EVALUATION OF THE FACTORS INFLUENCING SAFETY PERFORMANCE ON INFRASTRUCTURE PROJECTS IN GAZA STRIP

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Master's Thesis

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This thesis titled "EVALUATION OF THE FACTORS INFLUENCING SAFETY PERFORMANCE ON INFRASTRUCTURE PROJECTS IN GAZA STRIP" has been prepared and submitted by Osama Khaled ABU ELTAYF in partial fulfillment of the requirements in "Anadolu University Directive on Graduate Education and Examination" for the Degree of Master's in CIVIL ENGINEERING Department has been examined and approved on 17/06/2020.

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ABSTRACT

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Researchers agreed that because of its unique nature, the construction industry is among the most dangerous industries, not only in developing countries but also all around the world. Due to the high number of accidents in this industry, it is essential to pay more attention to construction safety and improve the safety performance of construction companies. Moreover, safety is a necessity for a significant function to be used against unnecessary losses. There are relatively few studies on the investigation of the factors influencing safety performance in construction projects in the Gaza strip. Within this context, this research aims to identify the factors that influence safety performance in infrastructure projects in Gaza Strip. A total of 119 factors were investigated in 19 groups.

A questionnaire survey was performed among 23 owners and consultant offices and 68 construction companies operating in Gaza Strip. The data were analyzed by SPSS to present statistical measures. The importance index was calculated to rank the safety factors. It was concluded that the most relevant groups influencing safety performance on Gaza Strip infrastructure projects are personal protective equipment; signs, signals, and barricades; work process; the role of government and engineering societies; and safety educating and training. The most critical factors affecting the performance of safety are the use of the protective foot, barricades to close the construction site for the pedestrian; use of protective head; use of danger signs; and use of caution signs. Finally, several recommendations have been made to enhance the safety performance of construction companies.

Keywords: Safety, Safety performance, Infrastructure, Construction, Projects.

ÖZET

GAZZE ŞERİDİ'NDEKİ ALTYAPI PROJELERİNDE İŞ GÜVENLİĞİ PERFORMANSINI ETKİLEYEN FAKTÖRLERİN DEĞERLENDİRİLMESİ

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Araştırmacılar inşaat sektörünün doğası nedeniyle sadece gelişmekte olan ülkelerde değil, tüm dünyada en tehlikeli sektörler arasında yer aldığını kabul etmektedir. Bu sektördeki kaza sayısının yüksek olması nedeniyle, iş güvenliğine daha fazla dikkat edilmesi ve inşaat şirketlerinin güvenlik performansını artırması gerekmektedir. Ayrıca, iş güvenliği uygulamaları inşaat projelerinde ölümcül kazaların önlenmesinde bir zorunluluktur. Gazze Şeridi'ndeki inşaat projelerinde iş güvenliği performansını etkileyen faktörlerin araştırılması konusunda nispeten az sayıda çalışma bulunmaktadır. Bu kapsamda, bu araştırma Gazze Şeridi'ndeki altyapı projelerinde iş güvenliği performansını etkileyen faktörleri belirlemeyi amaçlamaktadır. 19 grupta toplam 119 faktör araştırılmıştır. Gazze Şeridi'nde faaliyet gösteren 23 yapı sahibi ve müşavirlik firması ile 68 inşaat firması arasında anket çalışması yapılmıştır. Veriler SPSS ile istatistiksel önlemler sunmak üzere analiz edilerek iş güvenliği faktörlerinin sıralandığı önem endeksi hesaplanmıştır. Gazze Şeridi altyapı projelerinde iş güvenliği performansını etkileyen en önemli grupların kişisel koruyucu ekipmanlar; işaretler, sinyaller ve barikatlar; iş süreci; hükümet ve mühendislik toplumlarının rolü; ve iş güvenliği eğitimi olduğu sonucuna varılmıştır. İş güvenliği performansını etkileyen en kritik faktörler, ayak koruyucu aletlerin kullanımı, yayalar için şantiye kapatma barikatları, koruyucu baret kullanımı, tehlike işaretlerinin kullanımı ve uyarı işaretlerinin kullanımıdır. Son olarak, inşaat şirketlerinin iş güvenliği performansını artırmak için çeşitli öneriler sunulmuştur.

Anahtar Kelimeler: İş Güvenliği, İş güvenliği performansı, Altyapı, İnşaat, Projeler.

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Osama Khaled ABU ELTAYF

17/06/2020

STATEMENT OF COMPLIANCE WITH ETHICAL PRINCIPLES AND RULES

I hereby truthfully declare that this thesis is an original work prepared by me; that I have behaved in accordance with the scientific, ethical principles and rules throughout the stage of preparation, data collection, analysis, and presentation of my work; that I have cited the sources of all the data and information that could be obtained within the scope of this study, and included these sources in the references section; and that this study has been scanned for plagiarism with "scientific plagiarism detection program" used by Anadolu University, and that "it does not have any plagiarism" whatsoever. I also declare that, if a case contrary to my declaration is detected in my work at any time, I hereby express my consent to all the ethical and legal consequences that are involved.

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LIST OF ABBREVIATIONS

ANOVA	: Analysis of Variance
ARCTM	: Accident Root Causes Tracing Model
CFR	: Code of Federal Regulations
DAFWC	: Days Away from Work Case
ESAW	: European Statistics on Accidents at work
GPD	: Gross Domestic Product
HSE	: Health and Safety Executive
OSHA	: Occupational Safety and Health Administration
PCBS	: The Palestinian Central Bureau of Statistics
PCU	: Palestinian Contractors Union
PPE	: Personal Protective Equipment
RII	: Relative Important Index
SPSS	: Statistical Package for the Social Sciences
TRIR	: Total Recordable Injury Rate
UK	: United Kingdom
U.S	: United State

1 INTRODUCTION

1.1 Background

Based on its unique, dynamic, and temporary nature, construction is among the riskiest industries (Mohammadi, Tavakolan, & Khosravi, 2018). Construction sites are generally complicated and sometimes unsafe, due to the extensive usage of advanced plants, types of equipment, modern building methods, multidisciplinary and multi-tasked project workforce aspects (Alaqqad, 2009; Teo, Ling, & Chong, 2005). In the construction industry around the world, safety is one of the biggest challenges, not only due to its direct impact on workers and work itself, but also due to its indirect expenses of weak safety performance (McCabe, Alderman, Chen, Hyatt, & Shahi, 2016). Numerous challenges are facing the construction sector, including frequent accidents at the workplace (Aksorn & Hadikusumo, 2008). Overall, workplace accidents occur, either because of lack of knowledge or training, lack of supervision, lack of safe means or a result of misjudgment, apathy for carelessness. Furthermore, the short and transient duration of the construction industry, lack of a stable work environment and size/variety of organizations all impact safety performance inside the industry (Sawacha, Naoum, & Fong, 1999).

Safety can be defined as the converse of danger; safety is more loosely a situation in which the system is under control, and the harm process has not begun, shown Figure 1.1 (Hale & Glendon, 1987).

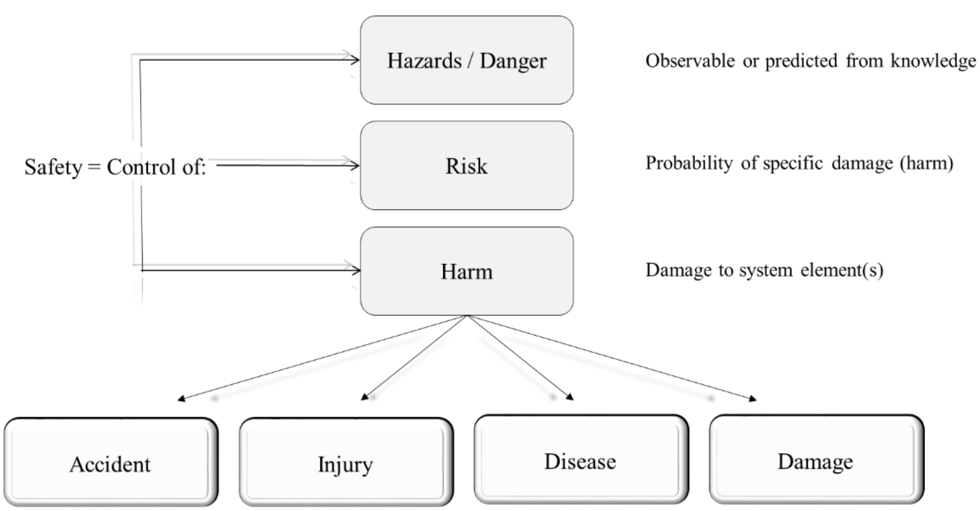


Figure 1.1. *The relation between safety, danger, and other concepts (Hale & Glendon, 1987)*

Mohamed (1999) has examined the correlation between the level of commitment to safety management and the overall safety performance operation and injury records on construction sites in Australia. He has tested the hypothesis that the severity of the safety management level is linked positively to the overall safety performance and pro-activeness. Sawacha et al. (1999) have examined the relationship between social, cultural, emotional, technological, procedural, environmental, and construction site safety factors in Britain (Fang, Xie, Huang, & Li, 2004). Nevertheless, the Social Security Organization statistics showed that there was a spate of construction accidents in 2016, there were 7,338 accidents compared with 4,330 in 2011, which indicates a 69,47 per cent increase (Wong & Soo, 2019).

What is needed to make the construction project safe? The objective was set to identify a list of factors and quantify the impact of these factors on the safety performance of a construction project to answer the question of how a project is safe (Cooper, 2015).

1.2 Problem Statement

Safety and health have always been a recurrent concern in the construction industry, owing to its unique and dangerous nature (Zekri, 2013). Thousands of people each year lose their lives in working places, and hundreds of thousands are injured or wounded. The total cost to employers for work-related injury and illness approaches £ 4 billion per year, apart from the pain and misery caused to those who directly or indirectly, is also reported (Amartey, 2014). 20.7% of worker deaths in the private industry were in construction in 2017, that is, in construction, one out of 5 worker deaths in 2017 (Alaqqad, 2009; OSHA, 2017).

During 2018/19, 30 fatal injuries have taken place in the United Kingdom (UK.) construction industry. In the last five years, an average of thirty-six deaths to workers every year, the cause falls from height accounted for 49 per cent of the deaths for the same five years. The rate of fatal injury is three times the average of all sectors (HSE, 2019). These studies, among many others, show that the industry has an abysmal safety performance record (Chua & Goh, 2004).

Deaths and injuries at the workplace are a significant loss for both people and communities. Heinrich's work (Petersen & Petersen, 1978) has been outlined in two aspects: (1) the main reason behind the accidents are humans and (2) the prevention of incidents is the responsibility of management (Alaqqad, 2009; Fang et al., 2004; Petersen & Petersen, 1978; Zekri, 2013).

Some researchers worked in Gaza Strip on safety subjects in construction projects, such as (Alaqqad, 2009; Alqumboz & Abed, 2007; Enshassi & Abu Zaiter, 2014; Enshassi, Ayyash, & Choudhry, 2016; Enshassi, Choudhry, & Alqumboz, 2011; Enshassi, Choudhry, Mayer, & Shoman, 2008; Enshassi & Mayer, 2004; Enshassi, Mohamed, & Abushaban, 2009; Hassona, 2005; Ibrahim & Al Hallaq, 2015; Mubarak, 2015; Nemer, 2014). Most of the previous studies dealt with the issue of safety in construction projects as a whole, and there was no study conducted in the Gaza Strip that specialized only in infrastructure projects and the extent to which factors affect the performance of safety on infrastructure projects. This work continues from what the researchers started to identify factors affecting safety performance in construction in Gaza Strip, and an evaluation will be made of the impact of these factors on safety performance in infrastructure projects only. The results that appear from the study will be compared with studies conducted on construction projects, especially those conducted in the Gaza Strip. Safety should be a high priority to reduce the number of incidents, injuries, and deaths at work. Although the issue of safety at work has traditionally been regarded as more of a problem of technology, many researchers (Enshassi, 2003; Hassona, 2005) have become increasingly aware that management factors play an important role in safety at work (Alaqqad, 2009).

1.3 Research Aim

This research aims to improve safety performance in infrastructure projects in Gaza Strip by evaluating the factors affecting safety performance and obtain the overall aim to get a minimum level of accidents and maximum level of benefits for the workers.

1.4 Research Objectives

In the following points, the principal objectives of the study can be identified

1. Assessing the level of safety practice in consulting offices and construction companies.
2. Identify and analyze the important factors that affect safety performance in an infrastructure project.
3. Recommend potential solutions and suggestions to improve the safety performance in infrastructure projects in Gaza Strip.

1.5 Thesis Structure

The thesis is divided into six chapters, as follows: The main points of the study are summarized in Chapter 1. It starts with the study background, the problem statement, the research aim, and the research objectives. Chapter 2 presents the literature review and the previous efforts and studies which have been made in the field of health and safety in construction projects in general. In contrast, the 3rd chapter indicates the current state of the Palestinian construction industry.

Chapter 4 shows the methodologies and approaches used to attain the study's objectives. It provides the data sources used and the data analysis method used. Chapter 5 discusses the results obtained from the distributed questionnaire to the owners, consultancy offices, and companies working in infrastructure projects. Finally, based on the findings of the study, Chapter 6 introduce conclusions and recommendations.

2 HEALTH AND SAFETY IN CONSTRUCTION PROJECTS

Since step into the Middle Ages, there has been a greater awareness of the connection between the work that people have done and the types of injuries and illnesses that they have endured. During this time, the first unions started to organize to try to protect employees from the hazards of the workplace. The only change in the 1800s was fire safety due to pressure from insurance companies (Alaqqad, 2009; Reese, 2015).

In the first part of the 1900s, workers ' compensation laws began to appear and were eventually deemed legal by the Supreme Court in 1916. Previously, many employers blamed and kept their employees accountable for work-related incidents using what was known as ' common law, ' which stated:

1. The employer is not liable if a colleague causes you injury due to negligence
2. The employer was not liable if the employee was injured because of his negligence.
3. If the worker took a job and knew that he or she was at risk and knew of the inherent risks of the work before taking the job and was hurt, the employer was not responsible.

Employers have taken responsibility for the safety and health of their employees under the workers ' compensation law. They are expected to provide and pay healthcare and lost wages due to on-job injuries (Alaqqad, 2009; Reese, 2015).

2.1 Occupational Safety and Health Administration

The Occupational Safety and Health Administration (OSHA) was created by the United State (U.S.) Congress and President Richard Nixon in the 1970s, OSHA was established to prove that no worker should have to choose between their life and work. The OSHA legislation clarifies that the right to a safe workplace is a fundamental human right. Since the creation of OSHA, health at work has significantly improved, reducing job-related deaths and injuries by more than 65 per cent, with the involvement of labour unions, workers, and safety and health experts. OSHA has addressed deadly safety hazards and health risks (Labor, 2018).

OSHA was commissioned to develop a set of legislation specifically for the construction industry that would protect those employed in the construction industry. Such Legislation is classified into Subparts A to Z and is set out in Title 29 of the Code of Federal

Regulations (CFR) Section 1926. As a result, the rules are often said to appear briefly in 29 CFR 1926. There are rules relating to construction in other sections of Title 29, such as Part 1910 (General Industry Requirements), while others are found in consensus requirements such as the American National Standards Institute (ANSI) (Reese & Eidson, 2006).

Occupational health and safety are of interest to all branches of industry, business, and commerce, including traditional industries. However, this is especially important for the construction sector (Phil Hughes, 2011).

Occupational Health and Safety control both low-risk and high-risk circumstances, but oversight of these cases is the difference between them. One aspect of supervision shall be discussed in the case of low risks, However, in the event of high risks, several components, such as engineers, work planners, and supervision, must be shared to ensure satisfactory occupational health and safety. (Phil Hughes, 2011). The construction sector has long been considered as one of the most dangerous industries in the world due to its large rates of work-related injuries and fatalities (Chan, Yang, & Darko, 2018).

Fatality rates in the construction sector remain the largest among all other industrial sectors in most countries, including Australia, Europe, and North America. Over the last decade, fatality rates have usually ranged from 3 to 14 work-related deaths per 100,000 employees. However, direct comparisons are not possible due to the different ways in which the data are recorded by each jurisdiction. Many nations, for instance, use medical reports as their source of information, while others use census and social security records. Many countries have self-employed workers; some do not. The data may also differ in the form in which deaths are attributed to the cause of the workplace (McCabe et al., 2016).

2.2 Statistics of Workplace Accidents in Construction

Workplace accidents, particularly in construction, still occur with distressing frequency. This situation has become increasingly known to industrialized countries (Martínez Aires, Rubio Gámez, & Gibb, 2010). In the U.S., the construction sector accounted for 19 percent of all industrial deaths. The fatality rate of the construction industry (10.1 deaths per 100,000 workers) was estimated to be higher than that of any other sector (Chan et al., 2018). Construction is the largest industry in the UK and responsible for 8% of its gross domestic product. It employs 10% of the workforce and has an annual turnover of GBP 250 billion (Phil Hughes, 2011). In the UK, the death rate for the construction industry (1.37 per 100,000 workers) was more than three times greater than the average for all other sectors. The construction industry accounted for 56% of all industrial deaths in Hong Kong. Whereas in Singapore, the industry accounted for 36% of all industrial deaths (Chan et al., 2018).

The methodology of the European Statistics on Accidents at work (ESAW) recognizes two main types of incident measures at work: the number of injuries and incidence rates. The incidence rate = (number of incidents * 100,000/number of workers in the study population) is more useful than the overall number of accidents as it makes it possible to compare the number of accidents in the workplace with the number of workers in the sector (Frequent Rate) (Martínez Aires et al., 2010).

Table 2.1 explains statistics of Fatal Accidents at work from 2011 – 2017 in counties of the European Union; these data were taken from the official web site of ESAW. The data represent the number of fatal injuries of four different activities according to the classification of the site (Construction, Construction of buildings, Civil Engineering, and Specialised construction activities) (Eurostat, 2017a).

Table 2.1. *Fatal accidents at work by NACE/ unite number (Eurostat, 2017a)*

GEO/TIME	2011	2012	2013	2014	2015	2016	2017
European Union - 28 countries	4,141	3,918	3,679	3,801	3,903	3,588	3,552
European Union - 27 countries (2007-2013)	4,103	3,864	3,650	3,775	3,873	3,555	3,515
European Union - 15 countries (1995-2004)	2,910	2,764	2,652	2,738	2,800	2,627	2,612
Belgium	75	49	66	52	64	64	59
Bulgaria	94	98	87	117	95	81	93
Czechia	150	113	113	118	132	106	95
Denmark	44	47	39	38	28	34	28

Table 2.1 *(Continued)*

GEO/TIME	2011	2012	2013	2014	2015	2016	2017
Germany (until 1990)	507	516	466	527	477	450	430
Estonia	19	14	20	16	17	26	8
Ireland	49	43	40	47	49	43	41
Greece	37	26	22	28	28	33	32
Spain	365	299	270	280	344	296	317
France	559	576	553	589	595	595	585
Croatia	38	54	29	26	30	33	37
Italy	621	604	517	522	543	481	484
Cyprus	5	9	9	5	4	5	2
Latvia	34	35	31	41	26	38	21
Lithuania	51	58	58	55	45	44	33
Luxembourg	11	14	6	10	13	22	10
Hungary	81	65	55	81	86	83	80
Malta	1	7	4	4	5	7	1
Netherlands	48	35	42	45	35	36	43
Austria	117	144	143	126	134	109	96
Poland	404	350	277	263	304	243	270
Portugal	192	169	160	160	161	138	140
Romania	297	276	269	272	281	236	241
Slovenia	19	22	20	25	23	14	16
Slovakia	38	53	55	40	55	45	43
Finland	33	36	22	35	35	35	23
Sweden	58	45	35	40	34	37	44
United Kingdom	194	161	271	239	260	252	280
Great Britain	:	:	:	:	:	:	:
Iceland	0	0	0	:	:	:	:
Norway	54	37	48	61	40	45	44
Switzerland	56	65	77	74	53	79	:

Table 2.2 represent statistics of Non-Fatal Accidents at work from 2011 – 2017 in countries of the European Union (Eurostat, 2017b).

Table 2.2. *Non-Fatal Accidents at work by NACE/ unite Number (in thousands) (Eurostat, 2017b)*

GEO/TIME	2011	2012	2013	2014	2015	2016	2017
European Union - 28 countries	3414.7	3165.4	3180.5	3276.6	3267.1	3339.9	3344.5
European Union - 27 countries (2007-2013)	3401.2	3154.3	3168.8	3264.9	3253.9	3326.6	3330.3
European Union - 15 countries (1995-2004)	3210.0	2963.0	2989.8	3085.0	3065.5	3126.1	3129.3
Belgium	65.033	58.4	56.4	65.6	63.9	70.7	70.9
Bulgaria	2.3	2.3	2.2	2.2	2.3	2.2	2.2
Czechia	42.5	41.3	40.8	42.3	42.6	45.3	45.0
Denmark	57.6	57.8	55.9	54.2	50.3	49.4	48.8
Germany (until 1990 former territory of the FRG)	886.8	854.7	852.1	902.9	899.7	917.9	878.5
Estonia	5.9	5.8	6.2	6.3	6.3	6.4	6.3
Ireland	16.7	15.3	18.0	18.1	16.7	14.1	22.1
Greece	13.5	11.1	9.7	3.4	3.7	4.0	4.2
Spain	445.5	355.8	370.2	387.4	413.8	432.1	453.4
France	611.8	587.1	567.4	724.7	731.1	749.7	753.2
Croatia	13.6	11.2	11.7	11.7	13.1	13.3	14.2
Italy	405.9	359.4	329.4	313.3	295.2	296.0	294.2
Cyprus	2.0	1.7	1.5	1.6	1.6	1.9	2.1
Latvia	1.4	1.5	1.7	1.7	1.7	1.8	1.9
Lithuania	2.6	2.8	3.0	3.1	3.3	3.5	4.0
Luxembourg	7.1	7.2	7.1	7.2	7.4	7.2	6.7
Hungary	17.3	20.5	18.9	19.5	20.8	27.4	25.5
Malta	2.5	2.5	2.6	2.6	2.3	1.8	1.8
Netherlands	170.6	165.4	152.2	88.0	72.8	81.2	93.3
Austria	70.4	67.0	64.6	65.4	61.2	62.9	64.0
Poland	87.7	86.7	77.3	76.3	81.9	84.0	84.4
Portugal	125.9	113.2	123.1	130.2	134.4	135.0	135.5
Romania	3.2	3.3	3.5	3.4	3.9	4.2	4.5
Slovenia	15.0	14.3	12.5	12.3	12.4	12.2	13.3

Table 2.2. *(Continued)*

GEO/TIME	2011	2012	2013	2014	2015	2016	2017
Slovakia	8.8	8.5	8.7	8.6	9.2	9.8	10.1
Finland	52.9	46.9	47.4	44.4	42.1	41.1	42.0
Sweden	34.6	36.1	36.2	35.3	36.4	37.9	36.8
United Kingdom	245.5	227.7	243.8	244.9	237.0	227.2	225.7
Iceland	0.9	1.6	1.8	-	-	-	-
Norway	26.4	45.7	22.8	10.1	10.8	10.2	10.0
Switzerland	84.2	85.4	86.0	86.3	85.7	87.4	-

2.2.1 Workplace accidents in construction at Turkey

Statistics from several developing countries indicate that construction workers are three to four times more likely to die from injuries at work than other jobs. In the developing world, Construction's associated risks are perhaps three to six times greater than in other industries. In February 2006, The International Labor Organization's code on safety and health in construction entered into force in Turkey (Dagdeviren, 2018).

Figure 2.1. represents the number of fatal accidents in the construction industry in Turkey, concerning total fatal accidents in all sectors according to the Social Security Institution from 2011 to 2018 (SSI, 2019).

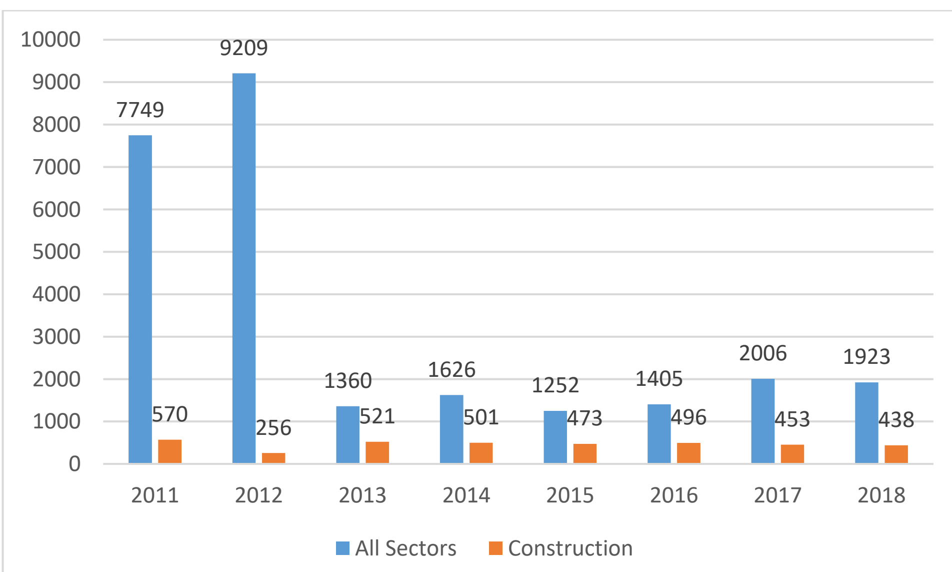


Figure 2.1. *Number of Fatal Accidents in Turkey (SSI, 2019)*

2.3 Safety Performance Concept

Safety means protecting a worker who is engaged in construction work from threats, accidents, harms, or injuries. Safety at the workplace is a complex phenomenon, and Safety performance is still more important in the construction industry (El-nagar, Hosny, & Askar, 2015). Construction sites themselves are commonly known as the most hazardous workplace. The industry is still labour-intensive, though working environments often shift and involve growing stakeholders. In order to achieve better safety performance, the construction sector has become the sector most important to the need for effective security measures and safety management systems (El-nagar et al., 2015).

Safety performance may include safety organization and management, safety equipment and measures, accident statistics, safety training and evaluation, accident investigations, and safety training practice, so the safety performance considers as a subset of construction companies ' overall performance (Nevhage & Lindahl, 2008; Wu, Chen, & Li, 2008).

2.3.1 Safety performance measurement

Accident or injury statistics are among the most common safety performance measures in construction (Tse, 2005). For many large companies, safety performance is becoming increasingly important for measuring the qualifications of a provider or a subcontractor. This rise in importance indicates a desire to choose manufacturers with the least risk of possible injuries. Any safety performance measurement is only useful in so far as the risk of potential incidents is expected. Traditional approaches are based on the frequency and severity of the accident and are extremely unreliable for this future prediction. Some of the current measurement widely used include (Veley, Ritchie, Coats, Disatell, & Cook, 2004).

- **OSHA recordable:** incidents are injuries, diseases, and deaths that employers must record under the standardized guidelines laid down by the OSHA.
- **Lost time:** is calculated for cumulative working days and uses the OSHA criteria to determine whether an injured worker is "away from work."
- **DAFWC (Days away from work case) frequency:** is a case where a worker has a workplace accident and must stay in the house for more than one day as the result of injuries sustained, and many days off work is calculated from the day following the occurrence of the accident. Typically, the DAFWC frequency is specified as the

number of lost time cases divided by 200,000 man-hours, but 100 man-years are the same as 200,000 man-hours if 100 employees work for 50 weeks a 40-hour week.

- **TRIR (total recordable injury rate):** is given by several different names, but it is the number of "recordable" injuries per 200,000 man-hours or per 100 man-years (Veley et al., 2004).

2.4 Safety Culture

Construction is one of the world's most dangerous sectors, incidents in this sector occur as a result of various causes, typically identified by hazardous behaviour and actions, as incidents in dangerous situations or physics. In the organization and individuals, the creation of an appropriate safety culture is believed to be an important strategy for reducing workplace accidents (Tehrani, Rezaifar, Gholhaki, & Khosravi, 2019). The concept ' Safety Culture ' was first submitted to the nuclear industry in 1986 as part of an analysis of the causes of Chernobyl by the International Atomic Energy Agency (Morrow, Kenneth Koves, & Barnes, 2014; Olivencia & Del Puerto, 2016).

The Advisory Committee on the Safety of Nuclear Installations (1993) defines the safety culture as “the result of individual and collective beliefs, attitudes, expectations, abilities and behaviour habits that characterize an organization's health and safety management engagement, style and ability. Communications based on mutual confidence, joint perceptions of the significance of safety and trust in the efficiency of precautionary measures are characteristic of positive culture organizations” (Abdullah & Wern, 2012; Biggs, Banks, Davey, & Freeman, 2013; Feng, Teo, Ling, & Low, 2014).

Safety culture is seen in the organization as values, convictions, and basic assumptions. The predictor of a positive culture of safety is the degree to which workers are willing to participate in safety management in the organization itself (Abdullah & Wern, 2012). Safety culture is the physical, organizational, behavioural, and spiritual culture system (He, Xu, & Fu, 2012). The culture of occupational safety is a measurement of compliance standard which considers the safety guidelines themselves. It can be assumed that the level of occupational safety culture is an objective indicator, that indicates the level of work safety in a production facility and that employees are following rules, standards and guidelines on safe work conditions (Krupa, Gabryelewicz, Edl, Pantya, & Patalas-Maliszewska, 2019). Most important reasons for injuries and deaths in the construction industry throughout the world are the weak culture of safety (Machfudiyanto, Latief, Arifuddin, & Yogiswara, 2017).

2.4.1 Relationship between safety culture and safety performance

The relationship between safety culture and safety performance and whether there is a stimulating effect on safety performance has always been the subject of exploration. However, it has been confirmed that the relationship between safety culture and safety performance is qualitative and quantitative in both theoretical and empirical studies (He et al., 2012).

Safety culture is highly linked to the safety behaviours of employees and represents proactive indicators of safety performance (Tehrani et al., 2019). Safety performance refers to the different kinds of security results, used as dependent variables in the study of safety culture from observed or auto reported safety behaviours (e.g., following procedures, wearing personal safety equipment, attending safety meetings) to organizational safety outcomes such as accident and injury rates (Morrow et al., 2014). K .J. Nielsen (2008) had found that a distinctive culture of safety can effectively reduce accidents and increase safety performance by conducting investigations between two homogenous companies. Safety cultures have a beneficial correlation with the performance of safety. The more mature safety cultures are, the better the performance of safety (He et al., 2012).

2.5 Factors Affecting Safety Performance on Construction Projects

Safe acts and safe conditions in performing construction works have been receiving widespread attention in the construction engineering and management literature, in recent years, numerous authors and scientists have dealt with several aspects of safety. A brief description of key safety researchers is given in Table 2.3 (Alaqqad, 2009; O. A. Jannadi & Bu-Khamsin, 2002).

Table 2.3. *Summary of researches relating to safety (Alaqqad, 2009; O. A. Jannadi & Bu-Khamsin, 2002)*

Authors	Summary of research
(Levitt & Parker, 1976)	It is related to the role of high management in reducing construction incidents.
(Jimmie Hinze, 1978)	Identify the safety impact of new workers and turnover rates.
(Jimmie Hinze & Pannullo, 1978)	Found that increased job control lead up to better safety performance.
(Jimmie Hinze & Parker, 1978)	Surveyed characteristics of superintendent related to improved safety performance.
(Jimmie Hinze & Gordon, 1979)	They investigated supervisor-worker relationships and how they affect injury rates.
(Jimmie Hinze & Harrison, 1981)	Identify safety program practices in large companies associated with reduced injury frequency rates.
(Samelson & Levitt, 1982)	Identified owner's guidelines for selecting safe contractors
(Jimmie Hinze & Raboud, 1988)	Identify appropriate means of achieving or maintaining acceptable safety performance on large projects.
(Jimmie Hinze & Figone, 1988)	They investigated speciality contractor safety as influenced by general contractors on small and medium-sized projects.
(J. Hinze & Talley, 1988)	Investigated speciality contractor safety as influenced by general contractors on large projects
(Liska, Goodloe, & Sen, 1993)	Identify zero accident techniques Contractors on large projects.

Previous studies have shown many factors affecting safety performance in the construction sector (Wong & Soo, 2019). Table 2.4 shows those factors and sub-factors. Moreover, in 2018, some Iranian researchers published a study combining the most important factors affecting safety performance in construction projects. This data was extracted from 90 reviewed papers (Mohammadi et al., 2018). The factors and sub-factors are as follow:

1. **Motivation**, this factor includes incentive programs, job satisfaction, job motivators, peer pressure, reward and penalty, and wage.
2. **Rules and regulations** this factor includes rule compliance, safety rules, and paperwork of regulations.
3. **HSE competency**, contains training and education, worker age, competency, safety knowledge, safety experience, subcontractors and contractors' prequalification on safety, hazard/safety awareness, skill/quality of worker, and learning.
4. **Safety investment and costs**, includes safety budget, cost of accidents, and the return of investment on safety.
5. **Financial aspects and productivity** contain project cost, construction and design errors, contract price, project size, quality, rework, and productivity.
6. **Resource and equipment** include safety personnel, resource constraints, and equipment.
7. **Work pressure** this factor includes production pressure, working pace, work overload, fatigue and burnout, schedule delay, overtime work, and working time.
8. **Work condition** this factor includes exposure to hazard/unsafe work situation, project hazard level, work environment, and workplace health and safety conditions of site-resident workers.
9. **Culture and climate** contain safety climate, safety culture, supportive environment, leadership, and supervisory environment.
10. **Attitude and behaviour**, previous studies have shown that attitude _refers to a set of emotions, beliefs toward a particular object, or event_ and behaviour _refers to the actions and mannerisms made by individuals in conjunction with themselves or their environment_ are one of the most important factors affecting construction safety. This factor contains supervisor's (behaviour, attitude, effectiveness), worker's (behaviour, attitude), perceived behaviour control, behaviour feedback, participation for safety improvement (workers' involvement, cognitive and emotional engagement), safety effort, personal responsibility for safety, risk-taking mindset/behaviour, emotional state, risk perception, perceived safety state, and safety compliance.
11. **Lesson learned from accidents** includes accident rate (frequency and severity), number of accidents, injury (death) rate/type, first aid rate, safety inspection/ investigation,

accident inspection/investigation, incidents control pressure, lessons learned, and willingness to investigate.

12. **The organization** contains the company's revenue, company reputation, company's costs, company size, client's control, the involvement of subcontractors, the number of subcontractors, and the number of employees/crew size.
13. **Safety programs and management systems** 15 sub-factors were extracted, including safety programs, safety management systems, communication and information, limited management time, management commitment, risk assessment implementation/thoroughness, safety policies and procedures, safety committees/meetings/organization/teams/managers, management work pressure, pre-hire screening of employees, management focus on safety, management concern/involvement, safety instructions, safety control mechanisms, safety management practices, and management skills.

Table 2.4. *Factors that are influencing safety performance in the construction industry (Wong & Soo, 2019)*

Factors	Sub-Factors	Cited Papers
Project nature	The arrangement and organization of the construction site	(Alaqqad, 2009; Wong & Soo, 2019)
	The volume of the project	(Alaqqad, 2009; Fang et al., 2004; Wong & Soo, 2019)
	Cost of the project	
	Application of new technology in the project	
	Type of owner	(Alaqqad, 2009; Wong & Soo, 2019; Zekri, 2013)
	The complexity of the design	(Alaqqad, 2009; Charehzehi & Ahankoob, 2012; Wong & Soo, 2019; Zekri, 2013)
	Duration	(Wong & Soo, 2019; Zekri, 2013)
Emergency Planning and Preparation	Development of a plan to respond to emergencies	(Alaqqad, 2009; Ismail, Doostdar, & Harun, 2012; Ng, Cheng, & Skitmore, 2005; Wong & Soo, 2019)
	Training worker to respond to emergency	
Signs, signals, and barricades	Use of danger signs	(Alaqqad, 2009; Wong & Soo, 2019)
	Use of caution signs	
	Use of instruction signs	
	Use of traffic signals	
	Barricades to close the construction site for the pedestrian	

Table 2.4. *(Continued)*

Factors	Sub-Factors		Cited Papers
Historic, human and psychological climate	Historical factors	Worker age	(Alaqqad, 2009; Ismail et al., 2012; Wong & Soo, 2019)
		Worker safety awareness	
		Worker experience	(Alaqqad, 2009; Charehzehi & Ahankoob, 2012; Wong & Soo, 2019)
		Worker education	(Alaqqad, 2009; Wong & Soo, 2019)
		Worker marital status	
		Knowledge and involvement	
		Worker accident's experience	
	Human behaviour	The relation between management and workers on the construction site	(Alaqqad, 2009; Ismail et al., 2012; Wong & Soo, 2019)
		The interrelation between the workers on the construction site	
	Psychological climate	Work pressure of workers	(Alaqqad, 2009; Wong & Soo, 2019)
Welfare facilities	Welfare	First aid kits	(Alaqqad, 2009; Ismail et al., 2012; Wong & Soo, 2019; Zekri, 2013)
		Provision of food and drinking water	

Table 2.4. *(Continued)*

Factors	Sub-Factors		Cited Papers
		Provision of adequate toilets	(Alaqqad, 2009; Wong & Soo, 2019; Zekri, 2013)
		Provision of special places for smoking	
		Provision of an ambulance on the construction site	
		Periodical medical examination of workers	(Alaqqad, 2009; Wong & Soo, 2019)
		Permanent of a medical specialist on the construction site	
	Medical	Crucial care for injuries	(Wong & Soo, 2019; Zekri, 2013)
		The availability of medical specialist on the construction site	(Alaqqad, 2009; Wong & Soo, 2019; Zekri, 2013)
Administrative and management commitment	Safety awareness of project managers and the firm's top management		(Alaqqad, 2009; Charehzehi & Ahankoob, 2012; Ismail et al., 2012; Wong & Soo, 2019)
	Management's attitude towards worker's welfare		(Alaqqad, 2009; Lee & Jaafar, 2012; Lin & Mills, 2001; Ng et al., 2005; Wong & Soo, 2019)
	Availability of a clear company safety policy		(Alaqqad, 2009; Ismail et al., 2012; Lee & Jaafar, 2012; Wong & Soo, 2019; Zekri, 2013)

Table 2.4. *(Continued)*

Factors	Sub-Factors		Cited Papers
	Dissemination and implementation of in-house safety rules		(Alaqqad, 2009; Ismail et al., 2012; Wong & Soo, 2019)
	Safety program or manuals including emergency plan and procedures		
	Conduction of safety policy review		
Safety inspection	conducted by	Government authorities	(Alaqqad, 2009; Wong & Soo, 2019)
		Insurance company	
		Firm's management	(Alaqqad, 2009; Fang et al., 2004; Wong & Soo, 2019)
Safety meeting	Conducting a safety meeting on the construction site by the site engineer		(Alaqqad, 2009; Fang et al., 2004; Wong & Soo, 2019)
	Conducting a safety meeting before each activity begins		
	Conducting safety meetings by the safety committee		(Lin & Mills, 2001; Wong & Soo, 2019)
Role of government and engineering societies	Strict implementation of safety instructions		(Ng et al., 2005; Wong & Soo, 2019; Zekri, 2013)
	Punishment in case of violation of laws		(Alaqqad, 2009; Amartey, 2014; Charehzehi & Ahankoob, 2012; Wong & Soo, 2019; Zekri, 2013)
	Standards regulation and legislation of safety		

Table 2.4. *(Continued)*

Factors	Sub-Factors	Cited Papers
	Issuance of laws, standards, and regulations for safety	(Alaqqad, 2009; Lee & Jaafar, 2012; Ng et al., 2005; Wong & Soo, 2019)
Work process	Crane and lifting equipment	(Alaqqad, 2009; Lee & Jaafar, 2012; Tam, Zeng, & Deng, 2004; Wong & Soo, 2019)
	Excavation and trenching	
	Scaffolds and transportation	
Safety educating and training	Cultivating the awareness of accident risks	(Charehzehi & Ahankoob, 2012; Ng et al., 2005; Wong & Soo, 2019)
	Understating the usage of protective equipment	(Amartey, 2014; Ng et al., 2005; Wong & Soo, 2019)
	First aid and emergency procedures	(Alaqqad, 2009; Wong & Soo, 2019; Zekri, 2013)
Disposal of hazardous materials and waste	Development of a risk management plan	(Alaqqad, 2009; Wong & Soo, 2019; Zekri, 2013)
	Development of a waste management plan	(Alaqqad, 2009; Wong & Soo, 2019)
	Quick transfer of construction wastes out of the construction site	
Personal protective equipment	The use of protective head	(Alaqqad, 2009; Ismail et al., 2012; Lee & Jaafar, 2012; Wong & Soo, 2019; Zekri, 2013)
	Use of protective foot	
	The use of protective clothing	

Table 2.4. *(Continued)*

Factors	Sub-Factors	Cited Papers
Economic investment	Safety incentives	(Alaqqad, 2009; Amartey, 2014; Charehzehi & Ahankoob, 2012; Ismail et al., 2012; Wong & Soo, 2019; Zekri, 2013)
	Allocation of a specific budget for safety requirements	(Alaqqad, 2009; Wong & Soo, 2019)

2.6 Causes of Accidents in Construction Sites

The incidence of construction accidents has resulted in thousands of injuries and a mortality rate of almost 20% in the US private sector. An accident can have been defined as an unplanned and unintentional occurrence that can cause an accident or loss to an individual, property, produce or anything that has an inherent value that exists. Accidents that can lead to fatality are usually classified by type as Fall, Struck-by, Caught-in or in-between, and Electrocution (Hamid et al., 2019). The accidents causes are not limited to a part-specific, as injuries may result from causes related to many elements. These elements are shown in Table 2.5. (S. Ahmed, 2019).

Table 2.5. *Causes of accidents (S. Ahmed, 2019)*

Causes related to projects	**Causes related to site condition**
Project value Poor project planning/scheduling Very tight project schedule Type and nature of the project Social and communal involvement of the project Financial body (government or private)	Project site conditions (exclude equipment, materials, weather) Project site layout/space Project working environment (light/noise/hot/cold/wet) Poor housekeeping
Causes related to the contract	**Causes related to design**
Not strict operation procedures in the contract Coordination between project participants Lack of management commitment in a contract Type of awarding the contract Unclear contract conditions on a safety issue	Design is not constructible Incompleteness and inconsistency of design document Safety is not considered when designing Lack of safety eliminating/ avoiding design
Causes related to material	**Causes related to cost and time**
Lack of protection in material carrying Lack of protection in material storage Working with toxic/hazardous materials Hazard during transportation Lack of knowledge about construction materials	Cost overrun reduce the safety cost Schedule delays and rework in the construction project Short time assigned to the worker

Table 2.5. *(Continued)*

Causes related to consultant	**Causes related to the contractor**
Lack of management/leadership skills Lack of knowledge and experience Unawareness of construction safety Irregular investigation Flexible to contractor/worker on the safety issue No interest to change the safety culture	Inaccurate or incomplete schedule Unawareness of safety-related issue Unwilling to spend the safety-related cost Lack of skill and experience of site staff Reckless action of the contractor
Causes related to a labourer	**Causes related to an owner**
Lack of collaboration among labourer's Lack of personal protective equipment Unskilled labourer's Worker empowerment to make decision Poor education of labourer's Lack of expertise, knowledge or training Interference with others' role Overtime for labourer's Behaviour of workers	Unwilling to pay extra cost for safety Owner's interference on schedule and process Variation in the owner's expectations Lack of owner's emphasis on safety Owner's late response (decision making)
Causes related to equipment and tools	**Causes related to management**
Unfit equipment Poor equipment maintenance Un-use of modern equipment The high cost of advanced equipment and tools Improper use of equipment Lack of knowledge and training on equipment	Lack of effective project supervision Lack of effective communication Inadequate safety policy Improper auditing system Poor organization structure Lack of information flow Lack of technique guide Lack of teamwork
Causes related to technology	**Causes related to external**
Un-use of safety control system Un-use of schedule system Unaware of advanced technology for safety Lack of implementation of Building Information Modeling (BIM) Lack of innovation technology Lack of implementing safety control sensor technology	Act of God External obstacle/barrier Nature of construction Bad weather

The root causes of construction accidents have been regarded as a central issue for the construction industry in the early twenty-first century worldwide (Gibb, Hide, Haslam, & Hastings, 2001). The central concept suggested in accident root causes tracing model (ARCTM) is that due to any or all the below three root causes, an occupational injury may occur:

1. Failure to recognize an unsafe condition that occurred before the activity began or that was formed after the activity began "unsafe conditions."
2. Deciding to carry on work after the worker discovers an actual unsafe condition "worker response to unsafe conditions."
3. Regardless of the initial conditions in the work environment, a decision is made to continue the work in an unsafe way, "unsafe worker acts."

These root causes obviously develop for different reasons and indicate various issues for remedial actions that should be considered. ARCTM has been designed to help the investigator determine the root cause of the accident through a set of questions and possible responses (Abdelhamid & Everett, 2000).

Other researchers have classified the causes of workplace accidents in construction into six categories, detail of each category shown in Table 2.6. Of these variables, 29 articles explain the connection between the background and characteristics of construction workers and the probability of accidents. In contrast, thirty-three of the research papers deal with the study of immediate causes, such as height dropping, slip-up, and object struck injuries. Twenty-five articles reveal critical factors of site accidents related to site conditions such as lighting, building design, and structural failure (Li, Poon, & Ho, 2015).

Table 2.6. *Construction incident causes categories (Li et al., 2015)*

Category	Variables included in the individual categories
Workers' characteristics/ background	History of workers such as age, gender, experience, human error, migrants, lack of safety training, poor relationship with others
Organization	History and strategies for grouping staff of companies such as large companies, subcontracting and pre-planning
Site condition	Characteristics of the construction sites, such as building design, structural failure, lack of protective measures, poor housekeeping
Time of accidents	In the morning, afternoon, evening/Monday to Saturday/ month when accidents happen
Immediate direct causes which lead to accidents	Fall from height, slip, struck by objects, etc.
Economic factors	Payment method, low cost of indemnification for accidents, high cost of transactions, developing countries

3 CONSTRUCTION INDUSTRY IN PALESTINE

The construction sectors of the Palestinian territory are regarded as one of the most productive industries in settlement of the Palestinian Territory after the year 1994, where political stability existed. Notably, through the establishment of a Palestinian National Authority in the Gaza Strip and parts of the West Bank, which led to active building and construction movement (Dmaidi, Mahamid, & Shweiki, 2016). The construction industry has a significant impact on the Palestinian economy and the instrument by which a community obtains its economic growth and development targets. The industry contributed significantly to extending the Palestinian labor force's work opportunities (Elnamrouty, 2012).

Construction industries are dynamic because they include a vast number of parties, such as owners (clients), contractors and consultants, stakeholders, and regulators. Despite this complexity, the sector has an essential role in developing and achieving the goals of society. It is one of the largest industries and contributes approximately 10% of the Gross National Product of industrialized countries (Enshassi et al., 2009).

The Palestinian Central Bureau of Statistics (PCBS) illustrates that the participation of the construction sector to Palestinian Gross domestic product (GPD) has risen since the incorporation of the PNA to 11,1% of Palestinian GDP in 2010 (Dmaidi et al., 2016). In 2013, the construction industry made a contribution of 14.1% of GDP to the Palestinian economy (Enshassi, Ayash, & Mohamed, 2019). In 2016 and 2017, the construction contributed 6.3% and 6.5%, respectively, of GDP to the Palestinian economy (PCBS, 2019), Figure 3.1 represents the percentage of GDP in four years mentioned above.

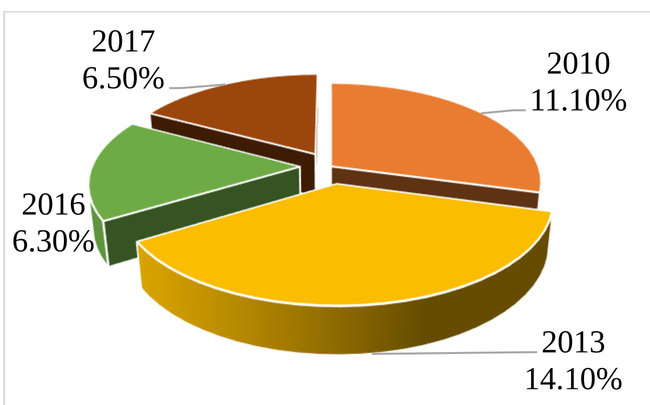


Figure 3.1. *Contribution of construction to GDP to the Palestinian economy (PCBS, 2019)*

According to the PCBS report in March 2019, the percentage distribution of employed persons (15 Years and Above) in Palestine by Economic Activity, 2015-2018 explain in Table 3.1 and Figure 3.2.

Table 3.1. *Percentage distribution of employed persons (15 years and above) (PCBS, 2019)*

Economic Activity	2015	2016	2017	2018
Transportation, Storage and Communications	5.9	6.3	6.5	6.2
Agriculture, Hunting, Forestry and Fishing	8.7	7.4	6.7	6.3
Mining, Quarrying, and Manufacturing	12.9	13.2	13.1	13.0
Construction	15.2	16.3	17.2	17.7
Commerce, Hotels and Restaurants	20.6	20.9	21.6	21.7
Services and Other Branches	36.7	35.9	34.4	35.1
Total	100	100	100	100

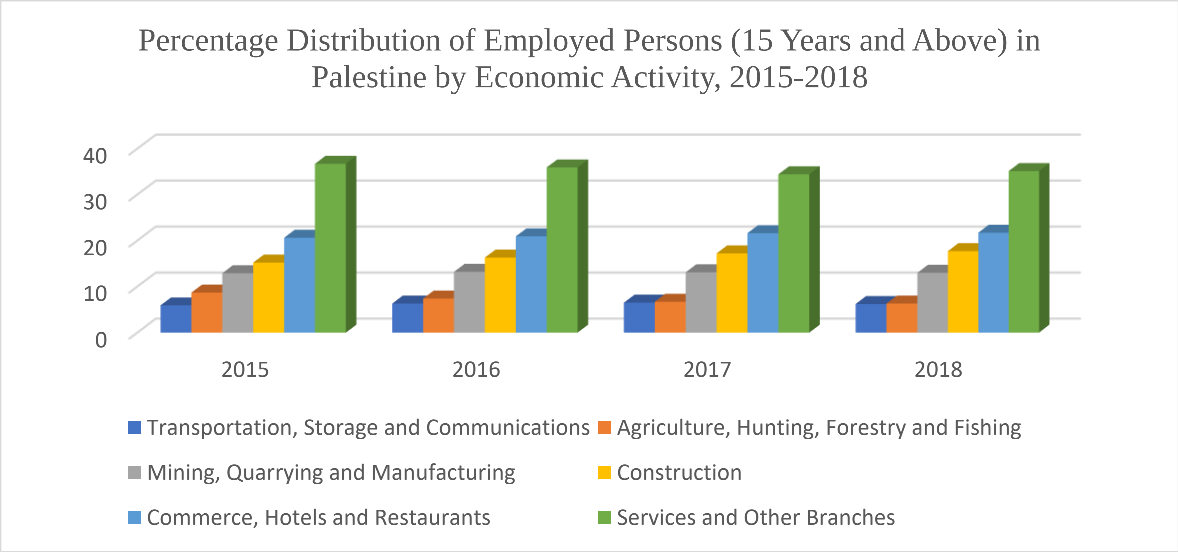


Figure 3.2. *Percentage distribution of employed persons (15 Years and Above) in Palestine by economic activity, 2015-2018 (PCBS, 2019)*

3.1 History of Construction Industry in Gaza Strip

The construction sector in Palestine is regarded to be amongst the main sectors of the economy. This sector has indeed been subjected to a tough situation since the Al Aqsa Intifada uprising, and the severity of the situation has increased since 2006. The frequent and persistent closing of borders is contributing to a severe shortage of building materials. Many projects have been either suspended or subject to significant differences due to a lack of construction materials (Enshassi, Arain, & Al-Raee, 2010).

The construction sector in the Gaza Strip could not embrace the great importance of regulating project participants. Currently, the project mainly focuses on internal stakeholders, including clients, contractors, and consultants, alienating the external stakeholders that are usually affected by the projects, e.g., end-users, local authorities, neighboring countries, and others (El-Sawalhi & Hammad, 2015). The PCBS proclaim that 15.6 per cent of people working in the West Bank and the Gaza Strip were employed in construction. The sector also indirectly employs around 30% of workers in construction-related industries and other services and productive sectors (Enshassi et al., 2019).

3.2 Construction Safety in Gaza Strip

One of the toughest issues for construction industries in the Gaza Strip is reduced safety requirements. For construction, the incident rate is the highest compared to that in other industries (Alaqqad, 2009; Enshassi, Smallwood, & Hassouna, 2007). Safety and health are not widely recognized as an essential part of construction projects in the Gaza Strip. Health and safety are seen by employers as a legal requirement that requires investing without income, though the quick assessment of the cost of injury at work and the possible return on investments in prevention of accidents shows that a safe and healthy environment can be a good profit, the consequence of this scenario was an increased number of accidents (Alaqqad, 2009).

"The Labor Law" in the Gaza Strip came into effect on 1 January 2001, aimed at safeguarding labor rights and interests and controlling working relations. The Labor Law describes employees ' fundamental rights and obligations and employers ' responsibilities. The act includes important work contract structures, social insurance, basic salaries, working hours, vacations, job disputes, and regulation of the labor force. Public Health and Safety in Labor Law stipulates the standards that may emerge in the work process to deal with safety issues and health problems. For instance, “employers are obligated to maintain safe and healthy working conditions” and “the workers are required to work in safe and healthy conditions.”. Building safety rules were introduced in June 2003. Such laws are restricted to buildings only and did not take infrastructure projects into account (M. H. Ahmed & Adnan, 2005).

3.3 The Projects in Gaza Strip

Infrastructure projects are categorized into several projects: roads, water, sewage, electricity, and communication. There are many parties responsible for the implementation of these projects in the Gaza Strip. Roads, water, and sewage works are carried out by the municipalities in the Gaza Strip. The Palestinian telecommunications and electricity companies, in cooperation with the municipalities, are implementing electricity and communications infrastructure projects.

The Gaza Municipality is the large municipality in Gaza Strip. According to a report issued by the Municipal Council during the period 2014-2018, the Municipality carried out 62 road projects at a total cost of approximately $ 52 million, while water and sewage works were carried out 86 projects at the cost of approximately $ 56 million, Table 3.2. shows the distribution of projects during this period according to the financial cost of the projects (Municipality, 2018).

Table 3.2. *Distribution of projects during 2014-2018 cost in a million $ (Municipality, 2018)*

	Roads	Water & Sewage	Total
2014	22.1	5.46	27.56
2015	0.0	7.39	7.39
2016	11.18	32.00	43.18
2017	4.75	2.47	7.22
2018	14.38	8.71	23.09
Total $	52.41	56.03	108.44

Due to the political situation experienced by the State of Palestine from the Israeli occupation and blockade of Gaza Strip since 2007 and three wars that have been waged between 2008 and 2014, the Qatari Committee for Reconstruction of Gaza was established in 2012, in order to reconstruction what was destroyed by the Israeli occupation and to implement new projects in all sectors including construction and infrastructure. It is the responsibility of the Gaza Reconstruction Committee for the management and implementation of His Highness Sheik Hamad Bin Khalifa Al Thani's US$ 407 million Qatar grant for reconstruction of Gaza.

Based on the statistics provided in the latest report of the $ 407 million grant, which is being supervised by the Qatari committee in the Gaza Strip, the construction, roads and infrastructure sector accounted for 76% of the total grant, estimated at an approximate cost of $ 310 million, Figure 3.3. shows the percentage and value of each sector of the total grant, while Figure 3.4 identifies the projects implemented by the Qatari Committee by the geographical distribution of the Gaza Strip (Committee, 2018).

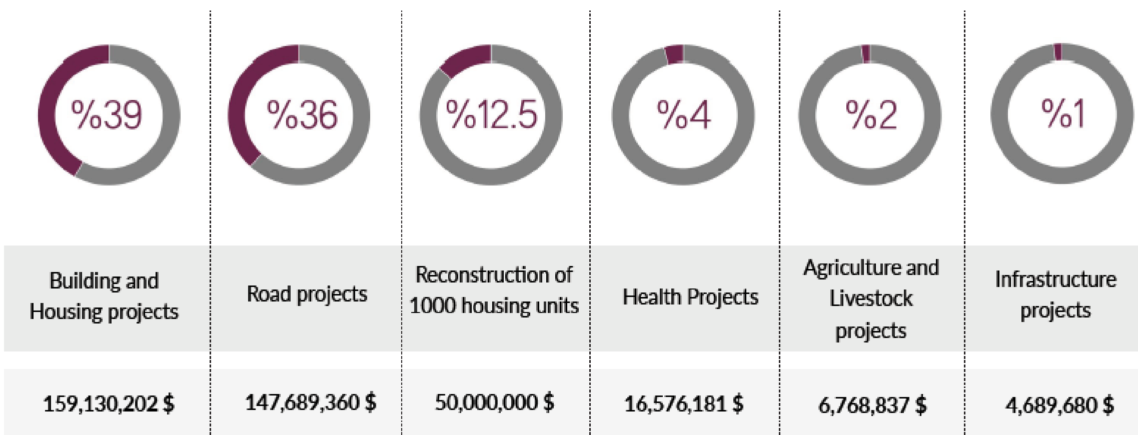


Figure 3.3. *Distribution of Qatar grant by Sectors (Committee, 2018)*

Figure 3.4. *Distribution of Qatar grant by governorates (Committee, 2018)*

4 METHODOLOGY

The methodology used in chapter four is described in order to ascertain the extent to which the hypothesis that the researcher puts at the forefront of the study.

Several elements in this chapter are explained: study design, size of the study population, size of the drawn sample in addition to determining the type of statistical sampling, the setting of the study, study instruments, pilot study, validity and reliability, statistical metrics used in measurement, determination of the study test used to judge the dimensions and items of the questionnaire (Likert scale). Finally, a summary of the methodology is presented.

4.1 Research Design

The expression "research design" refers to the plan or organization of scientific research, the design of a study includes developing a strategy or plan to guide the collection of data and analysis it (Polit & Hungler, 1985). Questionnaires are widely used for analytical and descriptive studies to discover the facts, views, and opinions (Naoum, 2012).

The questionnaire was the only way to collect the necessary data in this study. There are some limitations to the use of postal questionnaires, such as; it must include simple questions, no control over the respondents, and accuracy; respondents may answer generally, and they may answer according to their public profile rather than the underlying corporate reality (Naoum, 2012).

4.2 Research Location

The research was carried out in Gaza Strip (Gaza city, north, south, and middle area). The survey was distributed over Gaza Strip to cover the geographic locations.

4.3 Population

The target population was owner, consultant, and contractors who work in the field of construction (Site engineer, Consultant Engineer, and Project manager) in Gaza Strip. The contractor's companies had valid registration according to the Palestinian Contractors Union (PCU) records. In Gaza Strip, all contractor classes are classified into five major categories, according to sizes, capitals, executed projects, equipment prices, and professional qualifications, according to the Union of Contractors in Gaza Strip; where the largest contractors are classified as class 1 and the smallest of class 5. In the study, the contracting companies with the classification of roads, water and sewage were targeted, the number of them reached 214 companies, according to the Contractors Union in Gaza Strip. As for consulting offices, all consultant offices classified with the Engineers Syndicate - Gaza Strip and those with a category A were targeted, the number of them reached 46 office. The primary owners in Gaza Strip, such as municipalities, ministries, and UNRWA were selected. The number of them reached 30. The total population in this study is 290.

4.4 Sample Size

A representative sample is chosen for allocating the questionnaire by using the following equation 4.1 (Daniel & Cross, 2018):

$$X = Z^2 \times P \times (1 - P)$$

$$n = \frac{N \times X}{((N-1) \times E^2 + X)} \ldots\ldots\ldots\ldots\ldots\ldots.. Eq. (4.1)$$

Where.

n: Sample size.

N: Population size (290)

Z: 1.96 for confidence level 95%

P: Maximum at P= 0.5

E: Maximum error (0.09)

The sample size for the population can be calculated from the previous equations as follows

$$X = 1.96^2 \times 0.5 \times (1 - 0.5) = 0.9604$$

$$n = \frac{290 \times 0.9604}{((290 - 1) \times 0.09^2 + 0.9604)} = 84$$

Based on the equation shows that the required sample size equal to 84. One hundred questionnaires were distributed to 100 companies randomly chosen within the target population in the study by e-mail with a refund of 91 questionnaires (response % = 91.0%). Thus, the total questionnaires recovered by google forms and valid for statistical analysis are 91 questionnaires.

4.5 Data Collection

In this study, the survey questionnaire was used to gather data between February and March 2020. Scanning by questionnaire can be the fastest and easiest method of collecting data and is more accurate when starting processing and analyzing these data. The research data was collected using primary sources through the distribution of a descriptive survey to the owners, consultants, and contractors who work in the field of construction, where the questionnaires were sent to respondents' e-mails via google forms. The researcher revised the filled questionnaires to certify the completion of all information needed.

4.6 Instruments of the Study

For data collection, a questionnaire was used. On the background of a literature review, and questionnaires concerning construction safety, a draft of the questionnaire was developed. Modifications then added after interviewing panels of experts to suit the local construction industry in Gaza Strip. Three experts representing two panels contacted to assess the questionnaire validity. The first panel, which consisted of two experts (one academic and one contractor), was asked to verify the validity of the questionnaire contents and its relevance to the research objective. The second panel, which consisted of one expert in statistics, was asked to identify that the instrument used was valid statistically and that the questionnaire was designed well enough to provide relations and tests among variables. Expert comments and suggestions were collected and evaluated carefully. Some minor changes, modifications, and additions were considered to the questions, and the final questionnaire was constructed. The content of the draft questionnaire was discussed with the supervisor of the thesis. A questionnaire was developed with closed and open-ended questions.

The questionnaire was designed in the English language (Appendix A-1). An Arabic version was designed to be easily understood and because the study was conducted in Gaza Strip. Unnecessary personal data, complex, and duplicated questions were avoided. The questionnaire was provided with a cover letter that explained the purpose of the study, way of responding, the aim of the research, and the security of the information in order to encourage high response.

4.7 Research Framework

In this section, we review the framework of the study and the eight stages that were followed, in addition to the activities and deliveries.

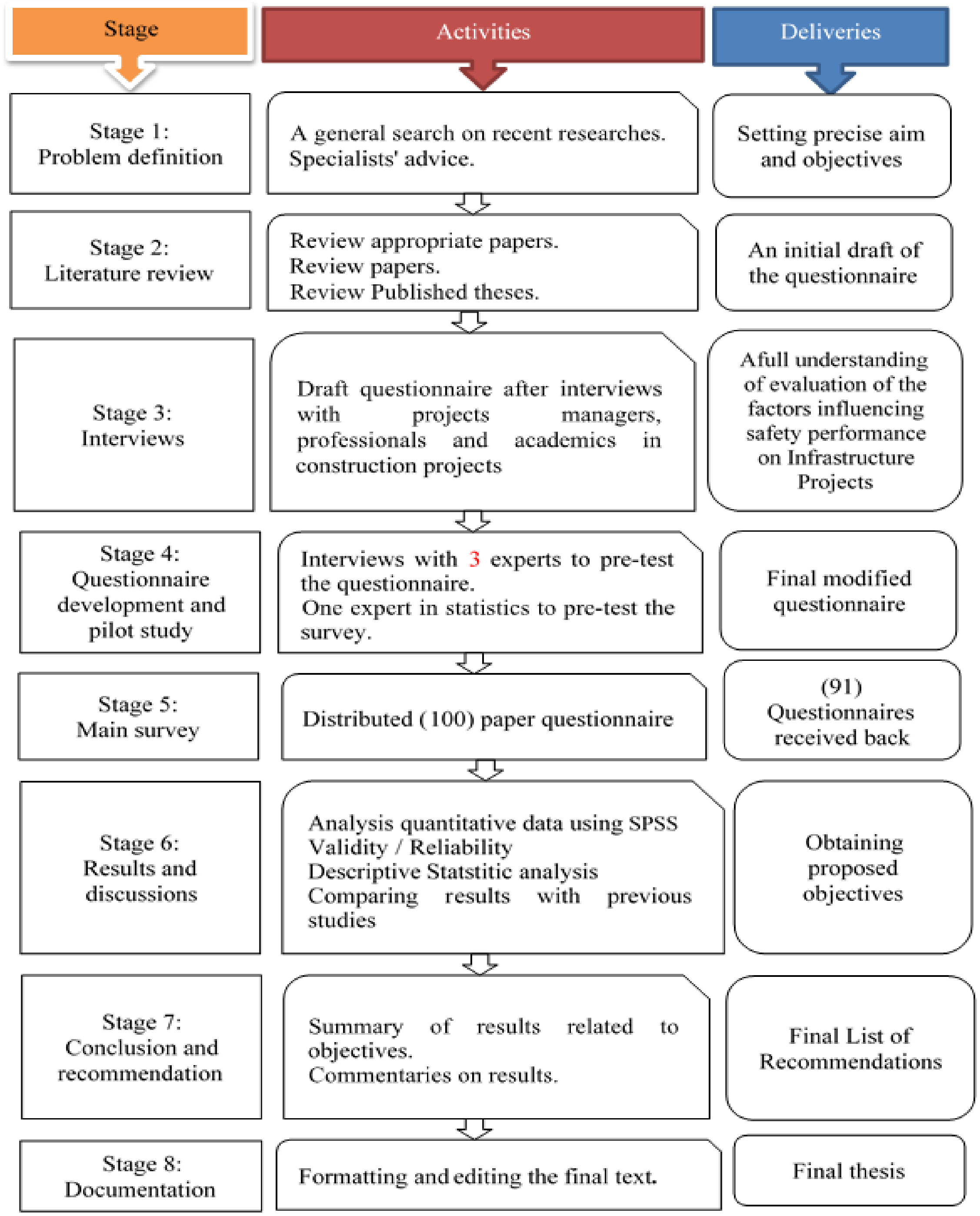


Figure 4.1: *Framework of methodology*

4.8 Questionnaire Design

The questionnaire design was composed of three parts to accomplish the objectives of the research, as follows:

- **Part A: Organization and Respondent Profile**

This part is used to determine the size, experience of respondents and companies, etc.

- **Part B: Information on Safety in Organization / Company**

This part is used to determine the safety situation (practice) and the perception of the respondents and companies. This part contains seven questions to evaluate the level of safety practice in the construction company.

- **Part C: Factors influencing the Safety Performance in infrastructure Projects**

This part includes the list of the factors affecting safety performance in the infrastructure industry in Table 4.1. It contains nineteen groups and a hundred and nineteen factors. These factors were prepared from the literature review (Mohammadi et al., 2018; Wong & Soo, 2019). The degree of impact is based on a five-point Likert scale. These five points are (very high), (high), (moderate), (low), and (very low).

Table 4.1: *List of 19 groups and Number of factors for each group*

No.	Name of Group	N. of Factors
1.	Motivation	6
2.	Project nature	7
3.	Work pressure	7
4.	Historic, human and psychological climate	10
5.	Emergency Planning and Preparation	2
6.	Signs, signals, and barricades	5
7.	Welfare facilities	8
8.	Safety culture and climate	5
9.	Attitude and behaviour	15
10.	Lesson learned from accidents	9
11.	The organization / The Company	8
12.	Safety programs and management systems	15
13.	Safety meeting	3
14.	Role of government and engineering societies	3
15.	Safety educating and training	3
16.	Disposal of hazardous materials and waste	3
17.	Personal protective equipment	3
18.	Safety and economic investment	4
19.	Work process	3

To determine the relative ranking of the factors these results were converted to significant indices based on a formula

Relative Importance Index $= \frac{\sum W}{AN} = \frac{5n_5+4n_4+3n_3+2n_2+1n_1}{5N}$

Where W is the weighting given to each factor by the respondent, ranging from 1 to 5, (n1 = number of respondents for very low, n2 = number of respondents for low, n3 = number of respondents for moderate, n4 = number of respondents for high, n5 = number of respondents for very high). A is the highest weight (i.e., 5 in the study), and N is the total number of samples. The relative importance index ranges from 0 to1.

4.9 Validity of Research

Validity relates to the level to which a tool tests what it is expected to calculate (Polit & Hungler, 1985). Validity has several different aspects, and assessment approaches. There are two ways to evaluate instrument validity: face validity and statistical validity, which include internal validity and structure validity.

4.9.1 Face validity

Face validity is the degree to which the examination is subjectively regarded as representing the definition that it purports to calculate. In other words, a test can be said to have face validity if it "looks like" it is going to amount to what it is supposed to measure (Gravetter, 2012; Holden, 2010). Several useful and important alterations and commentaries were made and take into consideration for the questionnaire.

4.9.2 Statistical validity

4.9.2.1 *Internal validity*

The internal validity of the questionnaire is calculated by a scouting survey composed of (25) questionnaires, by calculating the correlation coefficients between each paragraph in one field and the overall of the questionnaire. The significance values are less than 0.05 or 0.01. So, the correlation coefficients of all the groups are significant at $\alpha = 0.01$ (p-value < 0.01) or $\alpha = 0.05$ (0.01 < p-value < 0.05). It can be concluded that the items are valid to measure what it was set for to achieve the main purpose of the study. Appendix B shows the correlation coefficient and p-value for each field paragraph.

4.9.2.2 *Structural validity*

Structure validity is used to check the validity of the questionnaire structure by checking the validity of each field and the questionnaire validity as a whole. It calculates the coefficient of correlation between one group and all other groups. The results in table 4.2 clarify that groups are valid to be measured what it was set for to achieve the aim of the study.

4.10 Reliability

The reliability of the instrument is the degree of accuracy with which it calculates the attribute to be calculated (Polit & Hungler, 1985). For most purposes, the reliability coefficients above 0.7 are adequate. The researcher used two tests via the SPSS program to test the reliability of the questionnaire, Cronbach's coefficient alpha, and Half Split Method.

Table 4.2. *Structure Validity: Correlation coefficient between each factor and the whole factors*

No.	Factor	Correlation coefficient	P-value
1.	Motivation	0.712	0.000*
2.	Project nature	0.706	0.000*
3.	Work pressure	0.653	0.000*
4.	Historic, human and psychological climate	0.837	0.000*
5.	Emergency Planning and Preparation	0.805	0.000*
6.	Signs, signals, and barricades	0.729	0.000*
7.	Welfare facilities	0.684	0.000*
8.	Safety culture and climate	0.858	0.000*
9.	Attitude and behaviour	0.861	0.000*
10.	Lesson learned from accidents	0.809	0.000*
11.	The organization / The Company	0.648	0.000*
12.	Safety programs and management systems	0.860	0.000*
13.	Safety meeting	0.741	0.000*
14.	Role of government and engineering societies	0.685	0.000*
15.	Safety educating and training	0.767	0.000*
16.	Disposal of hazardous materials and waste	0.791	0.000*
17.	Personal protective equipment	0.764	0.000*
18.	Safety and economic investment	0.636	0.000*
19.	Work process	0.588	0.000*

* Correlation coefficient is significant at the $\alpha = 0.05$

* * Correlation coefficient is significant at the $\alpha = 0.01$

4.10.1 Cronbach's coefficient alpha

The approach is used to calculate the reliability of the questionnaire. The usual range of the alpha coefficient of Cronbach is between (0.00, + 1.00). Higher values represent a higher degree of internal consistency. As shown in table 4.3, the results were in the range from 0.807 and 0.969. This range is considered high; the result ensures the reliability of the questionnaire.

Table 4.3. *Cronbach's Coefficient Alpha for reliability (Cα)*

No.	Factor	Cronbach's Alpha (Cα)	Number of items
1.	Motivation	0.837	6
2.	Project nature	0.807	7
3.	Work pressure	0.883	7
4.	Historic, human, and psychological climate	0.879	10
5.	Emergency Planning and Preparation	0.889	2
6.	Signs, signals, and barricades	0.951	5
7.	Welfare facilities	0.865	8
8.	Safety culture and climate	0.900	5
9.	Attitude and behaviour	0.942	15
10.	Lesson learned from accidents	0.937	9
11.	The organization / The Company	0.898	8
12.	Safety programs and management systems	0.969	15
13.	Safety meeting	0.870	3
14.	Role of government and engineering societies	0.920	3
15.	Safety educating and training	0.909	3
16.	Disposal of hazardous materials and waste	0.854	3
17.	Personal protective equipment	0.942	3
18.	Safety and economic investment	0.839	4
19.	Work process	0.879	3
	All factors	**0.986**	**119**

4.10.2 Half split method

This approach depends on the discovery of a correlation coefficient between the means of items with an odd rank and the items with an even rank of each questionnaire element. Then, the correction of the correlation coefficient can be performed using the Spearman-Brown correlation coefficient of the correction. The revised correlation coefficient (consistency coefficient) is determined according to the following equation: consistency coefficient = $2r/(r+1)$, where r is the correlation coefficient. The standard range of the revised $2r/(r+1)$ correlation coefficient is between 0.0 and + 1.0. Table 4.4 clarifies the general reliability for all factors equal to 0.893. The significance values are less than 0.05, which indicates that the corrected correlation coefficients are significant at a=0.05. Therefore, according to the Half Split test, the factors analyzed were reliable.

Table 4.4. *Half Split coefficient method*

No.	Factor	Correlation Coefficient	Spearman-Brown Coefficient	Sig. (2-tailed)
1.	Motivation	0.743	0.852	0.000*
2.	Project nature	0.580	0.734	0.000*
3.	Work pressure	0.686	0.814	0.000*
4.	Historic, human, and psychological climate	0.728	0.843	0.000*
5.	Emergency Planning and Preparation	0.801	0.890	0.000*
6.	Signs, signals, and barricades	0.860	0.925	0.000*
7.	Welfare facilities	0.607	0.755	0.000*
8.	Safety culture and climate	0.753	0.859	0.000*
9.	Attitude and behaviour	0.656	0.792	0.000*
10.	Lesson learned from accidents	0.795	0.886	0.000*
11.	The organization / The Company	0.647	0.786	0.000*
12.	Safety programs and management systems	0.878	0.935	0.000*
13.	Safety meeting	0.682	0.811	0.000*
14.	Role of government and engineering societies	0.765	0.867	0.000*
15.	Safety educating and training	0.822	0.902	0.000*
16.	Disposal of hazardous materials and waste	0.652	0.789	0.000*
17.	Personal protective equipment	0.862	0.926	0.000*
18.	Safety and economic investment	0.579	0.733	0.000*
19.	Work process	0.726	0.841	0.000*
	All factors	**0.806**	**0.893**	**0.000***

* Correlation coefficient is significant at the $\alpha = 0.05$

* * Correlation coefficient is significant at the $\alpha = 0.01$

4.11 Measurements

The following measurements are carried out:

- Frequencies and Relative frequency.
- Statistical measures such as (mean and standard deviation)
- Relative Important Index
- Pearson's correlation coefficient, “product-moment correlation coefficient.”
- Cronbach's alpha and Half Split method for reliability statistics
- One sample t-test.
- Independent sample test. (T-test)
- One-way Analysis of Variance (ANOVA

5 RESULTS AND DISCUSSION

In this chapter, the results from field surveys collected were analyzed and discussed. The study used tables and statistics to provide a simpler and easier interpretation of the results. The study also discussed the results concerning the literature and earlier studies.

5.1 Organization Profiles

This section provides a description of the respondents who took part in this study. The results obtained from the questionnaire indicate that the study located in Gaza Strip was participated by 91 participants (68 contractors, 12 consultancy offices, and 11 owners). The next section identifies the profiles of those participants who took part in this survey. The characteristics of the participants are shown in Table 5.1

Table 5.1. *The characteristics of the participants*

Variable	Number	%
Organization		
Construction Company (Road - 1st class - A)*	6	6.6
Construction Company (Road - 1st class - B)*	8	8.8
Construction Company (Road - 2nd class)	16	17.6
Construction Company (Water&Sewage - 1st class)	14	15.4
Construction Company (Water&Sewage - 2nd class)	14	15.4
Construction Company (Water&Sewage - 3rd class)	10	11.0
Consultant Office	12	13.2
Owner	11	12.0
Title of the position of the respondent		
Contractor	12	13.2
Project Manager	27	29.6
Site Engineer	30	33.0
Consultant Engineer	22	24.2
Experience years of respondent		
From 1 – 10 years	55	60.4
From 11 – 20 years	31	34.1
From 21 – 30 years	4	4.4
More than 30 years	1	1.1
Experience years of the organization in constructions		
From 1 – 3 years	3	3.3
From 3 – 5 years	10	11.0
From 5 – 10 years	14	15.4
More than 10 years	64	70.3

Table 5.1. *(Continued)*

Variable	Number	%
Number of projects executed in the last five years		
Less than 10	21	23.1
From 11 – 20	24	26.4
From 21 – 30	27	29.7
More than 30	19	20.8
Value of executed projects during the last five years (in a million dollars)		
Less than 0.5	7	7.7
From 1 – 3	16	17.6
From 3 – 5	20	22.0
More than 5	48	52.7

* The criteria for classification between the two categories are the capital and the value of the implemented projects

5.2 Information Safety

5.2.1 Availability of Safety Professional / Department

Participants were investigated if their companies had a safety professional and/or safety department. Forty-seven per cent of the participants -70% contractors and 30% owners and consultants, - did not have a safety specialist or a team while 53 per cent had -79% contractors and 21% owners and consultants. -

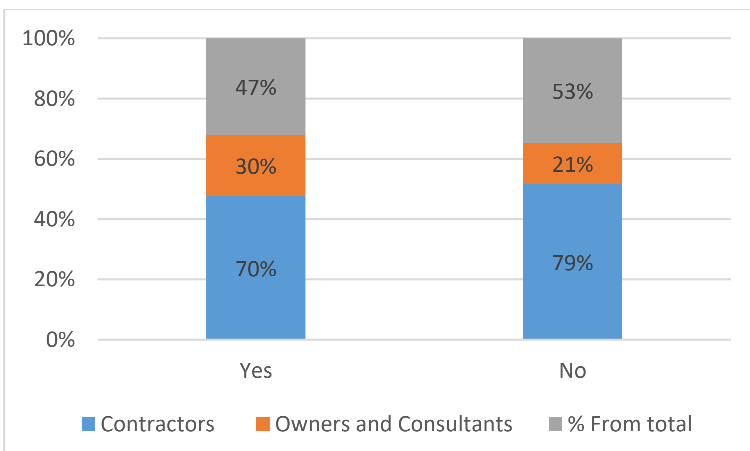


Figure 5.1. *Availability of safety professional / department*

5.2.2 Safety program or Manual

The participants were examined if their firms use a safety program or manual. 66% of the participants -75% contractors and 25% owners and consultants- are using a safety program or manual, while 34% of the participants -74% contractors and 26% owners and consultants- are not using a safety program at all.

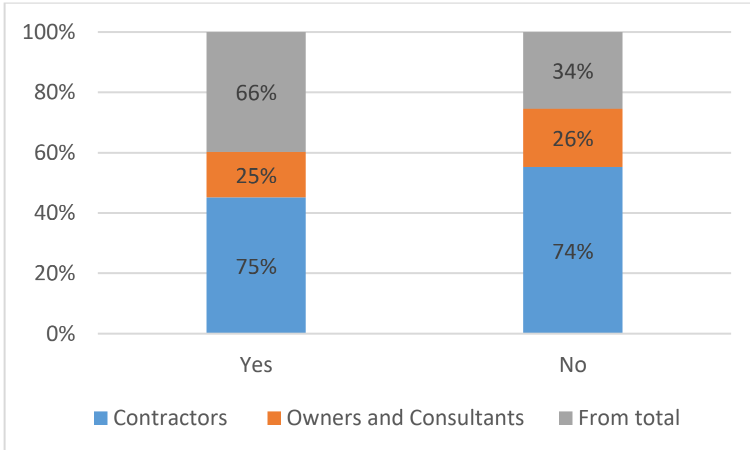


Figure 5.2. *Using of Safety program or manual*

5.2.3 Safety Knowledge

The participants were examined if they have information about safety situations, stipulations, and provisions. 59% of the participants -76% contractors and 24% owners and consultants- approve that they know about safety, 38% of the participants -71% contractors and 29% owners and consultants- agree that they have partial knowledge of safety. Just 3% of participants feel that they do not have adequate knowledge of safety, all of them from contractors.

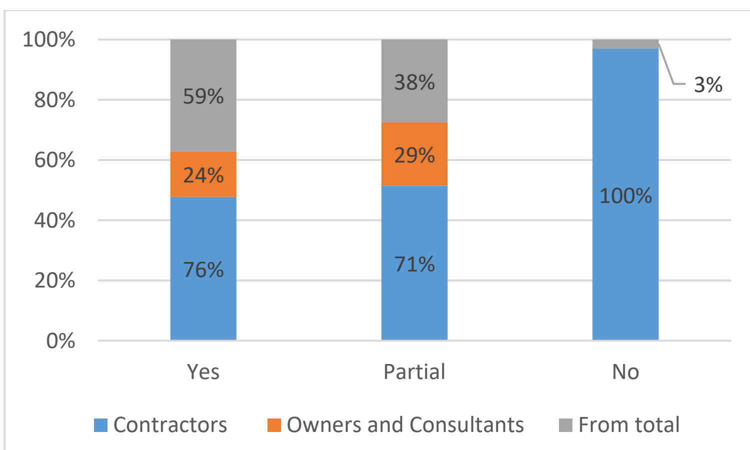
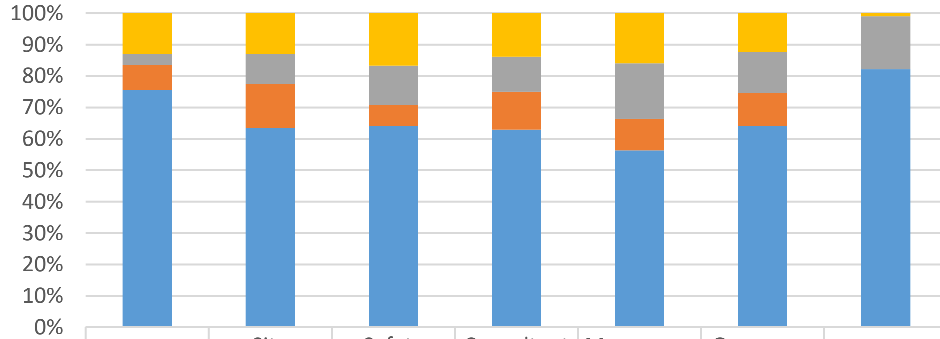


Figure 5.3. *The percentage of respondents to safety knowledge*

5.2.4 Responsibility of Safety Lacking

The participants were examined about their view on the responsibility of lacking safety through the construction on site. The parties that have the main responsibility for lacking safety on-site according to the respondents are site engineer 15%, safety engineer 20.0%, consultant engineer 16%, management 19.0%, and Government 14%. About 15% of the participants have an opinion that the worker is accountable for lacking safety on-site; only 1% answered the choice of others.



	Worker	Site Engineer	Safety Engineer	Consultant Engineer	Manageme nt	Governme nt	others
% From the total	15%	15%	20%	16%	19%	14%	1%
Consultant	4%	11%	15%	13%	21%	15%	17%
Owners	9%	16%	8%	14%	12%	12%	0%
Contractors	87%	73%	77%	73%	67%	73%	83%

Figure 5.4. *The percentage of respondents to the responsibility of safety lacking*

5.2.5 Financial Saving

The participants were asked if they expected any financial savings by complying with safety provisions. 46% of the participants -76% contractors and 24% owners and consultants- say that there are financial savings by complying with safety provisions, 30% of the participants -70% contractors and 30% owners and consultants- say sometimes, and 24% from respondents -77% contractors and 23% owners and consultants- say there is no financial saving.

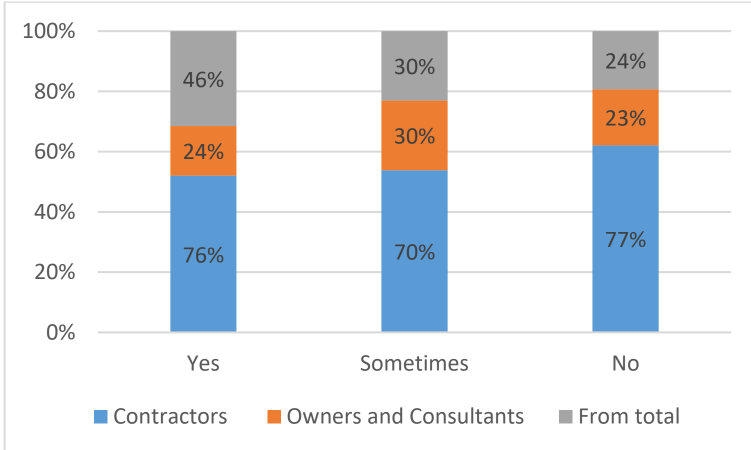


Figure 5.5. *The percentage of respondents to a financial saving*

5.2.6 A total number of disabling injuries during the last work year

Participants were questioned in the questionnaire about the number of injuries over the last working year. Table 5.2 indicates the number of injuries as the respondents reacted. The number of injuries is not an official number, but it only reflects the answers of the respondents.

Table 5.2. *Number of disabling injuries during the last work year in companies*

Total number	Frequency	%
0	20	22
1	14	15.4
2	17	18.7
3	13	14.3
4	6	6.6
5	9	9.9
6	2	2.2
7	1	1.1
8	5	5.5
9	1	1.1
15	1	1.1
20	1	1.1
29	1	1.1

5.2.7 Total number of workers in the company last work year

Participants were questioned in the questionnaire about the number of workers over the last working year. Table 5.3 indicates the number of workers as the respondents reacted.

Table 5.3. *Number of workers in company in last work year*

Total number	Frequency	%
From 1-100	78	58.7
From 101-200	7	7.7
From 201-300	3	3.3
From 301-400	1	1.1
From 401-500	2	2.2

5.3 Factor Affecting the Safety Performance in Infrastructure Projects

The third part of the questionnaire contains the factors affecting the performance of safety in infrastructure projects. It contains 119 factors into 19 groups. The groups were motivation; project nature; work pressure; historical, human and psychological climate; emergency planning and preparation; signs, signals, and barricades; Welfare facilities; Safety culture and climate; Attitude and behaviour; Lesson learned from accidents; The organization/ The Company; Safety programs and management systems; Safety meeting; Role of government and engineering societies; Safety educating and training; Disposal of hazardous materials and waste.

The interpretation of the factors of each group will be discussed in the following sections. These factors were subjected to the views of respondents. The researcher calculated the descriptive statistics, i.e., Means, Standard Deviations (SD), Relative Important Index (RII), P- values, and finally, the order of items.

5.3.1 Group 1: Motivation

This group consists of six factors related to "Motivation” and was ordered in the position 8th among all other groups with RII (0.722). Within this group of factors, respondents considered that “Reward and Penalty” was ordered in the 1st rank among the motivation group with RII (0.744). This result was not closed with (Mohammadi et al., 2018), who found an essential factor of the motivation group is “incentives.”, “Peer Pressure” was ordered in the last rank among the motivation group, RII (0.682). Table 5.4 shows the RII and rank for the group's factors.

Table 5.4. *RII and Rank of Motivation's group*

#	Motivation Factors	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Incentive Programs	3.64	1.11	72.80	5.47	0.000	4
2.	Job Satisfaction	3.64	1.07	72.80	5.68	0.000	3
3.	Job Motivators	3.56	1.12	71.20	4.78	0.000	5
4.	Peer Pressure	3.41	1.08	68.20	3.48	0.001	6
5.	Reward and Penalty	3.72	1.09	74.40	6.26	0.000	1
6.	Wage	3.71	1.26	74.20	5.41	0.000	2
All factors		**3.61**	**0.83**	**72.20**	**6.98**	**0.000**	

5.3.2 Group 2: Project nature

Table 5.5 shows the respondent's opinion about this group affecting the safety performance in infrastructure projects according to RII from high to low. The group consists of seven factors related to "Project nature." In general, this group was ranked in position 15th with respect to overall groups with RII (0.703). That means the overall project nature's factors strongly influence the safety performance conditions in infrastructure projects. Within this group of factors, "The arrangement and organization of the construction site" was ordered in the 1st rank among project nature group with RII (0.774). The results reflect the participants satisfied that the arrangement and organization of the construction site are critical to safety conditions. This factor is compatible with the findings of (Sawacha et al., 1999), which considered this factor to be of high importance in terms of safety performance. While (Alaqqad, 2009) was found this factor in the second position with RII (0.780), "The volume of the project" was ordered in 2nd rank, RII (0.724), within the project nature group. It represents the fact that respondents are satisfied that the volume of projects has an impact on the safety performance conditions of infrastructure projects.

Table 5.5. *RII and rank of project nature's group*

#	Project Nature Factors	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	The arrangement and organization of the construction site	3.87	1.05	77.40	7.92	0.000	1
2.	The volume of the project	3.62	0.90	72.40	6.49	0.000	2
3.	Cost of the project	3.40	0.97	68.00	3.91	0.000	6
4.	Application of new technology in the project	3.57	0.98	71.40	5.57	0.000	3
5.	Type of owner	3.45	1.13	69.00	3.81	0.000	5
6.	Complexity of the design	3.47	1.00	69.40	4.49	0.000	4
7.	Duration	3.23	1.08	64.60	2.05	0.044	7
All factors		**3.51**	**0.69**	**70.30**	**7.10**	**0.000**	

The results are relevant that the respondents are not satisfied with the importance of "duration" to improve the safety performance; this factor was ranked in the last position within this group with RII (0.646).

5.3.3 Group 3: Work Pressure

The group contains seven factors related to "Work pressure." This group was ordered in the position 14th with respect to overall groups with RII (0.708). "Fatigue and burnout" were ordered in the 1st rank among the work pressure group with RII (0.778), this reflects that fatigue and burnout influence the safety performance conditions in infrastructure projects. Overload work is the cause of fatigue (e.g., lack of sleep) that may deteriorate the physical condition of the worker (Guo, Yiu, & González, 2015; Han, Saba, Lee, Mohamed, & Peña-Mora, 2014; Jiang, Fang, & Zhang, 2015). “Working pace” was ordered in 2nd rank, RII (0.710), within the work pressure group. The results reflect that the respondents satisfy that working pace influence the safety performance conditions in infrastructure projects. “Schedule delay” was ordered in the last rank among the work pressure group, RII (0.676). Regard to the study of (Han et al., 2014) emphasizing that schedule delay is one of the significant factors affecting accident occurrence on the projects. Table 5.6 shows the RII and rank for the group's factors.

Table 5.6. *RII and rank of work pressure's group*

#	Work Pressure Factors	Mean	Std. Dev	RII (%)	Test value	P value Sig.	Rank
1.	Production pressure	3.54	1.06	70.80	4.86	0.000	3
2.	Working pace	3.55	0.92	71.00	5.57	0.000	2
3.	Work overload	3.40	1.09	68.00	3.45	0.001	6
4.	Fatigue and burnout	3.89	1.07	77.80	7.94	0.000	1
5.	Schedule delay	3.38	1.15	67.60	3.18	0.002	7
6.	Overtime work	3.54	1.12	70.80	4.59	0.000	4
7.	Working time	3.49	1.15	69.80	4.11	0.000	5
All factors		**3.54**	**0.83**	**70.80**	**6.20**	**0.000**	

5.3.4 Group 4: Historic, human, and psychological climate

The group contains ten factors related to "Historic, human and psychological climate." Table 5.7. This group was ranked in the position 16th concerning overall groups with a total RII (0.694). Inside this group, "Worker safety awareness" and “Worker accident’s experience” were ordered in 1st and 2nd rank, with RII of (0.754), (0.740), respectively. That reflects the respondents satisfy that worker safety awareness and accident’s experience influences the safety performance conditions in infrastructure projects. while “Worker marital status” was ordered in the last rank with RII of (0.610). The result of “Worker marital status” match with the findings of (Alaqqad, 2009) who believed that this factor could have the influence if we focus more on worker's aspects. The single worker has not life responsibilities like married workers; if the study focuses on the worker them, the result could be changed. The obtained results are agreed with (Sawacha et al., 1999; Teo et al., 2005), who observed the influential impact of worker marital status.

From these result we can observe that the respondents are not satisfied the importance or influence of the psychological climate at the labours such result could reflect a negative impact on the mayor's behaviour witch the labours as they consider the labours as a machine. The result will guide the decision-makers to consider the humanitarian aspects with their labours. The overall results within this group show that historical factors such as (experiences, safety awareness, and accident experience) have a stronger influence on the safety performance than the human factors like (relations, commutations).

Table 5.7. *RII and Rank of Historic, Human and Psychological Climate's group*

#	Historic, human and psychological climate factors	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Worker age	3.58	1.03	71.60	5.38	0.000	4
2.	Worker safety awareness	3.77	1.11	75.40	6.63	0.000	1
3.	Worker experience	3.67	1.01	73.40	6.32	0.000	3
4.	Worker education	3.33	1.17	66.60	2.70	0.008	8
5.	Worker marital status	3.05	1.09	61.00	0.48	0.631	10
6.	Knowledge and involvement	3.29	0.92	65.80	2.96	0.004	9
7.	Worker accident's experience	3.70	1.03	74.00	6.53	0.000	2
8.	The relation between management and workers on the site	3.36	1.06	67.20	3.27	0.002	7
9.	Interrelation between the workers on the construction site	3.46	0.95	69.20	4.65	0.000	6
10.	Work pressure of workers	3.47	1.17	69.40	3.86	0.000	5
All factors		**3.47**	**0.73**	**69.38**	**6.13**	**0.000**	

5.3.5 Group 5: Emergency planning and preparation

From Table 5.8, this group contained two factors and was ranked in the 9th position with respect to overall groups with RII (0.720). Within this group, two factors investigated to read this effect on safety performance. The results clarify that " Training worker to respond to emergency " was ordered in 1st rank among emergency planning and preparation group with RII (0.724). While " Development of a plan to respond to emergencies " was ordered in 2nd rank, with RII (0.716). This factor was ordered in the 1st rank by (M. O. Jannadi, 1995), in addition (Ng et al., 2005) found this factor in the 2nd rank with RII (0.810). These results are relatively close to our results that reflect the importance of training workers and the planning stage for the success of safety performance in the infrastructure projects.

Table 5.8. *RII and Rank of Emergency planning and preparation's group*

#	Emergency Planning and Preparation	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Development of a plan to respond to emergencies	3.58	1.16	71.60	4.81	0.000	2
2.	Training worker to respond to emergency	3.62	1.13	72.40	5.18	0.000	1
All factors		**3.60**	**1.09**	**71.98**	**5.26**	**0.000**	

5.3.6 Group 6: Signs, Signals, and Barricades factors

The group consists of five factors and ordered in 2nd rank with respect to overall groups with RII (0.789), which was revealed the importance of this group's respect to safety performance. Table 5.9 shows the results. "Barricades to close the construction site for the pedestrian" and "Using of danger signs" were ranked in the 1st and 2nd, respectively, with RII (0.806) and (0.800). This result revealed that the two factors have a critical influence on safety performance. Such signs could keep and director the labourers to take care of the surrounding situations, which inure protect the labour's life, also reflects that the respondents satisfy that barricades to close construction site for the strong influence the safety performance conditions in infrastructure projects.

"Use of traffic signals" was ordered in the last rank among Signs, signals, and barricades group, RII (0.768). This result could be traced to the small sites of projects in Gaza Strip's respect for construction projects. However, such results will not reflect a good indicator if we consider the infrastructure works where using the signs is too crucial for the safety conditions.

The overall results are closed from the results that were obtained from (Alaqqad, 2009) and relatively far away from the results that were obtained from (M. O. Jannadi, 1995) who found that group in the 9th rank, RII (0.662). The reasons could be returned to the different target groups in these studies, and the natural characteristics of the infrastructure projects.

Table 5.9. *RII and rank of signs, signals, and barricades' group*

#	Signs, signals, and barricades factors	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Use of danger signs	4.00	0.99	80.00	9.65	4.00	2
2.	Use of caution signs	3.99	0.90	79.80	10.48	0.000	3
3.	Use of instruction signs	3.87	1.09	77.40	7.62	0.000	4
4.	Use of traffic signals	3.84	1.14	76.80	7.00	0.000	5
5.	Barricades to close the construction site for the pedestrian	4.03	1.08	80.60	9.13	0.000	1
All factors		**3.95**	**0.95**	**78.90**	**9.45**	**0.000**	

5.3.7 Group 7: Welfare facilities

The group contains eight factors and ranked in the 19^{th} position with respect to overall groups with RII (0.655); Table 5.10 shows the results for this group. “First aid kits” was rank in 1^{st} position, with RII (0.782). The findings show that participants are satisfied that this factor is a critical factor affecting safety performance in infrastructure projects. The results reveal to the fact that the first aid is the first-line defence in case of anybody accidental (injuring) in the site. Therefore, the existence of these kits is critical for safety performance.

“Provision of food and drinking water” was ordered in 2^{nd} rank, with RII (0.692). While the results illustrated that; the respondents are not satisfied that the "Crucial care for injuries" will affect the safety performance. The respondents ranked this factor in 3^{rd} rank with RII (0.684). This result confirms again that the respondents do not take the humanitarian aspects with labor, and they just concentrate on the output products only. The results revealed that “Provision of special places for smoking” is not a crucial factor in obtaining safety performance. The obtained results are relatively matching (M. O. Jannadi, 1995) who found this group also in the position 16^{th} and with a low RII of (0.560), and approximately matching with (Alaqqad, 2009) who found this group also in the position 15^{th} and with a low RII of (0.674). On the other side, (Tam et al., 2004) found that “Provision of first aid” is a critical factor for safety performance with RII (0.811). The reason for the results could be traced to the fact that if the workers have not the willingness and tendency to take care of safety performance, it will be mean less to provide all the welfare facilities. No doubt, the benefit of this facility, but the important is the worker's culture towards the safety conditions.

Table 5.10. *RII and rank of welfare facilities' group*

#	Welfare facilities factors	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	First aid kits	3.91	1.01	78.20	8.64	0.000	1
2.	Provision of food and drinking water	3.46	0.98	69.20	4.49	0.000	2
3.	Provision of adequate toilets	3.41	1.12	68.20	3.48	0.001	4
4.	Provision of special places for smoking	2.71	1.19	54.20	-2.30	0.024	8
5.	Provision of an ambulance on the construction site	3.10	1.24	62.00	0.76	0.448	6
6.	Periodical medical examination of workers	3.16	1.20	63.20	1.32	0.192	5
7.	Permanent of a medical specialist on the construction site	3.04	1.26	60.80	0.33	0.741	7
8.	Crucial care for injuries	3.42	1.27	68.40	3.15	0.002	3
All factors		**3.28**	**0.83**	**65.55**	**3.18**	**0.002**	

5.3.8 Group 8: Safety culture and climate

This group consists of 5 factors ordered in the 6th rank with respect to overall groups with RII (0.734). “Leadership” was ranked in the 1st position with RII (0.748). The findings show that respondents are satisfied that (Leadership) is a critical and essential factor affecting safety performance in infrastructure projects. While “Supportive environment” was rank in the last position with RII of (0.712). The results could be matched with the fact that the construction work deserves comprehensive attention and care. This fact is shown clearly from the respondent's output as they ranked. Table 5.11 shows the results for this group’s factors.

Table 5.11. *RII and Rank of Safety culture and climate's group*

#	Safety culture and climate	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Safety climate	3.73	1.09	74.60	6.37	0.000	2
2.	Safety culture	3.71	1.04	74.20	6.58	0.000	3
3.	Supportive environment	3.56	1.17	71.20	4.58	0.000	5
4.	Leadership	3.74	1.18	74.80	5.94	0.000	1
5.	Supervisory environment	3.63	1.01	72.60	5.93	0.000	4
All factors		**3.67**	**0.93**	**73.45**	**6.91**	**0.000**	

5.3.9 Group 9: Attitude and behaviour

The group contains fifteen factors ordered in the 11th position among all other groups with RII (0.718). "Supervisor's attitude" was rank in 1st rank, RII (0.762). The findings show that respondents are satisfied that (Supervisor's attitude) is a critical and essential factor affecting safety performance in infrastructure projects. "Safety compliance" ordered in 2nd rank, RII (0.758) within attitude & behaviour group. "Emotional state" was rank in the last position with RII of (0.620). Table 5.12 shows the results for this group's factors.

Table 5.12. *RII and rank of attitude and behaviour's group*

#	Attitude and behaviour	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Supervisor's behavior	3.73	1.02	74.60	6.77	0.000	5
2.	Supervisor's attitude	3.81	0.98	76.20	7.94	0.000	1
3.	Supervisor's effectiveness	3.74	1.05	74.80	6.67	0.000	4
4.	Worker's behavior	3.63	1.09	72.60	5.47	0.000	7
5.	Worker's attitude	3.49	1.06	69.80	4.46	0.000	12
6.	Perceived behavior control	3.46	0.98	69.20	4.49	0.000	14
7.	Behavior feedback	3.48	1.08	69.60	4.28	0.000	13
8.	Participation for safety improvement (workers' involvement, cognitive and emotional engagement),	3.49	1.05	69.80	4.50	0.000	11
9.	Safety effort	3.59	1.01	71.80	5.60	0.000	8
10.	Personal responsibility for safety	3.76	1.07	75.20	6.77	0.000	3
11.	Risk-taking mindset/behavior	3.53	0.99	70.60	5.07	0.000	10
12.	Emotional state	3.10	1.15	62.00	0.82	0.412	15
13.	Risk perception	3.70	1.11	74.00	6.04	0.000	6
14.	Perceived safety state	3.59	1.14	71.80	4.99	0.000	9
15.	Safety compliance	3.79	1.13	75.80	6.68	0.000	2
All factors		**3.59**	**0.79**	**71.87**	**7.18**	**0.000**	

5.3.10 Group 10: Lesson learned from accidents

This group contains 9 factors and ordered in 17th rank overall groups with RII (0.680). Table 5.13 shows the results. "Lessons learned" was ordered in 1st rank, RII (0.714). The results show that participants are satisfied that (Lessons learned) is a critical factor affecting safety performance. "Willingness to investigate" was ordered in 2nd rank, RII (0.704), within Lesson learned from the accident group. "First aid rate" was rank in the last rank, RII (0.632).

Table 5.13. *RII and Rank of Lesson learned from accidents' group*

#	Lesson learned from accidents	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Accident rate (frequency and severity)	3.42	1.16	68.40	3.45	0.001	5
2.	Number of accidents	3.29	1.10	65.80	2.48	0.015	8
3.	Injury (death) rate/type	3.34	1.29	66.80	2.51	0.014	7
4.	First aid rate	3.16	1.07	63.20	1.47	0.144	9
5.	Safety inspection/ investigation	3.48	1.26	69.60	3.66	0.000	4
6.	Accident inspection/investigation	3.48	1.17	69.60	3.95	0.000	3
7.	Incidents control pressure	3.34	1.02	66.80	3.17	0.002	6
8.	Lessons learned	3.57	1.13	71.40	4.84	0.000	1
9.	Willingness to investigate	3.52	1.14	70.40	4.33	0.000	2
All factors		**3.40**	**0.94**	**68.01**	**4.07**	**0.000**	

5.3.11 Group 11: The organization / The Company

The group consists of eight factors and ordered in 18th rank among all other groups with RII (0.669). Table 5.14 shows the results for this group's factors. “Company reputation” was ordered in 1st rank with RII (0.752). The findings illustrate that respondents are considered that (Company reputation) is a critical factor affecting safety performance. While “Company size” was ordered in 2nd rank, RII (0.686) within the organization group. In the last rank was ordered “Company's revenue” with RII (0.604).

Table 5.14. *RII and rank of the organization / the Company's group*

#	The organization / The Company	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Company's revenue	3.02	1.11	60.40	0.19	0.850	8
2.	Company reputation	3.76	1.04	75.20	6.98	0.000	1
3.	Company's costs	3.37	1.04	67.40	3.43	0.001	3
4.	Company size	3.43	1.02	68.60	3.99	0.000	2
5.	Client's control	3.30	1.07	66.00	2.65	0.010	5
6.	The involvement of subcontractors	3.37	1.12	67.40	3.18	0.002	4
7.	The number of subcontractors	3.24	1.12	64.80	2.06	0.042	7
8.	The number of employees/crew size	3.30	1.09	66.00	2.60	0.011	6
All factors		**3.35**	**0.82**	**66.98**	**4.05**	**0.000**	

5.3.12 Group 12: Safety programs and management systems

This group contains fifteen factors and ordered in 13th rank among all other groups with RII (0.711). The "Safety programs" were ordered in 1st rank with RII (0.748). The results show that respondents are considering that (Safety programs) are a critical factor affecting safety performance. while the "Safety control mechanisms" were ordered in 2nd rank with RII (0.738) within Safety programs and management systems group. "Limited management time" was rank in the last rank with RII (0.642). Table 5.15 shows the findings for factors in this group.

Table 5.15. *RII and rank of safety programs and management systems' group*

#	Safety programs and management systems	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Safety programs	3.74	1.05	74.80	6.67	0.000	1
2.	Safety management systems	3.66	1.02	73.20	6.14	0.000	6
3.	Communication and information	3.51	0.97	70.20	4.97	0.000	12
4.	Limited management time	3.21	1.01	64.20	1.98	0.051	15
5.	Management commitment	3.52	1.02	70.40	4.85	0.000	10
6.	Risk assessment implementation/thoroughness	3.67	1.00	73.40	6.39	0.000	3
7.	Safety policies and procedures	3.67	1.12	73.40	5.73	0.000	4
8.	Management work pressure	3.52	1.07	70.40	4.61	0.000	11
9.	Pre-hire screening of employees	3.31	1.14	66.20	2.57	0.012	14
10.	Management focus on safety	3.55	1.12	71.00	4.69	0.000	9
11.	Management concern/involvement	3.46	1.15	69.20	3.84	0.000	13
12.	Safety instructions	3.63	1.19	72.60	5.02	0.000	7
13.	Safety control mechanisms	3.69	1.15	73.80	5.73	0.000	2
14.	Safety management practices	3.67	1.19	73.40	5.36	0.000	5
15.	Management skills	3.58	1.08	71.60	5.17	0.000	8
All factors		**3.56**	**0.91**	**71.16**	**5.86**	**0.000**	

5.3.13 Group 13: Safety meeting

The group of factors "safety meetings" consists of 3 factors and ordered in 12th rank respect to overall nineteen groups with RII (0.715). Table 5.16 shows the factors' results in this group. "Conducting a safety meeting on the construction site by the site engineer" was ordered in 1st rank with RII (0.746). The results indicate that the site engineer has a critical responsibility to advance the degree of awareness in the worker's safety performance. The periodic meeting with workers will enhance the importance of the concept of safety and will benefit the workers, which in turn enhances their culture in this direction. These results are agreed with (Kartam, Flood, & Koushki, 2000), who found essential benefits for the improvement of safety performance from the weekly meetings.

"Conducting a safety meeting before each activity begins" was ordered in 2nd rank with RII (0.730). That results in ensuring that the holding of meetings before each activity may not be significant, leads to uncontrollable delays and managerial work difficulties.

While "Conducting safety meetings by the safety committee" was ordered in 3rd rank with RII (0.670). The obtained results are relatively matching (Alaqqad, 2009), who found this group also in the position 10th and with a low RII of (0.754). The overall pictures reflect that since such meetings occurred naturally without during the works, the meeting done by site engineer is the most appropriate one. This guidance and advice from the site engineer will simply enhance and improve the level of awareness and knowledge for the works.

Table 5.16. *RII and rank of safety meeting's group*

#	Safety Meeting	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Conducting a safety meeting on the construction site by the site engineer	3.73	1.04	74.60	6.67	0.000	1
2.	Conducting a safety meeting before each activity begins	3.65	1.06	73.00	5.73	0.000	2
3.	Conducting safety meetings by the safety committee	3.35	1.21	67.00	6.39	0.000	3
All factors		**3.58**	**0.99**	**71.50**	**5.73**	**0.000**	

5.3.14 Group 14: Role of government and engineering societies

This group contains four factors and ordered in 4th rank for overall groups with RII (0.770), which indicates the critical impact and importance of these factors at the performance of safety in the construction process in Gaza strip. The results of the group's factors, as illustrated in table 5.17, while (Wong & Soo, 2019) found this group in 2nd rank with RII (0.868). Within this group, it is demonstrated that, with RII (0.774), "Strict implementation of safety instructions" was ordered in 1st rank. The results indicate that the strict implementation of safety instructions is essential. Tender documents contain safety laws, but they are not implemented in the construction phase. These results disagree with (Tam et al., 2004), who found this factor in 6th rank with RII (0.511); on the other hand, these results agree with (Alaqqad, 2009) who found this factor in 1st rank with RII (0.808). The reason for this deviation could be to return to the culture of workers and contractors towards self-motivation and monitoring, although there is no external monitoring.

Finding also shows that "Issuance of laws, standards, and regulations for safety" was ordered in 2nd rank with RII (0.772). "The punishment in case of violation of laws, standards, regulations & legislations of safety" was ranked in 3rd position with RII of (0.768). The result shows that government and engineering societies should deliver consequences to ensure that the safety regulations contained in the contract are implemented. These results were agreed with (Ng et al., 2005), who found this factor among the three most influencing safety performance factors.

Table 5.17. *RII and rank of the role of government and engineering societies' group*

#	Role of government and engineering societies	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Strict implementation of safety instructions	3.87	1.08	77.40	7.69	0.000	1
2.	Punishment in case of violation of laws, Standards regulation, and legislation of safety	3.84	1.15	76.80	6.94	0.000	3
3.	Issuance of laws, standards, and regulations for safety	3.86	1.05	77.20	7.92	0.000	2
All factors		**3.85**	**0.98**	**77.00**	**8.31**	**0.000**	

5.3.15 Group 15: Safety Educating and Training

This group contained three factors and was ordered in 5th rank among overall groups with RII (0.744). Within this group show that "Understating the usage of protective equipment" was ordered in 1st rank with RII (0.760). Finding also shows that "Cultivating the awareness of accident risks" was ordered in 2nd rank with RII (0.740). "First aid and emergency procedures" was ordered in 3rd rank with RII of (0.730). The results will alarm the decision-makers to ask the contractors or the sub-contractors to provide certified, showing their understanding of the safety conditions, problems, and solutions in infrastructure projects. Table 5.18 summarizes the factors related to Safety educating & training factors affecting safety performance. These results disagree with (Alaqqad, 2009) who found this group in 13th rank with RII (0.733).

Table 5.18. *RII and rank of safety educating and training's group*

#	Safety Educating and Training	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Cultivating the awareness of accident risks	3.70	1.01	74.00	6.67	0.000	2
2.	Understating the usage of protective equipment	3.80	0.97	76.00	7.90	0.000	1
3.	First aid and emergency procedures	3.65	1.10	73.00	5.63	0.000	3
All factors		**3.72**	**0.94**	**74.36**	**7.26**	**0.000**	

5.3.16 Group 16: Disposal of hazardous materials and waste

This group contained three factors and was ordered in 7th rank with respect to overall groups with RII (0.726). Within this group show that "Development of a risk management plan" was ordered in 1st rank with RII (0.750). This result is very close to (M. O. Jannadi, 1995) results which found the RII of this factor as (0.762).

"Develop a management plan for waste" was ranked in the 2nd position with RII (0.718). The infrastructure projects in Gaza Strip are relatively small compared to developed countries, so the quantities of wastes are small, and it may be in critical need for such a plan. The results also show that the "Quick transfer of construction waste out site" is not reflecting a strong safety performance level, which means respondents are not satisfied that the faster transform or transport of the construction waste material will be a strong indicator of the safety performance. The author of this thesis agrees with this trend, as the quick transform is not generally critical for the safety conditions.

In previous studies, (M. O. Jannadi, 1995) found this group in the ordered 14th, RII (0.611), (Alaqqad, 2009) found this group in the ordered 12th with RII (0.741), and (Wong & Soo, 2019) found this group in the ordered 11th with RII (0.734). Table 5.19 shows the results.

Table 5.19. *RII and rank of disposal of hazardous materials and waste's group*

#	Disposal of hazardous materials and waste	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Development of a risk management plan	3.75	1.06	75.00	6.72	0.000	1
2.	Development of a waste management plan	3.59	1.03	71.80	5.48	0.000	2
3.	Quick transfer of construction wastes out of the construction site	3.55	1.11	71.00	4.73	0.000	3
All factors		**3.63**	**0.94**	**72.60**	**6.40**	**0.000**	

5.3.17 Group 17: Personal Protective Equipment

This group contains 3 factors shows in table 5.20 and was ordered in 1st position among all other groups (19 groups) with RII (0.804). This result emphasizes that the Personal Protective Equipment (PPE) is essential for any industrial construction and each infrastructure project. "Use of protective foot" was ranked in 1st position with RII (0.816). The importance of this factor could be returned to the fact that the study was carried out on infrastructure projects such as roads, water, and sewage. This type of project is in which foot protection comes first before protecting the head with the importance of wearing a helmet for safety, this is what the results show, and that does not coincide with the results of a study was conducted on construction projects. This factor was ordered in third place, according to a study. This will reflect why this factor was ranked in the highest position within the group.

"Use of protective head" was ordered with RII (0.804) in the second rank. This result shows respondents were supportive of that PPE. "The use of protective clothing" was ordered in 3rd rank with RII (0.792). The results show that these three factors are too critical for safety performance measurements. The reasons could be returned to the fact that the hands, face, and feet are the critical enablers for any person to do any task professionally and especially the labours in the infrastructure projects.

Table 5.20. *RII and Rank of Personal protective equipment's group*

#	Personal protective equipment	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	The use of protective head	4.02	1.11	80.40	8.82	0.000	2
2.	Use of protective foot	4.08	1.09	81.60	9.45	0.000	1
3.	The use of protective clothing	3.96	1.13	79.20	8.04	0.000	3
All factors		**4.02**	**1.05**	**80.37**	**9.25**	**0.000**	

The overall group of these factors corresponds to the (O. A. Jannadi & Bu-Khamsin, 2002) who found this factor in the first ranked with RII (0.801), and (Alaqqad, 2009; Wong & Soo, 2019) who also found this factor in the 1st ranked with RII (0.889) and (0.868) respectively, but relatively far from (Sawacha et al., 1999) who found this factor in 3rd ranked, but with low RII (0.681), Also, the result obtained by (Tam et al., 2004) shows this group in a position 13th with RII (0.62). Such deviation among the importance of these factors could be traced to the fact that using such PPE in the infrastructure projects in the developed countries is a normal issue. Moreover, each labour wears gloves and face protection normally without any pressure, but in the developing countries and according to the labours culture they may not have the willingness to do this normally.

5.3.18 Group 18: Safety and economic investment

This group contained four factors and was ordered in 10th position among 19 groups with RII (0.719). These results almost matched to (Alaqqad, 2009; Wong & Soo, 2019), who found this group was ranked 11th with RII (0.742) and 12th with RII (0.730), respectively.

Within the group, "Safety incentives" were ordered in 1st rank with RII (0.740). Whilst, “Allocation of a specific budget for safety requirements" was ranked in 2nd position with RII (0.732). These results indicated that respondents take in their account at pricing the tender's documents the safety regulations and instructions as the contract required that they were assured for this factor, so the factors did not take the high rank. The overall results obtained by these factors are in line with (O. A. Jannadi & Bu-Khamsin, 2002; Tam et al., 2004), who shows influence factors towards safety performance. Table 5.21 shows the findings for this group’s factors.

Table 5.21. *RII and Rank of Safety and economic investment's group*

#	Safety and economic investment	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Safety incentives	3.70	1.18	74.00	5.69	0.000	1
2.	Allocation of a specific budget for safety requirements	3.66	1.11	73.20	5.68	0.000	2
3.	Cost of accidents	3.59	1.02	71.80	5.54	0.000	3
4.	The return of investment (ROI) on safety	3.43	1.10	68.60	3.73	0.000	4
All factors		**3.60**	**0.91**	**71.92**	**6.28**	**0.000**	

5.3.19 Group 19: Work process

This group was ordered in 3rd position among 19 groups with RII (0.779) in this study, and it contains 3 factors, while (Wong & Soo, 2019) found the rank for this group was 8th with RII (0.794). The results of the group's factors shown in Table 5.22.

"Excavation and trenching" have been ranked in 1st position with RII (0.786). This result showed that the participants were less interested in the obstacles expected to be found in work that adversely affected the performance of safety. The results obtained from (Hassan, Basha, & Hanafi, 2007) show a rank for this factor in 8th ranked with RII (0.672). While results obtained from (M. O. Jannadi, 1995) show higher with RII (0.871).

“Scaffolds and transportation" were ranked in 2nd position with RII (0.780). This result clarifies that the factor has a strong influence on safety performance on infrastructure projects. The scaffolding characterizes the main source of accidents because they are fixing on highly place in construction projects. Besides, these results are sustained by (Enshassi, 2003; O. A. Jannadi & Bu-Khamsin, 2002; Sawacha et al., 1999). "Crane and lifting equipment" was ranked in 3rd rank with RII (0.772). The crane and lifting equipment are used in infrastructure projects in our country, like other countries in construction works. Such a job has a great role in influencing the level of safety.

Table 5.22. *RII and rank of work process' group*

#	Work process	Mean	Std. Dev	RII (%)	Test value	P-value Sig.	Rank
1.	Crane and lifting equipment	3.86	1.08	77.20	7.57	0.000	3
2.	Excavation and trenching	3.93	1.02	78.60	8.74	0.000	1
3.	Scaffolds and transportation	3.90	1.12	78.00	7.70	0.000	2
All factors		**3.90**	**0.96**	**77.95**	**8.89**	**0.000**	

5.3.20 Summary ranks of groups affecting safety performance on infrastructure projects

Table 5.23 shows the summary of ranks for 19 groups, exemplified that, group of factors related to "Personal Protective Equipment's" was ordered in 1st rank among the nineteen groups with RII (0.804). The importance of this group of factors returned to the fact; such a group includes the main equipment that protects the worker from the daily working accidents. The protection of the head, eyes, nose, hands, and feet are covered in this group factor; this will be considering the first defence line to protect the workers and influence safety performance. The obtained results are very close to (Alaqqad, 2009; O. A. Jannadi & Bu-Khamsin, 2002; Wong & Soo, 2019) who found these factors (PPE) in the first position which reflects how important this factor is in influencing safety performance in construction projects for various construction companies around the world. Results shown in Table 5.24 illustrated that a group of factors including "Signs, Signals, and Barricades" was ranked in the second position respect to the remaining nineteen (19) group of factors with RII (0.789). The importance of this group returned to following reasons:

- These signs and signals are easy to be understood and critical to saving worker's efforts and lives during the working days.
- These signs could arrange the worker's conditions and working places and create pre-emptive guidance for the pedestrians (not to enter the site) and workers (during the working hours) to draw their attention to the site conditions.
- The workload desires a warning, caution, and instruction signs and signals to remain the workers in standing and ready for any unexpected events.

The results were shown in Table 5.24 also illustrated that the group of factors, including "welfare facilities" was ordered in the last ranked with RII (0.656). Relatively, the impact of this factor on safety performance is little. From our point of view, the respondents did not consider this factor in the critical position for the following:

- The welfare facilities mean additional expenditures without revenue.
- Our contractors, consultant, and owners' culture, they believe that more welfare facilities will reduce worker's productivity.

Table 5.23. *Ranks of Groups of Factors Affecting Safety Performance*

Groups of Factors	**RII**	**Rank**
Personal protective equipment	0.804	1
Signs, signals, and barricades	0.789	2
Work process	0.779	3
Role of government and engineering societies	0.770	4
Safety educating and training	0.744	5
Safety culture and climate	0.735	6
Disposal of hazardous materials and waste	0.726	7
Motivation	0.722	8
Emergency Planning and Preparation	0.720	9
Safety and economic investment	0.719	10
Attitude and behaviour	0.719	11
Safety meeting	0.715	12
Safety programs and management systems	0.712	13
Work pressure	0.708	14
Project nature	0.703	15
Historic, human, and psychological climate	0.694	16
Lesson learned from accidents	0.680	17
The organization / The Company	0.670	18
Welfare facilities	0.656	19

5.4 Kendall Coefficient of Concordance Tests

The hypotheses explain the relationships between variables and clarify the search results framework. The researcher, when formulating hypotheses on the subject of the research, puts the hypotheses, which he believes leads to an interpretation of the research problem. This hypothesis was to analyze the differences among opinions of respondents toward the factors affecting the safety performance in infrastructure projects due to profile information for respondents

5.4.1 First hypothesis

"There is no difference in the correspondence about the factors affecting the safety performance in infrastructure projects between (contractors and owners) at a significant level $\alpha = 0.05$."

Independent samples t-test provides a statistical test of whether the means of two groups are equal or not. The critical value of t = 1.99. Therefore, an independent samples t-test was used to test the differences among the opinions of the respondents taking into account their organization (contractors and owners). As shown in Table 5.24, the P-value for the Levene's test is higher than 0.05. Thus, the variances of the two groups (contractors and owners) are not significantly different (the groups are homogeneous). Besides, according to the results of the Independent samples t-test, as shown in Table 5.24, the significance values are not significant (P-value > 0.05). The absolute values of the t-test also less than the critical value of t (1.99). Thus, there are no statistically significant differences at the level of $\alpha \leq 0.05$ between the Means of their views about factors affecting the safety performance in infrastructure projects

Table 5.24. *Independent samples t-test between contractors and owners*

Field	Levene's test for equality of variances		t-test	P-value	Mean	
	F	P-value (Sig.)			contractors	owners
Factors Affecting the Safety Performance in Infrastructure projects	1.640	0.204	1.277	0.205	3.54	3.81
Critical value of t: at degree of freedom (df) = [N-2] = [79-2] = 77 and at significance (Probability) level 0.05 equals "1.99". *. The Mean difference is significant at the 0.05 level						

5.4.2 Second hypothesis

"There is no difference in the correspondence about the factors affecting the safety performance in infrastructure projects due to Respondent's Experience years at significant level $\alpha = 0.05$."

To check the hypothesis, we used one-way ANOVA, and table 5.25 shows that the p-value equals 0.009, which is less than < 5%, and the value of F is equal 4.07 that is greater than the value of critical value, which equals 2.71. The statistical results were shown in table 5.25 illustrated that there is a difference of opinion between (1 – 10 years, 11 – 20 years, 21 – 30 years, and More than 30 years) regarding the factors affecting safety performance. The result shows that the (p-value) was (0.009), which is less than (0.05). This deviation could be returned to the following reasons: the four categories of respondents have different fields of experience in the building, roads, and water sewage works, and like the safety conditions in the building projects are relatively different from the infrastructure projects such deviation in the perceptions have appeared.

Table 5.25. *One-way ANOVA -respondent's experience years*

Field	**Statistics**	**Sum of Squares**	**DF**	**Mean Square**	**F-Value**	**Sig. (P-Value)**
Factors Affecting the Safety Performance in Infrastructure projects	Between Groups	4.834	3	1.611	4.07	0.009
	Within Groups	34.470	87	0.396		
	Total	39.304	90			

The critical value of F at DF "3, 87" and significance level 0.05 equal 2.71

Furthermore, therefore, the Scheffe test was used for multiple comparisons between the Means of the opinions of the respondents taking into account their experience.

Table 5.26 shows that there is a difference between the averages of the opinions of the respondents who have (From 1 - 10 years) and the respondents who have (From 11 - 20 years) in favour of the respondents who have (From 11 - 20 years).

Table 5.26. *Results of Scheffe test for multiple comparisons due to experience years*

Mean difference	From 1 - 10 years	From 11 - 20 years	From 21 - 30 years
From 1 - 10 years		-0.425*	0.098
From 11 - 20 years	0.425*		0.523
From 21 - 30 years	-0.098	-0.523	

5.4.3 Third hypothesis

"There is no difference in the correspondence about the factors affecting the safety performance in infrastructure projects due to the company's experience in construction at significant level α = 0.05."

One-way ANOVA used to test the hypothesis. Results in Table 5.27 clarify that the p-value is greater than 0.05, and the value of F is equal 2.10 that is smaller than the value of critical value, which equals 2.71. That means there is no difference in the correspondence at the factors affecting the safety performance in infrastructure projects due to the company's experience in construction at a significant level 0.05. The consistency in the agreement level between respondents in this part reflects the importance of these factors in safety performance strongly. Moreover, this indicates that the companies that have more than (10) years of experience and have less than (3) years, experience are relatively consistent in the agreement level towards essential factors. That gives good indicators that the companies have the right to continue in the safety process.

Table 5.27. *One-way ANOVA -company's experience in construction*

Field	Statistics	Sum of Squares	DF	Mean Square	F-Value	Sig. (P-Value)
Factors Affecting the Safety Performance in Infrastructure projects	Between Groups	2.658	3	0.886	2.10	0.106
	Within Groups	36.646	87	0.421		
	Total	39.304	90			

The critical value of F at DF "3, 87" and significance level 0.05 equal 2.71

5.4.4 Fourth hypothesis

"There is no difference in the correspondence about the factors affecting the safety performance in infrastructure projects due to the number of projects executed in the last five years at significant level α = 0.05."

One-way ANOVA used to test the hypothesis. Results in Table 5.28 clarify that p-value > 0.05 and the value of F is equal to 0.91, which is smaller than the value of critical value, which equals 2.71. That means there is no difference in the correspondence at the factors affecting the safety performance in infrastructure projects due to several projects executed in the last five years at a significant level 0.05.

Table 5.28. *One-way ANOVA - Number of projects executed in the last five years*

Field	Statistics	Sum of Squares	DF	Mean Square	F-Value	Sig. (P-Value)
Factors Affecting the Safety Performance in Infrastructure projects	Between Groups	1.191	3	0.397	0.91	0.442
	Within Groups	38.113	87	0.438		
	Total	39.304	90			

The critical value of F at DF "3, 87" and significance level 0.05 equal 2.71

5.4.5 Fifth hypothesis

"There is no difference in the correspondence about the factors affecting the safety performance in infrastructure projects due to the value of executed projects during the last five years at significant level α = 0.05."

One-way ANOVA used to test the hypothesis. Results in Table 5.29 clarify that p-value > 0.05. That means there is no difference in the correspondence at the factors affecting the safety performance in infrastructure projects due to the value of executed projects during the last five years at significant level 0.05.

Table 5.29. *One-way ANOVA- Value of executed projects during the last five years*

Field		Statistics	Sum of Squares	DF	Mean Square	F-Value	Sig. (P-Value)
Factors Affecting the Safety Performance in Infrastructure projects	Contractor	Between Groups	0.921	3	0.307	0.703	0.554
		Within Groups	27.934	64	0.436		
		Total	28.855	67			
	Owner	Between Groups	1.168	2	0.584	1.549	0.270
		Within Groups	3.015	8	0.377		
		Total	4.183	10			

6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This chapter includes the conclusion and recommendations to the evaluation of the factors influencing safety performance on infrastructure projects in Gaza Strip. A literature review was carried out to identify the factors affecting safety performance in infrastructure projects. This study aims to identify the factors affecting the safety performance in infrastructure projects in Gaza Strip and to determine whether there is a relationship between the profile of the participants and the factors influencing infrastructure projects by applying hypotheses.

In this study, 119 factors were highlighted, which influence safety performance in infrastructure projects grouped into nineteen groups. These factors were introduced via a questionnaire that was carefully designed to achieve the research objectives. The degree of impact of the factors on the safety performance in the respondents was assessed based on a Likert scale of five points. The sample size was eighty-four participants between owners, consultant offices, and the company of construction in Gaza Strip, which participated in this study. These companies were qualified and registered in the PCU and classified as first, second, or third categories at roads, water, and sewage while consultant offices classified with the Engineers Syndicate - Gaza Strip.

The data collected through the questionnaires were statistically analyzed to compute the importance index of each factor presented to the respondents on the questionnaire, so these factors were ranked accordingly. The rank concordance and the hypothesis of agreement on ranking between the elements of the study have been tested. Construction companies could use the findings of this study to evaluate and assess their safety performance and practice relative to other construction companies, and to identify the reasons for success or failure.

The key results from the analysis may be taken,

1. By the analysis' results, 56% of the contractors that were analyzed have a professional safety and/or department, in comparison, 44% have not, and 44% of the consultant offices and owners have a professional safety and/or department while 56% have not. On the same line, 66% of the participated contractors, consultant offices, and owners are using a safety program or manual. On the other hand, through the results, it was

found that most of the survey participants have full knowledge of safety conditions, which represents 59%. In comparison, 38% have partial knowledge; only 3% do not know safety conditions. It can be concluded that the companies, which have not safety professional or department, are unnecessary mean that is not using a partially safety program or manual.

2. The parties that have the primary responsibility of lacking safety during the construction in the site, according to the respondents, are safety engineers, management, and consultant engineer, respectively. The worker came after the above parties in the responsibility for safety lacking. At the same time, 1% of respondents see that the responsibility rests with other parties that were not part of the survey options, such as the owner, the designer, the Engineers Syndicate, and the donor, and finally, because there is no fund for safety.
3. Forty-six per cent of the respondents agree that there is a financial saving by complying with safety provisions. Whereas 30% of participants have seen that partial financial savings will be made when applying safety provisions, conditions, and specifications. Just 24% of respondents answered that there would be no financial savings when applying safety conditions.
4. The most important groups affecting the safety performance agreed by owners, consultant offices, and construction companies in Gaza Strip are personal protective equipment, signs, signals, and barricades, work processes, the role of government and engineering societies, and safety educating and training. Besides, those for factors are Use of the protective foot; Barricades to close the construction site for the pedestrian; Use of the protective head; Use of danger signs; and Use of caution signs, respectively.
5. The results of the study show that the group of PPE has ranked first among the rest of the groups in affecting on safety performance, the reason may be due to the culture of the region or country in which the study was conducted. Perhaps if the survey was conducted in another country with a different culture, maybe this group does not get the same arrangement in influencing on safety performance in infrastructure projects.
6. Most companies 'accident data are not adequately documented, or data is considered confidential and not permitted to others, as they feared a bad reputation or further legal responsibility even though these data were only for scientific research.

6.2 Recommendations

The next points can be recommended based on the conclusions previously identified and the results obtained from this study, Which decision-makers in the infrastructure sector in the Gaza Strip must be taken into consideration:

1. Strengthening the awareness and attitude of top management and project managers towards the importance of safety is recommended. Company management must establish and enforce workers 'safety policies and should develop their activities by including more on-site monitoring of safety performance, and by providing more reliable feedback on the consequences. The responsible project parties should hold their project managers accountable for accidents.
2. It is recommended that the authorities concerned as the municipalities and consultant offices hire qualified and certified engineers to conduct regular site inspections and that the management of the company carries out clear safety policies and periodically random safety inspections for technical works.
3. It is recommended to increase the efficiency of site safety inspections by using a more competent safety engineer with a specific job description and, to hold formal safety meetings with all parties, such meetings are necessary for communicating safety information to all parties. Special meetings may be held before the start of each new activity.
4. It is recommended that only experienced workers can carry out risky tasks when heavy machinery or power tools are used, and drive should be provided for new employees because they are exposed to daily work hazards.
5. Within the company classification by PCU and in the pre-qualification process, the safety history of the construction company should be considered.
6. The owners and the engineer should ensure that the contractor meets the safety requirements. In construction contracts, a safety provision should be specified. It should also be considered in the tendering stage. An appropriate budget for implementing safety should be assessed.

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APPENDICES

Dear Sir

I am a graduate student at Anadolu University in Turkey. I am now preparing a master thesis in the construction management program. The title of the thesis is:

Evaluation of the Factors Influencing Safety Performance on Infrastructure Projects in Gaza Strip

The purpose of the study is to identify and analyze the factors, which affect the safety performance in infrastructure projects in Gaza Strip. The results of the study will be of great help to the industry and offering valuable results for all.

As you are one of the large organizations working in this field in Gaza, we are kindly inviting you to participate in filling this questionnaire with the required data which is an important element in this study.

Please let your safety personnel or project manager provide the required information requested in this questionnaire. The information provided by you will be analyzed as a whole, and we ensure you that this information will be held in strict confidence and used for the scientific research purpose only without mentioning the name of your organization.

We realize that there are numerous demands on your time. However, your involvement is a vital requisite for this study. We appreciate your anticipated cooperation in answering this questionnaire, which may take less than 30 minutes of your valuable time.

Thank you for your anticipated cooperation.

Best regards.
Yours Sincerely,

Researcher
Osama Khaled Abu Eltayf

PART A: ORGANIZATION PROFILE

1- Organization:

Road Contractors	☐ First class A	☐ First class B	☐ Second class
Water & Sewage Contractors	☐ First class	☐ Second class	☐ Third class
Organization:	☐ Consultant	☐ Owner	

2- Title of position of respondent
☐ Contractor ☐ Project Manager ☐ Site Engineer
☐ Consultant Engineer

3- Experience years: ………………………

4- Experience years of the organization in constructions:
☐ Less than 1 year ☐ 1 to 3 years ☐ 3 to 5 years
☐ 5 to 10 years ☐ More than 10 years

5- Number of projects executed in the last five years.
☐ Less than 10 ☐ 11 to 20 ☐ 21 to 30 ☐ More than 30

6- Value of executed projects during the last five years (in million dollars):
☐ Less than 0.5 ☐ 1 to 3 ☐ 3 to 5 ☐ More than 5

PART B: INFORMATION OF SAFETY

7- Does your company have a safety professional / department ? ☐ Yes ☐ No

8- Does your company use a safety program or manual ? ☐ Yes ☐ No

9- Do you have knowledge of the safety conditions, specifications and previsions?
☐ Yes ☐ Partially ☐ No

10- In your opinion, who should be responsible for lacking safety during construction on site? (you can select more than one answer for this question)
☐ Worker ☐ Safety Engineer ☐ Site Engineer ☐ Management
☐ Government ☐ Consultant Engineer ☐ Other (Specify) -----------------

11- Do you expect any financial saving with safety conditions, specifications and provisions?
☐ Yes ☐ Sometimes ☐ No

12- Total number of disabling injuries during last work year are:----------------

13- Total number of workers in company last work year are: -------------------

PART C: FACTOR AFFECTING THE SAFETY PERFORMANCE IN INFRASTRUCTURE PROJECTS

The list below includes the factors that are affecting the safety performance
For each of these factors, you are kindly requested to express your opinion by answering the following questions and placing (✓) in the appropriate circle

Likert Scale: Very low (1); low (2); Moderate (3); High (4); Very high (5)

No.	Factors Description	Degree of Impact				
1	Motivation	1	2	3	4	5
1.1	Incentive Programs	○	○	○	○	○
1.2	Job Satisfaction	○	○	○	○	○
1.3	Job Motivators	○	○	○	○	○
1.4	Peer Pressure	○	○	○	○	○
1.5	Reward and Penalty	○	○	○	○	○
1.6	Wage	○	○	○	○	○
2	Project nature	1	2	3	4	5
2.1	The arrangement and organization of the construction site	○	○	○	○	○
2.2	The volume of the project	○	○	○	○	○
2.3	Cost of the project	○	○	○	○	○
2.4	Application of new technology in the project	○	○	○	○	○
2.5	Type of owner	○	○	○	○	○
2.6	Complexity of the design	○	○	○	○	○
2.7	Duration	○	○	○	○	○
3	Work pressure	1	2	3	4	5
3.1	Production pressure	○	○	○	○	○
3.2	Working pace	○	○	○	○	○
3.3	Work overload	○	○	○	○	○
3.4	Fatigue and burnout	○	○	○	○	○
3.5	Schedule delay	○	○	○	○	○
3.6	Overtime work	○	○	○	○	○
3.7	Working time	○	○	○	○	○
4	Historic, human and psychological climate	1	2	3	4	5
4.1	Worker age	○	○	○	○	○
4.2	Worker safety awareness	○	○	○	○	○
4.3	Worker experience	○	○	○	○	○
4.4	Worker education	○	○	○	○	○
4.5	Worker marital status	○	○	○	○	○
4.6	Knowledge and involvement	○	○	○	○	○
4.7	Worker accident's experience	○	○	○	○	○
4.8	The relation between management and workers on construction site	○	○	○	○	○
4.9	Interrelation between the workers on the construction site	○	○	○	○	○

4.10	Work pressure of workers	○	○	○	○	○
5	Emergency Planning and Preparation	1	2	3	4	5
5.1	Development of a plan to respond to emergencies	○	○	○	○	○
5.2	Training worker to respond to emergency	○	○	○	○	○
6	Signs, signals, and barricades	1	2	3	4	5
6.1	Use of danger signs	○	○	○	○	○
6.2	Use of caution signs	○	○	○	○	○
6.3	Use of instruction signs	○	○	○	○	○
6.4	Use of traffic signals	○	○	○	○	○
6.5	Barricades to close the construction site for the pedestrian	○	○	○	○	○
7	Welfare facilities	1	2	3	4	5
7.1	First aid kits	○	○	○	○	○
7.2	Provision of food and drinking water	○	○	○	○	○
7.3	Provision of adequate toilets	○	○	○	○	○
7.4	Provision of special places for smoking	○	○	○	○	○
7.5	Provision of an ambulance on the construction site	○	○	○	○	○
7.6	Periodical medical examination of workers	○	○	○	○	○
7.7	Permanent of a medical specialist on the construction site	○	○	○	○	○
7.8	Crucial care for injuries	○	○	○	○	○
8	Safety culture and climate	1	2	3	4	5
8.1	Safety climate	○	○	○	○	○
8.2	Safety culture	○	○	○	○	○
8.3	Supportive environment	○	○	○	○	○
8.4	Leadership	○	○	○	○	○
8.5	Supervisory environment	○	○	○	○	○
9	Attitude and behavior	1	2	3	4	5
9.1	Supervisor's behavior	○	○	○	○	○
9.2	Supervisor's attitude	○	○	○	○	○
9.3	Supervisor's effectiveness	○	○	○	○	○
9.4	Worker's behavior	○	○	○	○	○
9.5	Worker's attitude	○	○	○	○	○
9.6	Perceived behavior control	○	○	○	○	○
9.7	Behavior feedback	○	○	○	○	○
9.8	Participation for safety improvement (workers' involvement, cognitive and emotional engagement),	○	○	○	○	○
9.9	Safety effort	○	○	○	○	○
9.10	Personal responsibility for safety	○	○	○	○	○
9.11	Risk-taking mindset/behavior	○	○	○	○	○
9.12	Emotional state	○	○	○	○	○
9.13	Risk perception	○	○	○	○	○
9.14	Perceived safety state	○	○	○	○	○
9.15	Safety compliance	○	○	○	○	○

10	Lesson learned from accidents	1	2	3	4	5
10.1	Accident rate (frequency and severity)	○	○	○	○	○
10.2	Number of accidents	○	○	○	○	○
10.3	Injury (death) rate/type	○	○	○	○	○
10.4	First aid rate	○	○	○	○	○
10.5	Safety inspection/ investigation	○	○	○	○	○
10.6	Accident inspection/investigation	○	○	○	○	○
10.7	Incidents control pressure	○	○	○	○	○
10.8	Lessons learned	○	○	○	○	○
10.9	Willingness to investigate	○	○	○	○	○
11	The organization / The Company	1	2	3	4	5
11.1	Company's revenue	○	○	○	○	○
11.2	Company reputation	○	○	○	○	○
11.3	Company's costs	○	○	○	○	○
11.4	Company size	○	○	○	○	○
11.5	Client's control	○	○	○	○	○
11.6	The involvement of subcontractors	○	○	○	○	○
11.7	The number of subcontractors	○	○	○	○	○
11.8	The number of employees/crew size	○	○	○	○	○
12	Safety programs and management systems	1	2	3	4	5
12.1	Safety programs	○	○	○	○	○
12.2	Safety management systems	○	○	○	○	○
12.3	Communication and information	○	○	○	○	○
12.4	Limited management time	○	○	○	○	○
12.5	Management commitment	○	○	○	○	○
12.6	Risk assessment implementation/thoroughness	○	○	○	○	○
12.7	Safety policies and procedures	○	○	○	○	○
12.8	Management work pressure	○	○	○	○	○
12.9	Pre-hire screening of employees	○	○	○	○	○
12.10	Management focus on safety	○	○	○	○	○
12.11	Management concern/involvement	○	○	○	○	○
12.12	Safety instructions	○	○	○	○	○
12.13	Safety control mechanisms	○	○	○	○	○
12.14	Safety management practices	○	○	○	○	○
12.15	Management skills	○	○	○	○	○
13	Safety meeting	1	2	3	4	5
13.1	Conducting a safety meeting on the construction site by the site engineer	○	○	○	○	○
13.2	Conducting a safety meeting before each activity begins	○	○	○	○	○
13.3	Conducting safety meetings by the safety committee	○	○	○	○	○
14	Role of government and engineering societies	1	2	3	4	5
14.1	Strict implementation of safety instructions	○	○	○	○	○

14.2	Punishment in case of violation of laws, Standards regulation and legislation of safety	○	○	○	○	○
14.3	Issuance of laws, standards, and regulations for safety	○	○	○	○	○
15	Safety educating and training	1	2	3	4	5
15.1	Cultivating the awareness of accident risks	○	○	○	○	○
15.2	Understating the usage of protective equipment	○	○	○	○	○
15.3	First aid and emergency procedures	○	○	○	○	○
16	Disposal of hazardous materials and waste	1	2	3	4	5
16.1	Development of a risk management plan	○	○	○	○	○
16.2	Development of a waste management plan	○	○	○	○	○
16.3	Quick transfer of construction wastes out of the construction site	○	○	○	○	○
17	Personal protective equipment	1	2	3	4	5
17.1	The use of protective head	○	○	○	○	○
17.2	Use of protective foot	○	○	○	○	○
17.3	The use of protective clothing	○	○	○	○	○
18	Safety and economic investment	1	2	3	4	5
18.1	Safety incentives	○	○	○	○	○
18.2	Allocation of a specific budget for safety requirements	○	○	○	○	○
18.3	cost of accidents	○	○	○	○	○
18.4	the return of investment (ROI) on safety	○	○	○	○	○
19	Work process	1	2	3	4	5
19.1	Crane and lifting equipment	○	○	○	○	○
19.2	Excavation and trenching	○	○	○	○	○
19.3	Scaffolds and transportation	○	○	○	○	○

No.	Items	Correlation coefficient	P-value (Sig.)
1	**Motivation**		
1.1	Incentive Programs	0.755	0.000*
1.2	Job Satisfaction	0.759	0.000*
1.3	Job Motivators	0.842	0.000*
1.4	Peer Pressure	0.789	0.000*
1.5	Reward and Penalty	0.720	0.000*
1.6	Wage	0.838	0.000*
2	**Project nature**		
2.1	The arrangement and organization of the construction site	0.612	0.000*
2.2	The volume of the project	0.693	0.000*
2.3	Cost of the project	0.691	0.000*
2.4	Application of new technology in the project	0.698	0.000*
2.5	Type of owner	0.649	0.000*
2.6	Complexity of the design	0.731	0.000*
2.7	Duration	0.702	0.000*
3	**Work pressure**		
3.1	Production pressure	0.765	0.000*
3.2	Working pace	0.711	0.000*
3.3	Work overload	0.768	0.000*
3.4	Fatigue and burnout	0.745	0.000*
3.5	Schedule delay	0.793	0.000*
3.6	Overtime work	0.745	0.000*
3.7	Working time	0.783	0.000*
4	**Historic, human and psychological climate**		
4.1	Worker age	0.569	0.000*
4.2	Worker safety awareness	0.689	0.000*
4.3	Worker experience	0.768	0.000*
4.4	Worker education	0.678	0.000*
4.5	Worker marital status	0.657	0.000*
4.6	Knowledge and involvement	0.712	0.000*
4.7	Worker accident’s experience	0.773	0.000*
4.8	Relation between management and workers in the site.	0.615	0.000*
4.9	Interrelation between the workers on the construction site	0.693	0.000*
4.10	Work pressure of workers	0.757	0.000*
5	**Emergency Planning and Preparation**		
5.1	Development of a plan to respond to emergencies	0.950	0.000*

No.	Items	Correlation coefficient	P-value (Sig.)
5.2	Training worker to respond to emergency	0.946	0.000*
6	**Signs, signals, and barricades**		
6.1	Use of danger signs	0.918	0.000*
6.2	Use of caution signs	0.934	0.000*
6.3	Use of instruction signs	0.936	0.000*
6.4	Use of traffic signals	0.914	0.000*
6.5	Barricades to close the construction site for the pedestrian	0.887	0.000*
7	**Welfare facilities**		
7.1	First aid kits	0.633	0.000*
7.2	Provision of food and drinking water	0.682	0.000*
7.3	Provision of adequate toilets	0.684	0.000*
7.4	Provision of special places for smoking	0.803	0.000*
7.5	Provision of an ambulance on the construction site	0.797	0.000*
7.6	Periodical medical examination of workers	0.745	0.000*
7.7	Permanent of a medical specialist on the construction site	0.741	0.000*
7.8	Crucial care for injuries	0.718	0.000*
8	**Safety culture and climate**		
8.1	Safety climate	0.827	0.000*
8.2	Safety culture	0.882	0.000*
8.3	Supportive environment	0.888	0.000*
8.4	Leadership	0.802	0.000*
8.5	Supervisory environment	0.764	0.000*
9	**Attitude and behavior**		
9.1	Supervisor's behavior	0.689	0.000*
9.2	Supervisor's attitude	0.710	0.000*
9.3	Supervisor's effectiveness	0.674	0.000*
9.4	Worker's behavior	0.782	0.000*
9.5	Worker's attitude	0.774	0.000*
9.6	Perceived behavior control	0.760	0.000*
9.7	Behavior feedback	0.833	0.000*
9.8	Participation for safety improvement (workers' involvement, cognitive and emotional engagement),	0.772	0.000*
9.9	Safety effort	0.771	0.000*
9.10	Personal responsibility for safety	0.760	0.000*
9.11	Risk-taking mindset/behavior	0.648	0.000*
9.12	Emotional state	0.611	0.000*

No.	Items	Correlation coefficient	P-value (Sig.)
9.13	Risk perception	0.699	0.000*
9.14	Perceived safety state	0.773	0.000*
9.15	Safety compliance	0.681	0.000*
10	**Lesson learned from accidents**		
10.1	Accident rate (frequency and severity)	0.758	0.000*
10.2	Number of accidents	0.835	0.000*
10.3	Injury (death) rate/type	0.795	0.000*
10.4	First aid rate	0.845	0.000*
10.5	Safety inspection/ investigation	0.873	0.000*
10.6	Accident inspection/investigation	0.873	0.000*
10.7	Incidents control pressure	0.770	0.000*
10.8	Lessons learned	0.817	0.000*
10.9	Willingness to investigate	0.789	0.000*
11	**The organization / The Company**		
11.1	Company's revenue	0.728	0.000*
11.2	Company reputation	0.655	0.000*
11.3	Company's costs	0.857	0.000*
11.4	Company size	0.783	0.000*
11.5	Client's control	0.747	0.000*
11.6	The involvement of subcontractors	0.734	0.000*
11.7	The number of subcontractors	0.757	0.000*
11.8	The number of employees/crew size	0.767	0.000*
12	**Safety programs and management systems**		
12.1	Safety programs	0.762	0.000*
12.2	Safety management systems	0.738	0.000*
12.3	Communication and information	0.842	0.000*
12.4	Limited management time	0.735	0.000*
12.5	Management commitment	0.789	0.000*
12.6	Risk assessment implementation/thoroughness	0.859	0.000*
12.7	Safety policies and procedures	0.861	0.000*
12.8	Management work pressure	0.775	0.000*
12.9	Pre-hire screening of employees	0.784	0.000*
12.10	Management focus on safety	0.881	0.000*
12.11	Management concern/involvement	0.870	0.000*
12.12	Safety instructions	0.893	0.000*
12.13	Safety control mechanisms	0.878	0.000*

No.	Items	Correlation coefficient	P-value (Sig.)
12.14	Safety management practices	0.914	0.000*
12.15	Management skills	0.865	0.000*
13	**Safety meeting**		
13.1	Conducting a safety meeting on the construction site by the site engineer	0.877	0.000*
13.2	Conducting a safety meeting before each activity begins	0.922	0.000*
13.3	Conducting safety meetings by the safety committee	0.873	0.000*
14	**Role of government and engineering societies**		
14.1	Strict implementation of safety instructions	0.864	0.000*
14.2	Punishment in case of violation of laws, Standards regulation and legislation of safety	0.915	0.000*
14.3	Issuance of laws, standards, and regulations for safety	0.902	0.000*
15	**Safety educating and training**		
15.1	Cultivating the awareness of accident risks	0.904	0.000*
15.2	Understating the usage of protective equipment	0.930	0.000*
15.3	First aid and emergency procedures	0.930	0.000*
16	**Disposal of hazardous materials and waste**		
16.1	Development of a risk management plan	0.851	0.000*
16.2	Development of a waste management plan	0.925	0.000*
16.3	Quick transfer of construction wastes out of the construction site	0.864	0.000*
17	**Personal protective equipment**		
17.1	The use of protective head	0.947	0.000*
17.2	Use of protective foot	0.947	0.000*
17.3	The use of protective clothing	0.948	0.000*
18	**Safety and economic investment**		
18.1	Safety incentives	0.718	0.000*
18.2	Allocation of a specific budget for safety requirements	0.862	0.000*
18.3	Cost of accidents	0.791	0.000*
18.4	The return of investment (ROI) on safety	0.809	0.000*
19	**Work process**		
19.1	Crane and lifting equipment	0.883	0.000*
19.2	Excavation and trenching	0.916	0.000*
19.3	Scaffolds and transportation	0.898	0.000*