*	2
	No	177 (57.8%)	80 (69.0%)			
	Not sure	49 (16.0%)	8 (6.9%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

C. Association Between Company Type and Implementation of HS Components

Statistically significant relationships are observed between the type of company (private versus public) and several

components of HS in the construction sector, as presented in Table III. HS policies are relatively more prevalent in the private sector (46.1%) than in the public sector (35.3%) ($\chi^2 = 15.273, p = 0.000$). Similarly, more private companies engage in HS procedures (33.3% versus 20.7%; $\chi^2= 13.511, p = 0.001$)

and have structured HS programs (27.5% versus 14.7%; $\chi^2=13.848$, $p = 0.001$). These differences are particularly extreme when it comes to the holding of HS meetings—36.6% private and only 12.9% public companies hold such meetings ($\chi^2=22.47$, $p = 0.000$). Finally, recording and reporting HS are slightly more frequent in the private sector (26.1%) compared to the public one (24.1%) ($\chi^2 = 7.016$, $p = 0.030$). These findings indicate that private sector employees are more likely to be actively involved with the implementation and management of

HS features, potentially benefiting from greater organizational monitoring or better adherence to regulations.

D. Association Between Company Type and Practical Implementation of OHS Measures

Table IV displays the analysis of additional OHS-related variables. It reveals varied levels of association between company type and OHS practices in the construction sector

TABLE IV. ASSOCIATION BETWEEN COMPANY TYPE AND PRACTICAL IMPLEMENTATION OF OHS MEASURES IN THE KURDISTAN CONSTRUCTION INDUSTRY (CHI-SQUARE TEST)

Variable	Classification	Private sector $n = 306$ (%)	Public sector $n = 116$ (%)	χ^2	p-value	Degree of freedom
Clarity of OHS risk reporting regulations	Yes	74 (24.2%)	27 (23.3%)	0.065	0.968	2
	No	215 (70.3%)	82 (70.7%)			
	Not sure	17 (5.6%)	7 (6.0%)			
Awareness of hazard control	Yes	127 (41.5%)	13 (11.2%)	41.638	0.000**	2
	No	161 (52.6%)	82 (70.7%)			
	Not sure	18 (5.9%)	21 (18.1%)			
MLSA or union site visits	Monthly	18 (5.9%)	5 (4.3%)	4.858	0.302	4
	Quarterly	10 (3.3%)	1 (0.9%)			
	Yearly	80 (26.1%)	40 (34.5%)			
	No	155 (50.7%)	57 (49.1%)			
	Not sure	43 (14.1%)	13 (11.2%)			
Toolbox talks by supervisors	Monthly	32 (10.5%)	2 (1.7%)	22.653	0.000**	4
	Quarterly	41 (13.4%)	4 (3.4%)			
	Yearly	45 (14.7%)	13 (11.2%)			
	No	167 (54.6%)	86 (74.1%)			
	Not sure	21 (6.9%)	11 (9.5%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

From Table IV, it can be observed that there was no significant association between the company type and the clarity of regulations for reporting OHS risks ($\chi^2 = 0.065$, $p = 0.968$). Furthermore, a low percentage of respondents in both sectors thought that the regulations were clear, suggesting a shared gap across both sectors in precise safety reporting procedures. There was a strong association between awareness of measures to prevent risks and hazards and sector type ($\chi^2 = 41.638$, $p = 0.000$), with 41.5% of the private sector employees being aware of these and only 11.2% of public sector employees. Concerning site visits by the Ministry of Labor or the Kurdistan Workers Union, although the responses were not significantly different ($\chi^2 = 4.858$, $p = 0.302$), more private sector workers reported having no site visits at all (50.7%) compared to public sector workers (49.1%). This highlights a concern over accountability and enforcement in the private sector. Regarding the toolbox talks prior activities, there was a strong association with sector type ($\chi^2 = 22.653$; $p=0.000$), where 54.6 % of private sector employees reported that they were not performed compared to public ones (74.1 %), which suggests the existence of more formal communication and safety briefings in private companies.

Overall, the results highlighted significant intervention targets for both sectors, while private sector employers with lower knowledge and fewer formal safety measures would be particularly targeted. These findings stress the need for standardized safety procedures as well as adherence to them, including hazard recognition and proactivity regarding jobsite safety conversations.

E. Association Between Company Type and Type of Hazards Present at Workplaces

The results in Table V show that perceived exposure to several types of hazards was consistently higher in the private sector. However, only three hazards showed statistically significant associations between the sector type and the presence of hazards. These were high temperatures ($\chi^2=11.198$, $p = 0.004$), high workloads or job demands ($\chi^2=13.529$, $p = 0.001$), and other unspecified hazards ($\chi^2 = 26.218$, $p < 0.001$). For instance, 243 workers (79.4%) in the private sector reported exposure to high temperatures compared to 106 (91.4%) in the public sector. Similarly, high job demands were reported by 177 employees (57.8%) in the private sector versus 44 (37.9%) in the public sector, and other unspecified hazards were noted by 74 employees (24.2%) in the private sector compared to 4 (3.4%) in the public sector.

In contrast, no statistically significant differences were found for the presence of hazards related to noise ($\chi^2=3.274$, $p = 0.195$), dust ($\chi^2 = 0.838$, $p = 0.658$), vibration ($\chi^2=1.175$, $p = 0.556$), unsafe workplace conditions ($\chi^2 = 1.639$, $p = 0.441$), fuels ($\chi^2=1.413$, $p = 0.493$), asbestos ($\chi^2=1.702$, $p = 0.427$), or discrimination ($\chi^2=5.676$, $p = 0.059$). The top three hazards in the private sector are dust (88.6%), noise (85.3%), and unsafe workplace (83.7%), while in the public sector, they are noise and high temperature (91.4% for both) and dust (85.3%). Despite numerically higher reports in the private sector across nearly all hazard types, the lack of statistical significance for most of them suggests that the perception of hazard exposure is widespread across both sectors, though some high-stress and

environmental factors appear more prevalent or recognized in private construction settings. The results suggest the need for interventions specifically on thermal exposure, controlling job

demand, and concealed risk factors, especially in the private sector.

TABLE V. ASSOCIATIONS BETWEEN COMPANY TYPE AND REPORTED WORKPLACE HAZARDS (CHI-SQUARE ANALYSIS)

Hazard type	Classification	Private sector <i>n</i> = 306 (%)	Public sector <i>n</i> = 116 (%)	χ^2	p-value	Degree of freedom
Noise	Yes	261 (85.3%)	106 (91.4%)	3.274	0.195	2
	No	33 (10.8%)	6 (5.2%)			
	Not sure	12 (3.9%)	4 (3.4%)			
Dust	Yes	271 (88.6%)	99 (85.3%)	0.838	0.658	2
	No	26 (8.5%)	13 (11.2%)			
	Not sure	9 (2.9%)	4 (3.4%)			
Vibration	Yes	199 (65.0%)	70 (60.3%)	1.175	0.556	2
	No	75 (24.5%)	30 (25.9%)			
	Not sure	32 (10.5%)	16 (13.8%)			
High temperature	Yes	243 (79.4%)	106 (91.4%)	11.198	0.004**	2
	No	55 (18.0%)	6 (5.2%)			
	Not sure	8 (2.6%)	4 (3.4%)			
Unsafe workplace	Yes	256 (83.7%)	98 (84.5%)	1.639	0.441	2
	No	36 (11.8%)	10 (8.6%)			
	Not sure	14 (4.6%)	8 (6.9%)			
Fuels	Yes	149 (48.7%)	49 (42.2%)	1.413	0.493	2
	No	114 (37.3%)	49 (42.2%)			
	Not sure	43 (14.1%)	18 (15.5%)			
Asbestos	Yes	25 (8.2%)	6 (5.2%)	1.702	0.427	2
	No	188 (61.4%)	73 (62.9%)			
	Not sure	93 (30.4%)	37 (31.9%)			
High workloads	Yes	177 (57.8%)	44 (37.9%)	13.529	0.001**	2
	No	98 (32.0%)	53 (45.7%)			
	Not sure	31 (10.1%)	19 (16.4%)			
Discrimination	Yes	48 (15.7%)	8 (6.9%)	5.676	0.059	2
	No	198 (64.7%)	82 (70.7%)			
	Not sure	60 (19.6%)	26 (22.4%)			
Other hazards	Yes	74 (24.2%)	4 (3.4%)	26.218	<0.001**	2
	No	150 (49.0%)	81 (69.8%)			
	Not sure	82 (26.8%)	31 (26.7%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

F. Association Between Company Type and Type of Accidents at Workplaces

Table VI presents statistical comparisons of all accident-related variables in private and public sector construction companies for each type of accident (significant and non-significant associations are found). Significant associations were observed for machinery-related accidents ($p = 0.035$), being struck by objects ($p < 0.001$), traffic collisions ($p = 0.009$), falling objects ($p = 0.005$), forklift accidents ($p < 0.001$), burns ($p = 0.017$), dangerous scaffolding ($p = 0.003$), and unspecified accidents ($p < 0.001$). Among all these types, it was found that the number of accidents in the private sector was higher than in the public sector. For instance, machinery accidents were reported by 45.8% of employees in the private sector and 34.5% of employees in the public sector. Given these results, it can be hypothesized that risk exposure is higher in private than public construction environments, possibly because of different safety protocols, enforcement, or resource allocation.

In contrast, for other types of accidents including electrocution ($p = 0.186$), falling ($p = 0.093$), slips ($p = 0.077$), falls from height ($p = 0.577$), chemical exposure ($p = 0.147$), caught-in/between ($p = 0.440$), building collapse ($p = 0.317$), and fires/explosions ($p = 0.197$), there were no statistically

significant differences between sectors. The results indicate that the most common accident for both the private and public sectors was falling, with 71.6% and 65.5%, respectively.

In general, these results highlight the fact that although some categories of accidents are much more frequent in the private sector, several risks are widely reported in both the public and private sectors. These findings could be used to guide the targeting of safety interventions, especially in areas characterized as high-risk by these data, with the ultimate aim of improving OHS practices throughout the construction industry.

G. Association Between Company Type and Designer-Related Risk Factors

The chi-square analysis, as presented in Table VII, revealed significant differences ($p < 0.05$) between private and public sector construction sites in terms of employees' perceptions of how design factors contribute to non-compliance with HS rules. There were nine main factors influencing employees' perceptions: unclear design specifications, inadequate design information, conflicting design information, designers' lack of construction knowledge, constructability issues, late design changes, disintegration of the design process, diversion from project objectives, and inadequate specification of materials.

The private sector identified late design modifications, changes in project goals, and undefined materials as the most significant factors, as they ranked them on a Likert scale as (4 = strong influence, and 5 = very strong influence). The public sector, in

contrast, placed relatively little value on these considerations. This observation suggests that both sectors had totally indifferent perceptions of the incorporation of HS hazards in the HS-related legislation.

TABLE VI. CHI-SQUARE ANALYSIS OF THE ASSOCIATION BETWEEN THE TYPE OF CONSTRUCTION COMPANY (PRIVATE VERSUS PUBLIC) AND THE OCCURRENCE OF VARIOUS WORKPLACE ACCIDENTS

Accident type	Classification	Private sector n = 306 (%)	Public sector n = 116 (%)	χ^2	p-value	Degrees of freedom
Machinery accidents	Yes	140 (45.8%)	40 (34.5%)	6.695	0.035*	2
	No	147 (48.0%)	62 (53.4%)			
	Not sure	19 (6.2%)	14 (12.1%)			
Electrocution	Yes	103 (33.7%)	32 (27.6%)	3.362	0.186	2
	No	185 (60.5%)	72 (62.1%)			
	Not sure	18 (5.9%)	12 (10.3%)			
Falling	Yes	219 (71.6%)	76 (65.5%)	4.745	0.093	2
	No	76 (24.8%)	30 (25.9%)			
	Not sure	11 (3.6%)	10 (8.6%)			
Struck by an object	Yes	130 (42.5%)	26 (22.4%)	15.822	<0.001**	2
	No	155 (50.7%)	75 (64.7%)			
	Not sure	21 (6.9%)	15 (12.9%)			
Traffic collision	Yes	81 (26.5%)	18 (15.5%)	9.527	0.009**	2
	No	203 (66.3%)	81 (69.8%)			
	Not sure	22 (7.2%)	17 (14.7%)			
Falling objects	Yes	127 (41.5%)	29 (25.0%)	10.591	0.005**	2
	No	155 (50.7%)	72 (62.1%)			
	Not sure	24 (7.8%)	15 (12.9%)			
Slip	Yes	202 (66.0%)	65 (56.0%)	5.119	0.077	2
	No	91 (29.7%)	41 (35.3%)			
	Not sure	13 (4.2%)	10 (8.6%)			
Falls from height	Yes	173 (56.5%)	67 (57.8%)	1.098	0.577	2
	No	121 (39.5%)	42 (36.2%)			
	Not sure	12 (3.9%)	7 (6.0%)			
Chemical exposure	Yes	47 (15.4%)	11 (9.5%)	3.839	0.147	2
	No	233 (76.1%)	90 (77.6%)			
	Not sure	26 (8.5%)	13 (11.2%)			
Caught-in/between	Yes	53 (17.3%)	15 (12.9%)	1.64	0.44	2
	No	222 (72.5%)	86 (74.1%)			
	Not sure	31 (10.1%)	15 (12.9%)			
Building collapse	Yes	14 (4.6%)	3 (2.6%)	2.296	0.317	2
	No	265 (86.6%)	98 (84.5%)			
	Not sure	27 (8.8%)	15 (12.9%)			
Fires and explosions	Yes	73 (23.9%)	22 (19.0%)	3.25	0.197	2
	No	209 (68.3%)	79 (68.1%)			
	Not sure	24 (7.8%)	15 (12.9%)			
Forklift accidents	Yes	73 (23.9%)	9 (7.8%)	16.689	<0.001**	2
	No	210 (68.6%)	90 (77.6%)			
	Not sure	23 (7.5%)	17 (14.7%)			
Burns	Yes	101 (33.0%)	25 (21.6%)	8.094	0.017*	2
	No	183 (59.8%)	75 (64.7%)			
	Not sure	22 (7.2%)	16 (13.8%)			
Dangerous scaffolding	Yes	164 (53.6%)	35 (30.2%)	19.728	<0.001**	2
	No	126 (41.2%)	68 (58.6%)			
	Not sure	16 (5.2%)	13 (11.2%)			
Other accidents	Yes	63 (20.6%)	3 (2.6%)	20.766	<0.001**	2
	No	190 (62.1%)	90 (77.6%)			
	Not sure	53 (17.3%)	23 (19.8%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

TABLE VII. CHI-SQUARE ANALYSIS OF THE ASSOCIATION BETWEEN COMPANY TYPE AND DESIGNER-RELATED FACTORS

Factor	Response	Private sector n = 306 (%)	Public sector n = 116 (%)	χ^2	p-value	Degrees of freedom
Unclear design specifications	1 – Very low influence	55 (18.0%)	15 (12.9%)	22.273	0.001**	6
	2	52 (17.0%)	37 (31.9%)			
	3	49 (16.0%)	30 (25.9%)			
	4	22 (7.2%)	5 (4.3%)			
	5 – Very high Influence	15 (4.9%)	4 (3.4%)			
	Not sure	74 (24.2%)	15 (12.9%)			
	Does not influence	39 (12.7%)	10 (8.6%)			
Inadequate design information	1	58 (19.0%)	17 (14.7%)	22.749	0.001**	6
	2	56 (18.3%)	35 (30.2%)			
	3	53 (17.3%)	35 (30.2%)			
	4	20 (6.5%)	3 (2.6%)			
	5	13 (4.2%)	4 (3.4%)			
	Not sure	71 (23.2%)	13 (11.2%)			
	Does not influence	35 (11.4%)	9 (7.8%)			
Conflicting design information	1	58 (19.0%)	17 (14.7%)	29.054	0.001**	6
	2	60 (19.6%)	14 (12.1%)			
	3	35 (11.4%)	27 (23.3%)			
	4	40 (13.1%)	32 (27.6%)			
	5	43 (14.1%)	16 (13.8%)			
	Not sure	21 (6.9%)	4 (3.4%)			
	Does not influence	74 (24.2%)	16 (13.8%)			
Designers' lack of construction knowledge	1	33 (10.8%)	7 (6.0%)	30.579	0.001**	6
	2	61 (19.9%)	14 (12.1%)			
	3	26 (8.5%)	25 (21.6%)			
	4	49 (16.0%)	35 (30.2%)			
	5	50 (16.3%)	16 (13.8%)			
	Not sure	22 (7.2%)	4 (3.4%)			
	Does not influence	61 (19.9%)	14 (12.1%)			
Constructability issues	1	37 (12.1%)	8 (6.9%)	31.167	0.001**	6
	2	43 (14.1%)	13 (11.2%)			
	3	20 (6.5%)	19 (16.4%)			
	4	37 (12.1%)	27 (23.3%)			
	5	60 (19.6%)	29 (25.0%)			
	Not sure	51 (16.7%)	5 (4.3%)			
	Does not influence	64 (20.9%)	14 (12.1%)			
Late design changes	1	31 (10.1%)	9 (7.8%)	21.692	0.001**	6
	2	30 (9.8%)	8 (6.9%)			
	3	45 (14.7%)	12 (10.3%)			
	4	42 (13.7%)	25 (21.6%)			
	5	54 (17.6%)	37 (31.9%)			
	Not sure	68 (22.2%)	17 (14.7%)			
	Does not influence	63 (20.6%)	12 (10.3%)			
Disintegration of the design process	1	25 (8.2%)	5 (4.3%)	14.91	0.021*	6
	2	35 (11.4%)	9 (7.8%)			
	3	59 (19.3%)	31 (26.7%)			
	4	69 (22.5%)	40 (34.5%)			
	5	24 (7.8%)	10 (8.6%)			
	Not sure	19 (6.2%)	5 (4.3%)			
	Does not influence	66 (21.6%)	15 (12.9%)			
Diversion in project objectives	1	34 (11.1%)	6 (5.2%)	35.172	0.001**	6
	2	33 (10.8%)	3 (2.6%)			
	3	53 (17.3%)	10 (8.6%)			
	4	39 (12.7%)	29 (25.0%)			
	5	53 (17.3%)	39 (33.6%)			
	Not Sure	38 (12.4%)	16 (13.8%)			
	Does not influence	57 (18.6%)	14 (12.1%)			
Inadequate specification of materials	1	33 (10.8%)	5 (4.3%)	28.834	0.001**	6
	2	36 (11.8%)	4 (3.4%)			
	3	25 (8.2%)	10 (8.6%)			
	4	49 (16.0%)	34 (29.3%)			
	5	60 (19.6%)	38 (32.8%)			
	Not Sure	51 (16.7%)	10 (8.6%)			
	Does not influence	60 (19.6%)	17 (14.7%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

The results indicate that there are significant factors that cause non-compliance with HS hazards during the design stage between the private and public construction sectors. Such large discrepancies highlight the necessity for more sectoral alignment and further discussion on consistent expectations and performance to avoid HS risks during design.

H. Association Between Company Type and Client-Related Risk Factors at Construction Sites

The comparative analysis of private and public sector employees' perceptions of barriers to HS provision (Table VIII) which indicates two statistically significant associations. First, an association was observed between client financial constraints and HS shortcomings ($\chi^2 = 10.139, p = 0.038$), with a higher proportion of public-sector employees reporting a lack of client funds for HS implementation. This implies that the

imposed restrictions by clients in the public sector are considered an obstacle. The second association suggests that the HS compliance is not a client requirement, especially in the private sector ($\chi^2 = 26.962, p = 0.000$). This implies that HS is deprioritized in contractor selection in private sector construction work. In contrast, the absence of concern from clients and consultants was not statistically associated with sector type ($\chi^2 = 10.817, p = 0.094$), but the trend indicates that it is a significant factor in HS non-compliance for private sector employees. Overall, the results indicate that a significant number of private sector employees believe that their HS outcomes are affected by client-related factors (budgets and prioritization). This raises concerns about the extent of policy enforcement and client commitment to HS implementation in private-sector projects. This issue can be addressed by integrating HS considerations into early project objectives.

TABLE VIII. ASSOCIATION BETWEEN TYPE OF CONSTRUCTION COMPANY AND PERCEPTIONS OF HS BARRIERS

Factor	Response	Private sector n = 306 (%)	Public sector n = 116 (%)	χ^2	p-value	Degrees of freedom
Clients' insufficient financial budgets	1 – Very low influence	21 (6.9%)	2 (1.7%)	10.139	0.038*	6
	2	7 (2.3%)	1 (0.9%)			
	3	16 (5.2%)	3 (2.6%)			
	4	54 (17.6%)	32 (27.6%)			
	5 – Very high influence	153 (50.0%)	63 (54.3%)			
	Not sure	36 (11.8%)	8 (6.9%)			
	Does not influence	19 (6.2%)	7 (6.0%)			
HS is not a client objective	1	43 (14.1%)	5 (4.3%)	26.962	0.000**	6
	2	20 (6.5%)	16 (13.8%)			
	3	34 (11.1%)	20 (17.2%)			
	4	50 (16.3%)	33 (28.4%)			
	5	64 (20.9%)	20 (17.2%)			
	Not sure	39 (12.7%)	12 (10.3%)			
	Does not influence	56 (18.3%)	10 (8.6%)			
Lack of concern from clients and consultants	1	23 (7.5%)	2 (1.7%)	10.817	0.094	6
	2	8 (2.6%)	2 (1.7%)			
	3	12 (3.9%)	10 (8.6%)			
	4	44 (14.4%)	22 (19.0%)			
	5	175 (57.2%)	68 (58.6%)			
	Not sure	23 (7.5%)	6 (5.2%)			
	Does not influence	21 (6.9%)	6 (5.2%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

I. Association Between Company Type and Contractor-Related Risk Factors at Construction Sites

Table IX highlights differences between private and public sector construction organizations in terms of perceived causes of inadequate provision of HS. A higher proportion of public sector respondents indicated a high level of agreement (rating 4 and 5) than their private sector counterparts across all constructs. For example, 84.5% of public sector employees highlighted the issue of HS not being included in contract documentation (agreement rating 4 and 5), but in the private sector, 70.6% agreed with this. Regarding contractors wanting to keep HS spending to a minimum in order to remain competitive, 74.5% of private and 89.8% of public sector employees agreed with this. Private and public sector workers differed in their perceptions of contractors being unaware of the importance of HS (76.5% versus 89.6%) and in the view that lower priority was given to HS than other costs, time, and quality (78.1 % versus 88.8%). All factors suggest significant differences (p-values from 0.008 to 0.050), indicating a system-wide difference between the two sectors in terms of awareness and prioritization of HS deficiencies. These findings highlight

the need for better inclusion of HS priorities in construction practices in the public sector.

J. Association Between Company Type and Selection of Contractors with Insufficient Commitment to HS

Table X demonstrates the significant differences between the opinions among employees in private and public sector construction companies regarding how contractor selection criteria influence the appointment of contractors with insufficient commitment to HS. In the public sector, respondents are more likely to believe that contractors prioritize cost, quality, and time over safety, and HS implementation is not a prequalification criterion for contractor selection. In particular, 44.1% of the private sector respondents agree that HS is not considered a core project value, compared to 54.3% respondents in the public sector. Stronger levels of agreement were also reported for all other characteristics, with highly significant p-values ($p < 0.001$ or $p = 0.002$). These findings suggest that HS is not considered an important contractor selection criterion. This is a significant challenge for policymakers and construction organizations.

TABLE IX. ASSOCIATION BETWEEN TYPE OF CONSTRUCTION COMPANY AND CONTRACTORS' CONTRIBUTION TO WORKERS' EXPOSURE TO RISKS AND HAZARDS AT CONSTRUCTION SITES

Factors	Response	Private sector n = 306 (%)	Public sector n = 116 (%)	χ^2	p-value	Degrees of freedom
Contract documentation excludes HS considerations	1 – Very low influence	18 (5.9%)	1 (0.9%)	14.54	0.02*	6
	2	9 (2.9%)	1 (0.9%)			
	3	10 (3.3%)	5 (4.3%)			
	4	43 (14.1%)	27 (23.3%)			
	5 – Very high influence	173 (56.5%)	71 (61.2%)			
	Not sure	39 (12.7%)	8 (6.9%)			
	Does not influence	14 (4.6%)	3 (2.6%)			
Spending on HS by the contractor is minimal to remain competitive	1	13 (4.2%)	2 (1.7%)	17.46	0.008**	6
	2	12 (3.9%)	1 (0.9%)			
	3	7 (2.3%)	0 (0.0%)			
	4	33 (10.8%)	25 (21.6%)			
	5	195 (63.7%)	78 (67.2%)			
	Not sure	34 (11.1%)	9 (7.8%)			
	Does not influence	12 (3.9%)	1 (0.9%)			
Participants' insufficient HS awareness relating to the nature of their work	1	13 (4.2%)	1 (0.9%)	17.01	0.008**	6
	2	10 (3.3%)	1 (0.9%)			
	3	9 (2.9%)	1 (0.9%)			
	4	29 (9.5%)	23 (19.8%)			
	5	205 (67.0%)	81 (69.8%)			
	Not sure	27 (8.8%)	8 (6.9%)			
	Does not influence	13 (4.2%)	1 (0.9%)			
HS are not regarded as significant compared to cost, quality, and time	1	13 (4.2%)	1 (0.9%)	13.62	0.03*	6
	2	6 (2.0%)	2 (1.7%)			
	3	6 (2.0%)	1 (0.9%)			
	4	30 (9.8%)	23 (19.8%)			
	5	209 (68.3%)	80 (69.0%)			
	Not sure	30 (9.8%)	8 (6.9%)			
	Does not influence	12 (3.9%)	1 (0.9%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

TABLE X. ASSOCIATION BETWEEN TYPE OF CONSTRUCTION COMPANY AND CONTRACTORS' INSUFFICIENT COMMITMENT TO HS

Factor	Response	Private sector n = 306 (%)	Public sector n = 116 (%)	χ^2	p-value	Degrees of freedom
HS is not a project value	1 – Very low influence	33 (10.8%)	7 (6.0%)	21.088	0.002 **	6
	2	19 (6.2%)	14 (12.1%)			
	3	37 (12.1%)	18 (15.5%)			
	4	61 (19.9%)	37 (31.9%)			
	5 – Very high influence	74 (24.2%)	26 (22.4%)			
	Not sure	30 (9.8%)	8 (6.9%)			
	Does not influence	52 (17.0%)	6 (5.2%)			
Cost, quality, and time are prioritized over HS	1	45 (14.7%)	3 (2.6%)	25.311	< 0.001 **	6
	2	16 (5.2%)	5 (4.3%)			
	3	29 (9.5%)	20 (17.2%)			
	4	72 (23.5%)	43 (37.1%)			
	5	84 (27.5%)	31 (26.7%)			
	Not sure	26 (8.5%)	9 (7.8%)			
	Does not influence	34 (11.1%)	5 (4.3%)			
Insufficient validation of contractors' quality assurance	1	53 (17.3%)	11 (9.5%)	29.671	< 0.001 **	6
	2	30 (9.8%)	15 (12.9%)			
	3	37 (12.1%)	34 (29.3%)			
	4	50 (16.3%)	21 (18.1%)			
	5	34 (11.1%)	11 (9.5%)			
	Not sure	64 (20.9%)	22 (19.0%)			
	Does not influence	38 (12.4%)	2 (1.7%)			
Excluding HS as a prequalification criterion	1	47 (15.4%)	7 (6.0%)	27.006	< 0.001 **	6
	2	35 (11.4%)	6 (5.2%)			
	3	52 (17.0%)	29 (25.0%)			
	4	57 (18.6%)	41 (35.3%)			
	5	41 (13.4%)	17 (14.7%)			
	Not sure	44 (14.4%)	6 (5.2%)			
	Does not influence	42 (13.7%)	6 (5.2%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

K. Association Between Company Type and the Factors Related to the Lack of HS Regulations at Construction Sites

The chi-square analysis for the determinants of non-compliance with HS regulations is presented in Table XI. Six factors differed significantly ($p < 0.05$) between private and public sector construction organizations in their perceptions of the causes of non-compliance with HS regulations. These factors are: lack of HS knowledge, inadequate monitoring agencies, corruption, lenient penalties for violators, insufficient

resourcing of the inspectorate, and the size and type of the construction establishment. The low p-values suggest that the respondents from both sectors perceive these issues differently. Overall, public sector respondents were significantly more likely to emphasize the importance of these factors. This indicates that the public sector faces challenges in enforcement, funding, and oversight. These results emphasize the importance of sector-wide interventions to improve training, monitoring mechanisms, and strong anti-corruption steps, especially in the public sector.

TABLE XI. CHI-SQUARE TEST RESULTS FOR FACTORS INFLUENCING NON-COMPLIANCE WITH HS REGULATIONS BY SECTOR

Factor	Response	Private sector n = 306 (%)	Public sector n = 116 (%)	χ^2	p-value	Degrees of freedom
Lack of HS knowledge	1 – Very low influence	19 (6.2%)	0 (0.0%)	15.44	0.017*	6
	2	6 (2.0%)	2 (1.7%)			
	3	10 (3.3%)	1 (0.9%)			
	4	35 (11.4%)	21 (18.1%)			
	5 – Very high influence	198 (64.7%)	84 (72.4%)			
	Not Sure	23 (7.5%)	6 (5.2%)			
Inadequate monitoring agencies	Does not influence	15 (4.9%)	2 (1.7%)	17.114	0.009**	6
	1	19 (6.2%)	0 (0.0%)			
	2	4 (1.3%)	2 (1.7%)			
	3	6 (2.0%)	0 (0.0%)			
	4	39 (12.7%)	26 (22.4%)			
	5	202 (66.0%)	80 (69.0%)			
Not enough rules for HS	Not sure	22 (7.2%)	6 (5.2%)	11.661	0.07	6
	Does not influence	14 (4.6%)	2 (1.7%)			
	1	14 (4.6%)	1 (0.9%)			
	2	7 (2.3%)	3 (2.6%)			
	3	15 (4.9%)	1 (0.9%)			
	4	49 (16.0%)	20 (17.2%)			
Corruption	5	180 (58.8%)	82 (70.7%)	12.617	0.049*	6
	Not sure	26 (8.5%)	7 (6.0%)			
	Does not influence	15 (4.9%)	2 (1.7%)			
	1	14 (4.6%)	1 (0.9%)			
	2	7 (2.3%)	4 (3.4%)			
	3	11 (3.6%)	5 (4.3%)			
Inadequate punishments for offenders	4	54 (17.6%)	34 (29.3%)	17.27	0.008**	6
	5	176 (57.5%)	63 (54.3%)			
	Not sure	30 (9.8%)	7 (6.0%)			
	Does not influence	14 (4.6%)	2 (1.7%)			
	1	13 (4.2%)	0 (0.0%)			
	2	3 (1.0%)	2 (1.7%)			
Inadequate training for HS	3	10 (3.3%)	0 (0.0%)	11.746	0.068	6
	4	49 (16.0%)	21 (18.1%)			
	5	189 (61.8%)	84 (72.4%)			
	Not sure	25 (8.2%)	9 (7.8%)			
	Does not influence	17 (5.6%)	0 (0.0%)			
	1	16 (5.2%)	0 (0.0%)			
Inadequate implementation of laws	2	5 (1.6%)	2 (1.7%)	8.019	0.237	6
	3	12 (3.9%)	2 (1.7%)			
	4	41 (13.4%)	15 (12.9%)			
	5	192 (62.7%)	88 (75.9%)			
	Not sure	26 (8.5%)	5 (4.3%)			
	Does not influence	14 (4.6%)	4 (3.4%)			
Ineffective prohibition procedures	1	16 (5.2%)	3 (2.6%)	10.217	0.116	6
	2	4 (1.3%)	2 (1.7%)			
	3	8 (2.6%)	2 (1.7%)			
	4	41 (13.4%)	20 (17.2%)			
	5	197 (64.4%)	83 (71.6%)			
	Not sure	26 (8.5%)	4 (3.4%)			
	Does not influence	14 (4.6%)	2 (1.7%)			
	1	14 (4.6%)	2 (1.7%)			
	2	8 (2.6%)	2 (1.7%)			
	3	12 (3.9%)	2 (1.7%)			

	4	38 (12.4%)	20 (17.2%)			
	5	193 (63.1%)	83 (71.6%)			
	Not sure	28 (9.2%)	6 (5.2%)			
	Does not influence	13 (4.2%)	1 (0.9%)			
Inadequate funding of the inspectorate	1	16 (5.2%)	1 (0.9%)	16.619	0.011*	6
	2	6 (2.0%)	1 (0.9%)			
	3	21 (6.9%)	2 (1.7%)			
	4	51 (16.7%)	21 (18.1%)			
	5	172 (56.2%)	84 (72.4%)			
	Not sure	28 (9.2%)	6 (5.2%)			
	Does not influence	12 (3.9%)	1 (0.9%)			
Size and type of construction enterprise	1	33 (10.8%)	1 (0.9%)	20.393	0.002**	6
	2	21 (6.9%)	8 (6.9%)			
	3	48 (15.7%)	27 (23.3%)			
	4	43 (14.1%)	19 (16.4%)			
	5	109 (35.6%)	52 (44.8%)			
	Not sure	35 (11.4%)	7 (6.0%)			
	Does not influence	17 (5.6%)	2 (1.7%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

L. Association Between Company Type, Lack of Workplace Management Practices, and Workers' Resistance to PPE Use

Table XII presents the rating for the factors associated with workers' resistance to PPE utilization, which includes inadequate supervision ($p = 0.003$) and a lack of hazard awareness ($p = 0.023$). There is a significant difference between the ratings for the private sector and the public sector. Private sector workers reported higher resistance to the use of

PPE. The other factors, such as insufficient HS training, lack of PPE, poor HS culture among workers, and lack of attention from management, did not attain statistical significance ($p > 0.05$). A lack of HS engineers on the site also demonstrated a statistically significant difference ($p = 0.044$), highlighting the importance of specific interventions for enhancing stricter attitudes toward site safety management practices, particularly in private sector projects.

TABLE XII. CHI-SQUARE TEST RESULTS FOR FACTORS INFLUENCING NON-COMPLIANCE WITH MANAGEMENT PRACTICES AT THE WORKPLACE BY SECTOR

Factor	Response	Private sector $n = 306$ (%)	Public sector $n = 116$ (%)	χ^2	p-value	Degrees of freedom
Inadequate supervision	1 – Very low influence	14 (4.6%)	3 (2.6%)	19.541	0.003*	6
	2	4 (1.3%)	9 (7.8%)			
	3	11 (3.6%)	9 (7.8%)			
	4	33 (10.8%)	13 (11.2%)			
	5 – Very high influence	204 (66.7%)	75 (64.7%)			
	Not sure	28 (9.2%)	6 (5.2%)			
	Does not influence	12 (3.9%)	1 (0.9%)			
Insufficient HS training	1	11 (3.6%)	1 (0.9%)	9.056	0.170	6
	2	5 (1.6%)	1 (0.9%)			
	3	12 (3.9%)	2 (1.7%)			
	4	33 (10.8%)	13 (11.2%)			
	5	204 (66.7%)	91 (78.4%)			
	Not sure	24 (7.8%)	6 (5.2%)			
	Does not influence	17 (5.6%)	2 (1.7%)			
Inadequate hazard awareness	1	11 (3.6%)	0 (0.0%)	14.685	0.023*	6
	2	6 (2.0%)	2 (1.7%)			
	3	15 (4.9%)	2 (1.7%)			
	4	26 (8.5%)	18 (15.5%)			
	5	209 (68.3%)	86 (74.1%)			
	Not sure	24 (7.8%)	7 (6.0%)			
	Does not influence	15 (4.9%)	1 (0.9%)			
Inadequate PPE	1	12 (3.9%)	0 (0.0%)	10.511	0.105	6
	2	4 (1.3%)	1 (0.9%)			
	3	14 (4.6%)	3 (2.6%)			
	4	30 (9.8%)	16 (13.8%)			
	5	204 (66.7%)	87 (75.0%)			
	Not sure	27 (8.8%)	7 (6.0%)			
	Does not influence	15 (4.9%)	2 (1.7%)			
HS culture among workers	1	13 (4.2%)	2 (1.7%)	8.881	0.180	6
	2	4 (1.3%)	2 (1.7%)			
	3	6 (2.0%)	1 (0.9%)			
	4	23 (7.5%)	13 (11.2%)			

	5	220 (71.9%)	91 (78.4%)			
	Not sure	24 (7.8%)	6 (5.2%)			
	Does not influence	16 (5.2%)	1 (0.9%)			
Insufficient attention from management	1	10 (3.3%)	0 (0.0%)	11.568	0.072	6
	2	3 (1.0%)	4 (3.4%)			
	3	16 (5.2%)	4 (3.4%)			
	4	36 (11.8%)	17 (14.7%)			
	5	200 (65.4%)	83 (71.6%)			
	Not sure	27 (8.8%)	5 (4.3%)			
	Does not influence	14 (4.6%)	3 (2.6%)			
Insufficient HS engineers on site	1	11 (3.6%)	0 (0.0%)	12.949	0.044*	6
	2	3 (1.0%)	2 (1.7%)			
	3	11 (3.6%)	2 (1.7%)			
	4	32 (10.5%)	12 (10.3%)			
	5	206 (67.3%)	92 (79.3%)			
	Not sure	30 (9.8%)	8 (6.9%)			
	Does not influence	13 (4.2%)	0 (0.0%)			

*Significant at level $p < 0.05$, ** Significant at level $p < 0.01$

V. SUMMARY

Figure 1 illustrates the comparative OHS performance according to the conceptual data extracted from the data analysis. Five weaknesses and strengths are presented for each sector based on six key metrics, with 5 being the highest possible score:

- Workforce quality: the public sector has higher workforce quality with better experience and learning opportunities.
- Policy existence: the private sector demonstrated better performance in this metric, with a higher number of formal policies.
- Policy efficacy: the public sector outperforms the private sector in policy efficacy.



Fig. 1. Comparative OHS performance between public and private sectors.

- Exposure to hazard/risk: Public sector employees reported lower exposure to hazard/risk compared to private sector employees.
- OHS management priority: Public sector outperforms private sector in OHS management priority, with greater management involvement.

- Low systemic barriers: The private sector demonstrated better performance due to lower corruption and higher funding.

Overall, the private sector (orange area) is well-managed but poorly executed, while the public sector (blue area) has a strong inside but suffers from low funding and low policy existence.

A. Practical Scenarios and Real-World Implications

As illustrated in Figure 1, there is an implementation/a gap between OHS policy and its implementation in the field. The private sector, shown in orange, exhibits higher Policy Existence, but significantly lower Policy Efficacy and OHS Management Priority. In real-world terms, safety exists only. For example, a private contractor working on a high-rise project in Erbil has all the necessary safety manuals to pass legal permits, but safety supervisors break these rules every day during routine operations because they have very tight production deadlines.

In contrast, the public sector, shown in blue, exhibits a higher quality of Workforce and Efficacy of Policy; however, they are significantly affected by low Systems Barriers such as funding delay and systemic corruption. A possible reason for low OHS implementation lies in the lack of equipment or high-quality safety gear, such as special harnesses or scaffolding. Finally, these findings highlight the lack of policy harmonization. The results also suggest that the private sector possesses more developed systems, but their on-site execution is limited due to a lack of oversight, resources, and appropriate incentives. In contrast, the public sector has strong internal knowledge and resources; however, it suffers from systemic corruption and low-quality execution. These challenges can be addressed by developing a single audit system that forces compliance in the private sector and improves resource management in the public sector.

VI. CONCLUSIONS

This study presented an in-depth investigation of Occupational Health and Safety (OHS) practices at construction sites in the Kurdistan Region of Iraq, revealing a significant discrepancy in OHS implementation between public and private sectors. The statistical analysis shows that the

private sector workforce is younger and less experienced compared to the highly educated and experienced public service workforce. This demographic difference highlights the need for a safety training policy in the private sector.

The private sector construction companies have better OHS policies and procedures; however, their implementation remains inadequate, resulting in suboptimal safety standards. Higher risk exposure was also reported in the private sector, with a higher prevalence of identified accidents, hazardous conditions (high temperature and work load), obstacles due to inadequate supervision, low hazard awareness, and absence of safety engineers. In contrast, public sector participants demonstrated steady employment history, higher levels of education, management involvement in hazardous substance risk prevention, and better implementation of OHS policy. However, there were some challenges regarding stakeholder engagement and safety regulation.

In both sectors, clarity of OHS legislation, ease of access to safety policies, and organizational involvement by external regulatory agencies and labor unions were common weaknesses. Other factors, including a lack of Health and Safety (HS) knowledge, low funding for inspectorates, corruption, and ineffective penalties on non-compliant organizations, were found to have high contributory effects to non-compliance, especially in the public sector. It was also observed that client-related and contractor-related factors, such as inadequate funding and cost/time-driven decision making, were, in general, more prominent in the private sector.

Overall, these findings stress the need for immediate policies and legislation to address sector-specific issues, including enforcement failure in the private sector and corruption in the public sector. Policies are also needed to address systemic weaknesses, such as a lack of legislation clarity and stakeholder engagement, to improve the implementation of OHS practices.

A. Strengthening Systemic Frameworks

The improvements proposed to strengthen the systemic framework are:

1. Legislative and enforcement overhaul: existing laws should be updated to ensure that OHS laws are clear, simple, and accessible for all stakeholders (employers, workers, unions).
2. Increase penalties and enforcement: higher fines and penalties should be collected from non-compliant businesses.
3. Reduce corruption: transparent and digital reporting should be established to reduce corruption and ensure effective utilization of resources.
4. Empowering regulatory agencies:
 - Additional resourcing: additional funding should be allocated for training and retention of human resources.
 - Professionalize the inspectorate: professional and specialized training programs should be created for OHS

inspectors (especially on construction-specific hazards, risk assessment, and legal processes). This step will improve efficacy by enhancing resources.

B. Stakeholder Engagement and Communication

The study also proposes the creation and activation of National Tripartite Committees (government, employers, and employees/unions) to engage in ongoing social dialogue on OHS policy development and enforcement. Stakeholders should also enhance the participation and access of external regulatory authorities and trade unions to oversee OHS compliance at all construction sites.

C. Targeted Actions for the Private Sector

1) Targeted Training and Competency

The private sector should enforce enhanced and mandatory appropriate OHS training for the younger, more transient, and inexperienced workforce, with an emphasis on practical on-the-job hazard awareness. In addition, it should mandate that all projects exceeding a specific size or risk category have qualified and accredited safety engineers/officers on their project facility for proper supervision and hazard identification.

2) Contractual OHS Integration and Risk Assessments

OHS obligations should be funded and clearly expressed in all contracts, and they should be part of legislation. Contractors should ensure that they have a structured, documented HS Management System, and employees carrying out high-risk activities should conduct detailed risk assessments and reviews of control measures.

3) Supervision and Culture

The quality and quantity of supervision should be increased to address issues related to inadequate supervision, fostering a robust site safety culture.

D. Targeted Actions for the Public Sector

The stakeholders should ensure effective governance and implement safety policy in the field by taking the following steps:

1) Internal Governance and Accountability

Executive-level OHS policy and practices should be supported by an explicit internal accountability system for combating resistance in moving from policy to safety regulation. Furthermore, a dedicated budget should be allocated in publicly funded projects for OHS implementation, ensuring safeguards against cost-saving.

2) Policy Translation and Practice

Standard operating procedures should be maintained for dealing with environmental risks and hazardous substances to ensure that the OHS policy is easily converted from paper to action on the ground.

Table XIII presents a consolidated roadmap of prioritized OHS recommendations for the Kurdistan Region.

TABLE XIII. CONSOLIDATED ROADMAP OF PRIORITIZED OHS RECOMMENDATIONS FOR THE KURDISTAN REGION

Dimension	Strategic action	Focus area
Systemic	Streamline OHS laws and implement digital anti-corruption monitoring.	National policy
Regulatory	Expand inspectorate funding and establish tripartite (Government-Employer-Union) committees.	Oversight
Private sector	Mandate accredited safety engineers and integrate OHS costs into contracts.	Operational efficacy
Public sector	Safeguard dedicated OHS budgets and mandate executive-level accountability.	Governance

With the effective implementation of these recommendations, construction organizations within the public and private sectors can ensure higher safety with fewer accidents and create a safer, healthier environment for employees.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This work is an observational study with professional experts' interviews and anonymous surveys. This research article does not contain any clinical studies or studies with human participants performed by any of the authors, so ethical approval is not necessary according to Mandatory Written Authorization from the Salahaddin University, Institutional Review Board/ethical committee. However, the experiment was carried out in full compliance with the Helsinki Declaration. The research objective was disclosed to all respondents, and written informed consent was acquired from 422 survey participants before their involvement in the study. Anonymized data management was performed to protect privacy.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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