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An Evaluation Study of the Impact of Occupational Health and Safety on Productivity in Saudi Arabia Construction Industry

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Abstract Vision 2030's transformative drive in Saudi Arabia has ignited a construction boom. However, this sector also holds the unfortunate distinction of boasting the highest workplace injury rates. This study delves into the critical link between health and safety (H&S) practices and construction productivity within the Kingdom. It aims to illuminate the significant impact of robust H&S protocols on project productivity, ultimately promoting their adoption across the industry. By employing a mixed-methods approach, 36 key H&S factors are identified and categorised. A comprehensive questionnaire survey, distributed across diverse construction sites throughout Saudi Arabia, garnered insights from 108 industry professionals. Total Importance Index Impact (T.I.I.I.) analysis was then utilised to extract the most impactful factors influencing productivity. The findings unequivocally demonstrate the vital role of H&S in construction success. Companies can unlock significant productivity gains by prioritising improved working conditions and implementing effective H&S management programs. This research offers a compelling case for prioritising worker well-being as a cornerstone for a thriving construction sector within Saudi Arabia.

Keywords: *construction industry, health, safety, productivity, saudi arabia*

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1. Introduction

One of the world's most dangerous industries is construction, with thousands of fatalities and accidents occurring every year due to neglecting health and safety issues. Construction safety in both developed and underdeveloped countries has been assessed. Safety is typically measured in the construction industry using lagging indicators such as fatalities, recordable injuries, lost time, and safety incidents. The construction industry was evaluated among five high–risk sectors [1]. Computer vision techniques have been used to extract safety-related information from site photographs and videos as a robust and automated way of field observation. They are viewed as effective alternatives to the current time-consuming and unreliable manual observational practices [2]. Continuous inspection of risky conditions and action is required for construction safety and health to eliminate potential dangers as soon as possible. Workplace factors such as heavy workloads, extreme heat or cold, chemical odours, noise, inadequate lighting, vibration, and dust can affect employees' performance directly and indirectly. These circumstances make workers less focused on their work, which leads to low productivity, high costs, poor quality, and physical and mental stress [3]. The importance of occupational safety and health (O.S.H.) in raising health awareness and enhancing motivation and dedication at the individual level is highlighted by research into the relationship between cost savings and occupational safety and health programs. It was discovered that each construction project is different due to its size, materials, budget for the location, weather, and human resources [4].

Low productivity in the construction sector is still a big problem in many countries. As a result, to increase construction productivity rates, it is essential to understand the factors affecting labour productivity [5]. To prevent unfavourable outcomes, contractors, subcontractors, owners, consultants, and all other project stakeholders are encouraged to analyse all productivity-influencing factors under their control [6]. The most important factors that affect labour productivity are bad weather, slow payment, poor working conditions, and a lack of skilled workers [7]. The safety and health management system should be regularly reviewed and improved to enhance the organisation's overall performance in terms of safety and health [8]. However, it is uncommon to find information on how construction workers use personal protective equipment (P.P.E.) like

hand gloves, hard hats, dungarees, safety boots, earplugs, safety harnesses with lanyards and face shields. This study investigated the factors that affect building construction workers' use of personal protective equipment (P.P.E.) in Kampala, Uganda [9]. Workers deal with various problems, such as not getting paid on time for work completed, living in appalling conditions, paying for their healthcare, and being unable to plan. Most contractors blame employees for being untrained for project failure [10].

The high accident rate in the construction industry is primarily due to issues with health and safety. Recent studies have shown that implementing the building information modelling (BIM) methodology can make construction sites and building maintenance facilities more pleasant workplaces [11]. Protecting people's minds and bodies from disease brought on by improper handling of materials, procedures, and processes at work can be characterised as health. Health and safety are frequently used in tandem to maintain employees' physical and mental well-being at work [12]. With fatalities and significant workers' compensation lawsuits ranking third in the last five years (accounting for 16% of fatalities and 11% of serious claims), the construction industry is regarded as a relatively high-risk sector. Consequently, it has a detrimental impact on employees' physical, mental, and social well-being. It also raises production costs and lowers competitiveness [13]. On the other hand, because of the high cost of personal protective equipment (P.P.E.), safety training, and operations, the construction industry in developed countries does not concentrate on O.S.H. [14, 15]. Even though many small businesses dominate the industry, little is known about their occupational safety and health (O.S.H.) requirements, practices, or limits [16]. A skilled worker must have received professional training, have at least two years of experience, be knowledgeable about construction materials, tools, and techniques, and be in good physical shape [17]. The psychological and physical well-being of construction workers and those whose health is impacted by construction activities are addressed by construction site health and safety. Governments, project stakeholders, employers, and workers are all worried. Therefore, maintaining health and safety standards requires sound management oversight and is a financial and humanitarian responsibility [18]. Industrial practitioners face a critical challenge in this regard: identifying and analysing the variables that affect worker productivity. These factors and their connections to worker productivity have been the subject of numerous studies in the academic literature [19]. Occupational safety is a crucial element of production efficiency in this industry because construction sites have a high risk of harm. The injured workers were unable to work and missed workdays. The social and economic efficiency of the construction industry is impacted by financial costs [20].

The effect of health and safety on labour productivity in Saudi Arabian construction firms is still not satisfactory. The study aims to identify the health and safety aspects that influence Saudi Arabian employees' productivity.

2. Research Methodology and Data Collection

The study's methodology encompasses three pivotal steps to achieve its objectives, starting with identifying factors influencing workers' health, performance, and productivity. A questionnaire was developed to evaluate the impact of the workplace environment on workers' health, safety, and productivity. Subsequently, data were collected from construction professionals, followed by an analysis that led to calculating a total importance index for each identified factor. Utilising both primary and secondary data, the research adopts a literature review approach to pinpoint health and safety factors affecting construction worker productivity in Saudi Arabia. By examining sources [11-47], the study identifies critical areas for improvement within the Saudi Arabian construction sector to boost worker productivity, as detailed in Table 1 below.

Table 1. 36 Identified Factors related to Health and Saftey (OHS) Affecting Prductivity in Saudi Arabian Construction and their Defenetions

Code	Factor	Code	Factor	Code	Factor
X1	Affordable Insurance Coverage	X13	Work Suspension	X25	Poor Safety Management.
X2	Limited Performance Incentives	X14	Improper Reporting of Incidents	X26	Poor Occupational Safety and Health Administration
X3	Strong Social Protections	X15	Lack of Training Provided	X27	Fire Hazard Risk
X4	Worker Dissatisfaction	X16	Unskilled and/or Unqualified Workers	X28	Heat Stress
X5	Low Workers' morale	X17	Missing Safety Training	X29	Discomfort Work Environment
X6	Workers Inexperience	X18	Lacking Safety Oversight	X30	Noisy Workplace
X7	Lack of Safety in Site	X19	Poor Supervision Relationships with Workers	X31	Airborne Toxin Exposure
X8	Unsafe Site Entry	X20	Crush Injury Risk	X32	Unsafe Work Environment
X9	Inadequate Tools and Missing Instructions	X21	Lack of PPE	X33	Lack of Sheds
X10	Improper Disposal of Construction Waste	X22	Discomfort Workplace	X34	Radiating Work Environment

Code	Factor	Code	Factor	Code	Factor
X11	Unclean Workplace	X23	Lack of First Aid Tools	X35	Chemical Skin Reaction
X12	Lack of Pre-approved Site Organization Plan	X24	Poor Usage of Safety Signing	X36	Unsecured Workplace

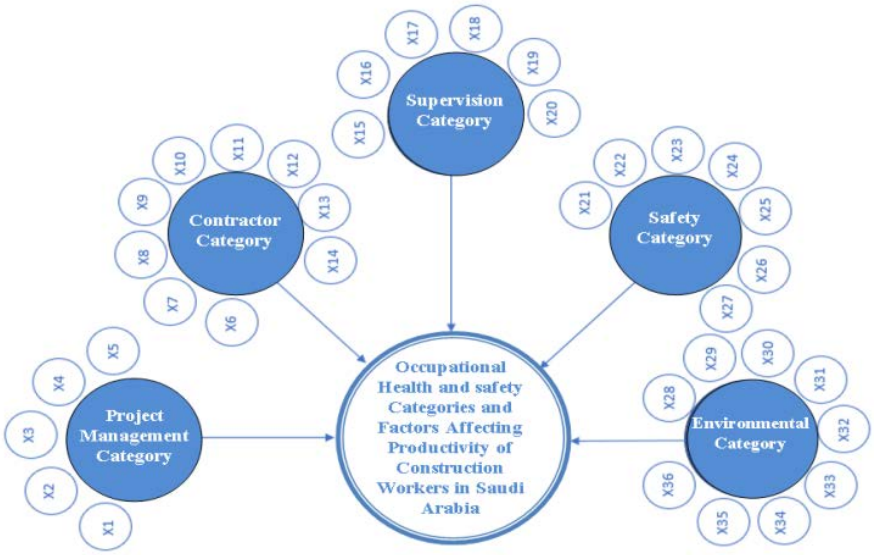

Figure 1. The Five Categories of Occupational Health and Safety (OHS) Factors Influencing Productivity in Saudi Arabian Construction

Figure 1 illustrates the strategic categorization of occupational health and safety (OHS) factors within the construction industry into five key groups: Project Management, Contractor, Supervision, Safety, and Environmental. This classification is particularly applied to the context of construction workers in Saudi Arabia, aiming to streamline the management and understanding of the multifaceted elements influencing worker safety and project outcomes. By organizing these factors into distinct categories, it facilitates the identification of their origins, comprehends their impacts, and aids in crafting precise interventions to reduce risks. Furthermore, this categorization is in harmony with established theoretical frameworks in OHS research, such as the Protection Motivation Theory (PMT) and the Theory of Planned Behavior (TPB), offering insights into the psychological and behavioral dimensions of workplace safety [48].

2.1. Questionnaire Structure

The questionnaire should be simple to design, can be sent to all respondents, take less time to complete, and be more accurate in the outcome. It should avoid asking long questions to avoid wasting the participants' time and avoid confusing questions that are readily misinterpreted, resulting in a poor response rate. Closed questions were the best choice for this case [49]. Four questions for each factor were posed to the respondents. The first dealt with the Frequency with which this factor occurred, and the second one with the severity with which this factor affected the workers' health.

2.2. Sampling Size

The questionnaire was distributed to a large number of experts in the construction industry. In Saudi Arabia, a huge number of construction projects are conducted throughout the Kingdom. For an 86% confidence level, the sample size can be computed using equations derived by [22] and [23]. The sample size-based standard formula is indicated in Equation (1).

$$\text{Sample Size} = (Z^2 \times p(1-p))/(1+((Z^2 \times p(1-p))/(e^2\ N))) \quad (1)$$

Where N refers to the size of the population, z refers to the Z-score, e refers to the error's margin, and p refers to the standard deviation. Considering the number of engineering consultants is 8500, the number of project management consultants is 600, and the confidence level is 90% (i.e., Z-score is 1.65), then the accepted sample is 73 participants; however, in this paper, the collected sample was 108 participants in the field of construction. Six interviews were conducted with construction professionals among the 108 respondents to benefit from their advice and writing recommendations. Their answers to the questionnaire were used to classify the more influential factors.

2.3. Data Analysis

This paper proposes a way to deal with a complete ranking of delay using a statistical technique called the Important Index (I.I.), which is based on the degree of severity and degree of Frequency. It is carried out based on the responses. The factors have been analysed to rank the cause of changes in the timeline based on the importance index. For each case, the important index was calculated as a function of both frequency and severity index as follows:

$$\text{Important Index (I.I) of health, performance, or productivity Impact \%} = [F.I\% \times S.I\%]/100 \quad (2)$$

Where, F.I is Frequency Index, and S.I is Severity Index

Frequency Index (F.I): A formula is used to rank causes of delay based on frequency of occurrence as identified by the participants [24,25].

$$\text{Frequency Index (F.I) (\%)} = \sum a\,(n/N)*100/5 \quad (3)$$

Severity Index (S.I): A formula is used to rank causes of delay based on severity as indicated by the participants.

$$\text{Severity Index (S.I) (\%)} = \sum a\,(n/N)*100/5 \quad (4)$$

Where a is the constant expressing weighting given to each response (ranges from 1 for very low to 5 for very high), n is the Frequency of the response, and N is the Total number of responses [26].

The Frequency, F.I. and severity indices for health, S.H.I., performance, S.P.I., and productivity, S.PR.I, impact factors. Total Importance Index of overall health, performance, and productivity Impact as the average of the function of importance indices for health, performance, and productivity Impact as:

$$T.I.I.I = [I.I.H.I + I.I.P.I + I.I.PR.I]/3 \quad (5)$$

Where: T.I.I.I is the total importance index impact, I.I.H.I is the importance index of health impact, I.I.P.I is the importance index of performance impact, and I.I.PR.I is the importance index of productivity impact.

Using the Statistical Package for the Social Sciences (SPSS V25) program, the alpha coefficients for the Frequency of occurrence factor, the severity impact of health, the severity impact of performance, and the severity impact of productivity for all 36 factors were 0.905, 0.905, and 0.919, respectively. These values are more than 0.7 from the specified limit value, demonstrating the strength of the data's internal consistency [27] and [28].

3. Results and Discussion

3.1. Respondent's Statistics

The results of the study, based on a sample of 108 respondents, provide a comprehensive overview of the demographics and experience levels within the construction industry are all represented in Figure 2. 62% of respondents are contractors, and 38% are owners, indicating a contractor-dominated sector with a trend towards flexible staffing and specialised skills. The job position breakdown shows a significant presence of project managers (39%) and technical office engineers (27.5%), highlighting the importance of project oversight and technical planning. Experience levels among respondents are skewed towards those with over 30 years (39%), indicating a mature workforce but with a gap in mid-level experience that could pose challenges for knowledge transfer. There is also a steady influx of new professionals, with 12% having less than five years of experience, ensuring some level of generational diversity within the industry.

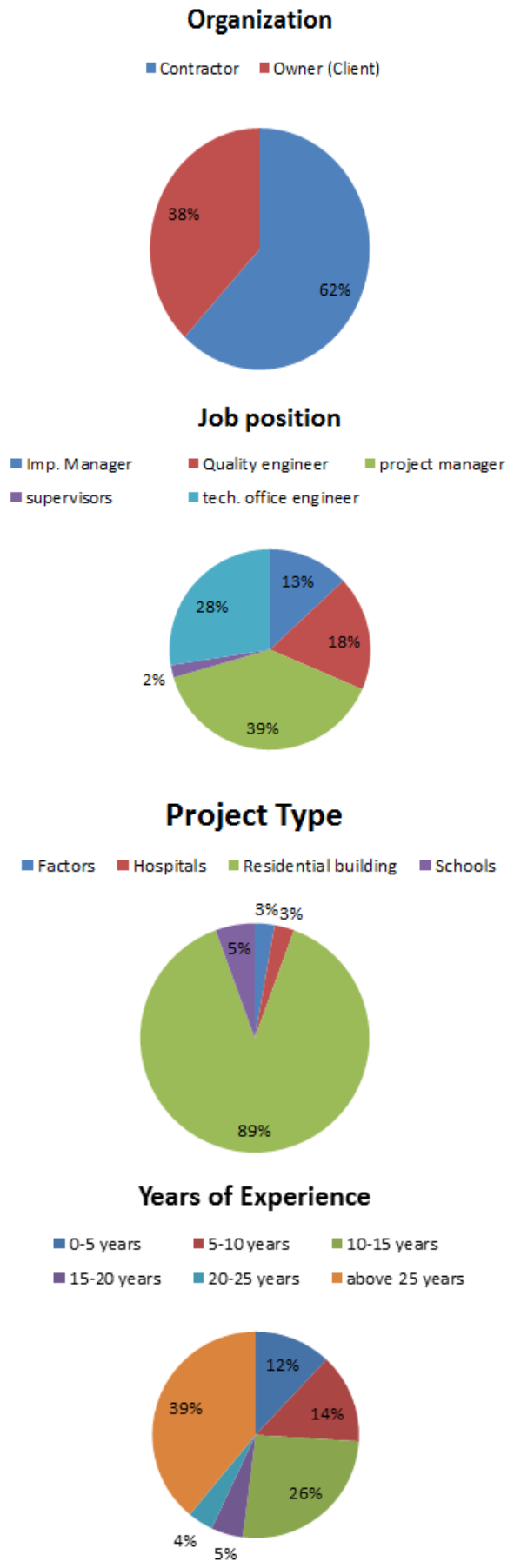

Figure 2. Respondent's statistics

3.2. Project Management Category

Factors related to Occupational Health and Safety that impact workers' productivity are included in Table 2's list of the most effective project management variables. It was found that the factor " Affordable Insurance Coverage " was ranked as the most significant factor impacting worker productivity, with a Total Importance Index (T.I.I.I.) of 57.12%, underscores the critical role of health insurance in ensuring worker well-being and productivity. This finding aligns with the research presented in [50], which discusses the Affordable Care Act's impact on health outcomes and productivity. The factor "Limited Performance Incentives," with a T.I.I.I of 52.54% highlights the importance of monetary and non-monetary incentives in motivating workers and improving productivity. A study on the effect of monetary incentives on worker performance and the impact of non-monetary benefits towards employee performance 5 corroborates this. "Strong Social Protections," with a T.I.I.I of 48.32% reflects the necessity of a supportive social framework for worker productivity. This includes access to healthcare, job security, and a safe working environment [51].

Table 2. Ranking the Project Management Category's Related Factors

Code	Factor	TIII %	Rank	Overall rank
X1	Affordable Insurance Coverage	57.12	1	4
X2	Limited Performance Incentives	52.54	2	7
X3	Strong Social Protections	48.32	3	17
X4	Worker Dissatisfaction	46.32	4	22
X5	Low Workers' morale	45	5	27

3.3. Contractor Category

Table 3. Ranking the Contractor Category's Related Factors

Code	Factor	TIII %	Rank	Overall rank
X6	Workers Inexperience	55.58	1	6
X7	Lack of Safety in Site	50.31	2	11
X8	Unsafe Site Entry	46.94	3	20
X9	Inadequate Tools and Missing Instructions	45.76	4	24
X10	Improper Disposal of Construction Waste	44.26	5	28
X11	Unclean Workplace	42.96	6	29
X12	Lack of Pre-approved Site Organization Plan	41.86	7	30
X13	Work Suspension	39.32	8	32
X14	Improper Reporting of Incidents	37.44	9	33

The factor " Workers Inexperience " was found to be the most critical factor in this category, with a rank of 6th of the 36 factors with T.I.I.I of 55.58%. This result is consistent with [52]'s result, which found that there are fewer fatalities among young people than among older people in the workplace. This indicates that even though they have a lower chance of dying, they have a very high chance of developing permanent impairment. Table 3 shows the factors related to the contractor category, which consists of each factor's ranking as well as its overall ranking among the 36 factors.

3.4. Supervision Category

The survey's findings indicated that the fifth-ranked factor among the 36 factors " lack of training provided " with a T.I.I.I of 56.8% was the most significant one. Studies consistently show inadequate training can lead to inefficiencies, increased accident rates, and lower productivity [53]. This result also aligns with findings from authors like [54], who argue that robust training programs are essential for enhancing skill levels and ensuring quality workmanship. " Unskilled and/or Unqualified Workers " and " Missing Safety Training " with a T.I.I.I of 48.8% and 48.8%, respectively. Literature suggests that the presence of unskilled workers is often a direct consequence of insufficient training and recruitment strategies [55]. Safety training is highlighted as a pivotal area where gaps can lead to serious safety breaches and accidents on-site [56]. Table 4 lists the supervisory factors ranking.

Table 4. Ranking the Supervision Category's Related Factors

Code	Factor	TIII %	Rank	Overall Rank
X15	Lack of Training Provided	56.8	1	5
X16	Unskilled and/or Unqualified Workers	48.8	2	14
X17	Missing Safety Training	48	3	19
X18	Lacking Safety Oversight	46.5	4	21
X19	Poor Supervision Relationships with Workers	41.5	5	31
X20	Crush Injury Risk	33.8	6	35

3.5. Safety Category

Table 5. Ranking the Safety Category's Related Factors

Code	Factor	TIII %	Rank	Overall rank
X21	Lack of PPE	57.9	1	2
X22	Discomfort Workplace	51.7	2	8
X23	Lack of First Aid Tools	50.9	3	9
X24	Poor Usage of Safety Signing	49	4	15
X25	Poor Safety Management.	48.3	5	18
X26	Poor Occupational Safety and Health Administration	46.2	6	23
X27	Fire Hazard Risk	45.6	7	25

Table 5 lists three safety-related factors that are most prevalent in this study. The factor " Lack of P.P.E. "has a T.I.I.I, of 57.9%, and is ranked first in this category and second among the 36 factors, was discovered to be the cause. That is followed by " Discomfort Workplace " and " Lack of First Aid Tools " with a T.I.I.I of 51.7% and 50.9%, respectively. The prominence of "Lack of P.P.E." as a leading factor reflects widespread issues in the enforcement and adherence to safety protocols, a concern echoed by researchers like [57], who highlight the direct correlation between P.P.E. usage and the reduction of workplace injuries. Similarly, the significance of "Discomfort Workplace" points to environmental and ergonomic factors that can significantly impact worker health and productivity, a topic extensively discussed in the works of [58]. Lastly, the "Lack of First Aid Tools"

indicates a gap in emergency preparedness, which is crucial for immediate response to accidents, potentially saving lives and reducing the severity of injuries.

3.6. Environmental Category

The factors related to the environmental category are listed in Table 6, including their (T.I.I.), rankings among the group, and overall ranking. " Heat Stress " ranked first in its group and among the 36 factors, with a T.I.I.I of 71.3%. Similarly, [59] highlights that exposure to excessive heat can lead to heat exhaustion, heatstroke, and diminished mental alertness, thereby increasing the risk of accidents on construction sites. That is followed by " Discomfort Work Environment " and Noisy Workplace " with a T.I.I.I of 57.3% and 50.6%, respectively. According to [60], poor ergonomic conditions can lead to musculoskeletal disorders, significantly affecting worker comfort and long-term health. Noise pollution, as discussed by [61], poses a risk to hearing and contributes to stress and decreased concentration, further compromising safety and efficiency.

Table 6. Ranking the Environmental Group's Related Causes and Effects

Code	Factor	TIII %	Rank	Overall rank
X28	Heat Stress	71.3	1	1
X29	Discomfort Work Environment	57.3	2	3
X30	Noisy Workplace	50.6	3	10
X31	Airborne Toxin Exposure	49.8	4	12
X32	Unsafe Work Environment	49.8	5	13
X33	Lack of Sheds	48.3	6	16
X34	Radiating Work Environment	45.4	7	26
X35	Chemical Skin Reaction	36.4	8	34
X36	Unsecured Workplace	29	9	36

3.7. The Top Ten Factors Affecting Workers Productivity

Table 7. Ranking of the Top Ten Most Effective Factors

Code	Factor	TIII %	Rank	Category of the Factor
X28	Heat Stress	71.3	1	Environmental
X21	Lack of PPE	57.9	2	Safety
X30	Discomfort Work Environment	57.3	3	Safety
X1	Affordable Insurance Coverage	57.1	4	Project Management
X15	Lack of Training Provided	56.8	5	Supervision
X6	Workers Inexperience	55.6	6	Contractor
X2	Limited Performance Incentives	52.5	7	Project Management
X22	Discomfort Workplace	51.7	8	Safety
X23	Lack of First Aid Tools	50.9	9	Safety
X30	Noisy Workplace	50.7	10	Environment

Table 7 and Figure 3 list the top ten factors that impact workers' productivity most. Starting with " Heat Stress ", which was ranked first, and continuing through exposure to " Lack of Training Provided ", ranked fifth with a T.I.I.I of 56.8%. Noticeably, two factors among the top ten most effective factors are related to the Safety Category, which should draw attention to such an issue. However, the intense heat significantly reduces working hours and productivity, necessitating adaptive measures such as modified work schedules and enhanced hydration practices to mitigate its effects [59]. "Lack of P.P.E." significantly impacts workers' productivity, consistent with the literature emphasising the critical role of safety measures in construction [62]. Proper P.P.E. usage is essential for preventing injuries and ensuring worker well-being.

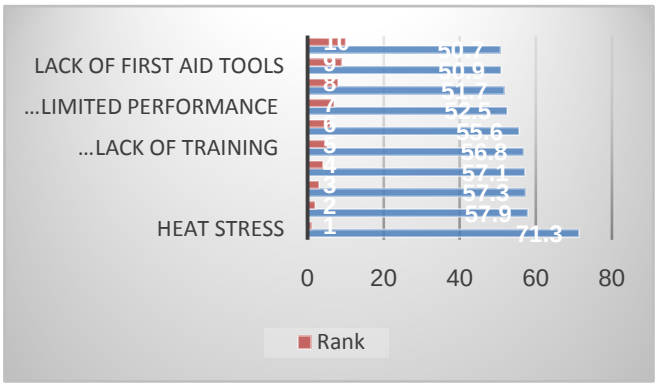

Figure 3. Ranking of the Top Ten Most Effective Factors

4. Conclusion

Occupational health and safety (O.H.S.) practices profoundly impact productivity within the construction industry in Saudi Arabia. The transformative drive of Vision 2030 has significantly increased construction activities. However, it has also highlighted the need for improved O.H.S. protocols to ensure the well-being and efficiency of the workforce. This research has identified 36 key O.H.S. factors and determined their influence on productivity. The study's results indicated that factors such as "Heat Stress," "Lack of P.P.E.," and "Discomfort Work Environment" are among the most critical issues affecting worker productivity.

In conclusion, the research presents a compelling case for prioritising worker well-being as a cornerstone for a thriving construction sector within Saudi Arabia. Several recommendations are suggested to be implemented as the construction industry in Saudi Arabia can significantly improve occupational health and safety practices, leading to enhanced productivity and contributing to the successful realisation of Vision 2030 objectives. as follows:

- Implementation of Comprehensive Safety Training Programs: Construction companies in Saudi Arabia must develop and implement comprehensive safety training programs. These programs should be mandatory for all employees, regardless of their position or experience level.

- Adoption of Advanced Safety Monitoring Technologies: The integration of advanced technologies such as wearable devices, drones, and artificial intelligence (A.I.) for real-time monitoring can significantly enhance the safety of construction sites.
- Strengthening of Regulatory Compliance and Enforcement: The Saudi government should strengthen the enforcement of existing O.H.S. regulations and consider introducing more stringent standards to ensure higher safety levels in the construction industry.
- Promotion of a Safety-First Culture: Construction companies should work towards fostering a safety-first culture where safety is integrated into every aspect of the work process.
- Enhancement of Worker Welfare and Support Systems: Improving the overall welfare of construction workers, including their physical and mental health, can positively impact productivity.

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