

Analyzing Construction Site Accidents in Kuwait

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ABSTRACT

This paper presents a research study that seeks an understanding of the causes of accidents in the construction industry in Kuwait, and focuses on the role of management, human and behavioral and the project's nature in construction accidents. The paper presents an analysis of accidents in Kuwait along with accident causation and injuries based on accident reports extracted from government agencies. The paper then discusses the results of a survey with the individuals involved in accidents in construction projects and it analyzes and ranks the causes of accidents in construction projects in Kuwait. The respondents were 154 workers ranging from tradesmen to unskilled labor. A questionnaire used in the survey is divided into three parts, the first part identifies the general characteristics of the person involved in the accident. The second part identifies the characteristics of the accident events. The third part identifies the major causes of accidents, in which 30 factors were identified and have been given to the survey respondents to state the level of influence or effect of each factor on the accident. The causes were categorized into three groups, management-related factors, labor and behavioral related factors, and job or project related factors. The factors were measured and ranked under each group by the 'Relative Importance Index' technique. The conclusions of this paper suggest that accidents are attributed mainly to management practices rather than human or behavioral issues. Recommendations are included in the paper to suggest a better application of policy and management actions and procedures to improve the safety at construction sites and projects.

Key words: Accident Analysis, Construction Industry, Human Errors.

INTRODUCTION

Construction is a hazardous profession, and accidents are likely to occur because of the nature of the activities and tasks performed at construction sites. Prevention of construction accidents usually requires predicting future accidents and their nature under given circumstances. Making such predictions must be based on knowledge about past accidents. Clearly, research and prudent safety practices are required to prevent construction accidents. The major causes of accidents are related to the unique nature of the industry, human behavior,

difficult work-site conditions, and poor safety management, which result in unsafe work methods and procedures (CII 1988).

Accident rates in the construction industry are high. Thus, safety and site engineers should be fully prepared to deal with accidents when they occur and carry out proper investigation and reporting procedures afterwards. Accident statistics represent not only terrible human tragedies but also substantial economic costs. This is because accidents cause damage to plant equipment, and loss of productive work time until normal site working rhythm and morale are restored. Accidents can also cause work disruption and reduce the work rate while investigations are carried out by the company's safety department, the insurers, and inspectors from the health and safety authorities. Moreover, contractors face increased insurance premiums and face loss of confidence and reputation. This has to be balanced against the cost of working safely.

Details about causes and physical conditions of construction injuries have been insufficient or almost lacking in Kuwait in particular and in the Middle East in general. Information available on this subject is too generic and it does not provide enough guidance by which accident prevention programs can be more effective. This study presents an analysis of construction accidents in Kuwait, along with accident causes and types of injuries, so that corrective measures can be taken to decrease casualties, resulting in a safer construction industry. The paper evaluates existing injuries from construction accidents and describes the relationship between the conditions and circumstances that were existent at the time of the accident and the accident itself. Data were collected and analyzed from accidents that occurred in construction sites in Kuwait and were reported to the Worker's Affairs Department at the Ministry of Social Affairs and Labor during the period of this research.

The paper also determines the factors that effect the safety of the construction industry in Kuwait. These factors are considered to be the root cause of construction accidents in Kuwait and are categorized and discussed in terms of three groups: management-related factors, labor-related factors and project-related factors. This approach highlights a detailed accident investigation that determines causes of accidents, in which unsafe practices can be eliminated. The paper conducted a questionnaire as a survey instrument in determining these causes for each accident that occurred in a particular construction site in Kuwait. The questionnaire attempts to investigate the managerial, labor, and project related factors and circumstances surrounding that particular accident.

This paper is of importance since it identifies the root causes of accidents and their relation to management, labor and project factors. It has been noticed that very few studies have undertaken the evaluation of labor information collected to study and improve different aspects of work and workers. The methodology

used for determining the causes to accidents as reported in this paper is considered to be a new approach in the construction accident literature as it attempts to investigate the role of management, labor and project related factors causing accidents. The major objectives of conducting this research are as follows:

- To obtain an overview of construction accidents and serious injuries in Kuwait.
- To analyze causes of accidents in construction using numerical ranking techniques.
- To study the effects of project related and safety factors, management factors and human factors on accidents in construction sites in Kuwait.

ACCIDENTS AND HUMAN ERROR

Accidents can be defined as "any avoidable action by personnel or any failure of equipment, tools or other devices that interrupts production and has the potential of injuring people or damaging property" (Oglesby *et al.* 1989). Human Error is an inappropriate or undesirable human decision or behavior that reduces, or has the potential for reducing effectiveness, safety, or system performance. A human error either involves failure to do something or it involves performing an act incorrectly. The effect of accidents and human errors can be property loss with or without personal injury.

One can learn much about safety by reviewing data about past safety violations and injuries. Several studies have been conducted in the past few years that provide considerable insight into this pervasive problem. For example, studies such as Hinze (1998), Hinze Appelgate (1991), and Hinze Bern (1996) collected different data on types of fatalities and injuries related to accidents such as falling from height, being struck by material or falling from scaffolding. However, the root causes of accidents were not investigated.

Accident prevention starts with having a clear understanding of those factors that play a key role in their causation. Agencies such as the Occupational Safety and Health Administration (OSHA) in the United States, have the goal of establishing and analyzing contributing factors in accident causation (Hinze Russell 1995). The efforts of OSHA are essential to many safety departments in the different industries to acquire needed data and information. OSHA also establishes databases on past injuries that might be useful to make predictions about the number and types of injuries that are likely to occur in the future. These databases analyze information about each incident. It includes information about the injured worker (i.e., age, sex, event type, extent of injury,

location, date, environment and behavioral factors). OSHA also studies the size of penalty to be compensated to workers and establishes safety guidance on occupational prevention programs.

SAFETY IN THE CONSTRUCTION INDUSTRY IN KUWAIT

Construction site safety and accident reporting in Kuwait is monitored by two different government authorities. The first authority is the Administration of Safety (AOS) at the Kuwait Municipality (KM), which deals with construction safety procedures at the construction sites. The second authority is the Worker's Affairs Department (WAD) at the Ministry of Social Affairs and Labor (MSAL), which deals with protecting workers' rights if an accident occurs. AOS is concerned with accidents occurring at construction sites, while WAD deals with accidents that occur in all industries. Coordination and sharing of information between the two agencies are still lacking. In addition, construction accident data are neither accurate nor complete, due to the absence of a reliable accident reporting and recording system. These data account for only the reported accidents and do not include the causative factors involved in accidents and their consequences. An incomplete recording system and poor accident investigations are attributed to many factors that include: (a) inexperienced and untrained investigators, (b) reluctance on the part of the investigator to assert authority, (c) narrow interpretation, (d) judgmental behavior, (e) incomplete or erroneous conclusions, (f) poor interviews, and (g) delays in accident investigation (Kartam Bouz, 1998).

A comparative and analytical overview of accidents in the construction industry with other industries and work sectors in Kuwait is provided in Tables 1 and 2. Table 1 provides knowledge of the overall measurements of the different sectors and industries and includes information on the percentage of construction accidents as compared with other industries. Table 2 summarizes and analyzes the data of 3,288 accidents that were collected by WAD from different industries' locations and sites for the year of 1998 in terms of major accident causes, injury type and part of the body injured.

Table 1 Workforce size as of June 30 1999

Industry	Building Construction Sector	Transformation Industries	Wholesales,			Community, Social, Personal services	Other (Agriculture, mining, utilities)	Total
			Retail, Trading, Restaurant	Courier Storage services	Community, Social, Personal services			
Technicians	4,230	1,930	4,272	437	14,029	2,864	27,762	
Tradesmen (Skilled labor)	38,399	34,188	28,179	4,176	15989	7,297	128,228	
Unskilled labor	64,834	26,344	120,267	24,645	333,596	38,499	608,185	
Total	107,463	62,462	152,718	29,258	363,614	48,660	764,175	
Percentage of this sector to total workforce	14%	8%	20%	4%	48%	6%	100%	
Number of accidents	1,182	1,105	522	88	342	49	3,288	
Percentage to total accidents	35.9%	33.6%	15.9%	2.7%	10.4%	1.5%	100.0%	
Accident ratio (1:1000)	11.0	17.7	3.4	3.0	0.9	1.0	4.3	

Source Ministry of Planning 1999

Table 2 Analysis of Accidents in Kuwait

1	Accidents No.	Construction		Transformation Industries		Wholesale, Retail Trading, Restaurants		Courier, Storage & Transportation		Community, Social & personal services		Other	Total					
		1182	35.9%	291	33.6%	1105	33.6%	522	15.9%	88	2.7%			342	10.4%	49	1.5%	3288
	<i>Percentage</i>																	
2	<i>Falling from height</i>	355	30%	291	26%	171	33%	17	19%	111	32%	22	45%	967	29%			
	<i>Falling objects</i>	355	30%	228	21%	111	21%	32	36%	85	25%	4	8%	815	25%			
	<i>Lifting objects</i>	36	3%	82	7%	16	3%	0	0%	9	3%	3	6%	146	4%			
	<i>Tools</i>	224	19%	205	19%	104	20%	19	22%	64	19%	7	14%	623	19%			
	<i>Materials</i>	75	6%	120	11%	19	4%	1	1%	16	5%	0	0%	231	7%			
	<i>Electric shock</i>	2	0%	1	0%	1	0%	0	0%	2	1%	0	0%	6	0%			
	<i>Fire/explosion</i>	18	2%	15	1%	8	2%	1	1%	8	2%	0	0%	50	2%			
	<i>Transport means</i>	48	4%	43	4%	31	6%	9	10%	16	5%	8	16%	155	5%			
	<i>Chemical materials</i>	12	1%	23	2%	0	0%	0	0%	1	0%	1	2%	037	1%			
	<i>Others</i>	57	5%	97	9%	9%	12%	61	12%	9	10%	30	9%	4	8%	258	8%	
3	<i>Amputation</i>	34	3%	43	4%	27	5%	5	6%	7	2%	4	8%	120	4%			
	<i>Wounds</i>	270	23%	375	34%	235	45%	8	9%	48	14%	14	29%	950	29%			
	<i>Fractures</i>	559	47%	285	26%	236	45%	45	51%	137	40%	24	49%	1286	39%			
	<i>Bruises</i>	179	15%	204	18%	70	13%	12	14%	48	14%	6	12%	519	16%			
	<i>Burns</i>	26	2%	32	3%	12	2%	0	0%	9	3%	0	0%	79	2%			
	<i>Others</i>	114	10%	166	15%	42	8%	18	20%	38	11%	10	20%	388	12%			
	<i>Head</i>	31	3%	46	4%	18	3%	2	2%	18	5%	1	2%	116	4%			
4	<i>Eye</i>	74	6%	106	10%	16	3%	1	1%	18	5%	1	2%	216	7%			
	<i>Upper half</i>	571	48%	560	51%	285	55%	53	60%	175	51%	18	37%	1662	51%			
	<i>Lower half</i>	390	33%	307	28%	160	31%	26	30%	104	30%	20	41%	1007	31%			
	<i>Torso</i>	62	5%	55	5%	25	5%	2	2%	12	4%	4	8%	160	5%			
	<i>Few organs</i>	54	5%	31	3%	18	3%	4	5%	0	0%	5	10%	112	3%			
5	<i>Recovery</i>	344	29%	535	48%	161	31%	0	0%	135	39%	8	16%	1183	36%			
	<i>Disability</i>	819	69%	568	51%	360	69%	1	1%	202	59%	40	82%	1990	61%			
	<i>Death</i>	19	2%	2	0%	1	0%	0	0%	5	1%	1	2%	28	1%			

Source WAD 1998

1. Accidents by Industry

Table 1 describes the overall size of the workforce in the major sectors and industries in Kuwait (as reported in June 1999 by the Ministry of Planning (MOP) statistics department) and the rate of accidents in each sector as collected and reported by MSAL for the year of 1998. The construction industry's labor size is 14% of the workforce total population and is ranked first with 1182 (35.9%) cases of total accidents reported at WAD followed by the manufacturing industry with 1105 (33.6%) of total accidents reported in 1998. However when comparing the ratio of accidents to the total size of the industry workforce, the construction industry emerged as the industry with the second highest ratio. The transformation (manufacturing) industry came up first with 17 accidents for every 1000 laborers, while the accidents ratio in the construction industry was 11 accidents for every 1000 individuals.

The evidence is clear that worker injuries in the construction industry are a serious issue, and the industry has not had a favorable safety record. Why does the construction industry have such dismal record when compared with most other industries? The answer is not a simple one. Explanations would have to include such issues as the unique and changing nature of the work site, the changing composition of the work force and the adverse weather conditions during summer months.

2. Accident type

WAD categorizes major accident types for all economic activities to be: falling from height, falling objects, lifting objects, tools, materials, electric shock, fire/explosion, transport means, chemical materials, and others. As indicated in the second section of Table 1, 967 (29%) of all reported accidents were falling from height and 815 (25%) of accidents were due to falling objects, while 623 (19%) were caused by tools. In construction, these three causes are the major three accident types and make up 73% of the causes of accidents.

3. Accident injury type

Based on WAD's data, accident injury types are divided into six categories which are: amputations, wounds, fractures, bruises, burns, and others as shown in the third section of Table 1. Fractures have the highest occurrences with 1286 (39%) of accidents in all of the industries, followed by wounds with 1077 (33%) occurrences. The same pattern is happening to the construction industries, where fractures were 559 (47%) of the construction accidents, and wounds to the body are also a major injury type with 270 (23%).

4. Part of the body

The fourth section of Table 1 shows the distribution of which part of the body was injured. It shows six categories: head, eye, upper half, lower half, torso, and a few organs. The table shows that most injuries affected the upper half of the body with 1662 (50%) of all of the cases, and the lower half injuries is the second most injured body part with 1007 (31%). The same pattern is happening to the construction industry.

5. Consequences of accidents

The results of accidents can be divided into three categories: recovery, disability, and death. The last section of Table 1 shows the distribution of accident consequences for all economic activities. It shows that 819 (69.28%) of the construction accidents led to disability, 344 (29.1%) of accidents led to recovery and 19 (1.61%) of accidents led to death. In total, the accidents that led to mortality are 28 cases (1%) during the year 1998. Of these cases 19 (68%) cases occurred in construction sites, while 2 (7%) were in the manufacturing industries. This confirms that the construction industry is the most hazardous profession in Kuwait.

In summary, the 1998 data shows that the construction industry has consistently been among those industries with the highest percentage of accidents and falling from height. Falling objects and tools are the major source of accidents in Kuwait. The data also confirms the majority of the accidents led to disability of the injured person. The current level of injuries and fatalities (i.e. the 1998 data) is unacceptable. Therefore, one way of improving safety performance in the construction industry is to focus on the root causes of many of the injuries that do occur. The following sections present research that investigates the role and relationship of managerial, human and behavioral, and the-job-it-self-related factors to construction accidents. The research was based on a survey of workers involved in accidents.

RESEARCH METHODOLOGY

To understand and identify the causes leading to construction accidents, a questionnaire-type survey was conducted as described in this and following sections. The questionnaire was developed as part of a research project at the Civil Engineering department at Kuwait University aimed at analyzing and factoring causes of accidents. Once the data outlined in the first part of paper (i.e. data reported from MSAL) were analyzed in terms of statistics and occurrences, the author directed the research by carefully examining the root causes of accidents that occur in construction sites in order to improve safety

performance in the construction industry. These factors are identified as situations surrounding construction accidents and categorized as management related factors, human behavior factors, and project or job-related factors. The questionnaire was designed in such a way that it describes the situation and circumstances surrounding a particular accident which occurred in a construction site and in which an individual was involved. The questionnaire (attached as an appendix to this paper) was divided into three major parts:

Part 1: Injured worker's personal data

The first part was general information about the worker involved in an accident. This included nationality, age, marital status, job title, level of education, upbringing environment, years of experience, level of training, pay, health status, and if he has experienced similar accidents.

Part 2: Accident and site conditions

The second part of the questionnaire was about accidents and site conditions.

- 1 - Type of accident (e.g. contact with electricity, tools, fire exposure, crane accident, hazardous material, failure of the lift device, gas explosion, structural failure, natural causes, trench accident, fall from height, fall from ladder, fall from scaffolding, struck against fixed, falling object, slip/trip fall on the same level, fall from roof opening, drowning, machinery and vehicle, asphyxiation).
- 2 - Time of accident
- 3 - Weather conditions during the accident (e.g., normal, hot, cold, humid, windy, rainy, foggy, moderate).
- 4 - Season: (e.g., summer, autumn, winter and spring).

Part 3: Factors attributed to construction accidents

The aim of this part is to carefully examine and focus on the root causes of accidents that occur in order to improve safety performance in the construction industry. It identifies the major causes surrounding construction accidents. Factors that can be attributed to construction accidents were collected and identified through interviews with local construction site engineers, safety engineers, and WAD's employees. Then a total of 30 causes of accidents were categorized in the three groups: management factors, human factors and the project factors. The following is a description of each group.

1. Factors attributed to the management:

- M1: Appropriate Personal Safety procedures were not specified.
- M2: Correct tools/equipment were not used for the specific task.
- M3: Lack of supervision and control on workers' adherence to wear safety items.
- M4: Non compliance to governmental safety regulations.
- M5: No safety engineer at site.
- M6: Safety items were not available on site.
- M7: The management is pushing the work regardless of workers' abilities.
- M8: No or lack of weekly safety meetings.
- M9: No training program for the worker to implement the job.
- M10: No written/known procedure for the assigned job is available.
- M11: Lack of appreciation after completion of the task.
- M12: No cohesiveness among job crew.
- M13: Not enough rest time during the task.

2. Factors attributed to the worker:

- W1 The worker was suffering from health problems.
- W2 The worker was not in an acceptable physical condition.
- W3 Physical fatigue caused the accident.
- W4 The worker was suffering from mental fatigue at the job
- W5 Worker was rushing the work
- W6 The accident occurred due to the worker's misjudgement
- W7 The worker had no satisfaction with the nature of the job
- W8 The worker had not enough sleeping hours.
- W9 Workers were negligent regarding wearing personal protection items.
- W10 The worker was always taking overtime.
- W11 The worker was overconfident
- W12 Lack of knowledge by worker on wearing personal safety items.
- W13 The worker was delaying the accomplishment of the orders.

3. Factors attributed to the project

- E1 Weather conditions were extreme.
- E2 The social life in Kuwait is uncomfortable to the worker.
- E3 Unsuitable living, housing and transportation facilities for the worker.
- E4 Job or task was too difficult to perform.

Each factor was written in a statement form, in which the worker is asked to answer whether he highly agrees, agrees, is neutral, disagrees, or highly disagrees as to whether each statement had caused the accident to happen or contributed to it. This range used a 5-point scale. For example, a highly agree answer indicates the highest effect and a value of 5 was attached to it; while a highly

disagree answer has the lowest effect and a value of 1 was given to it. A final section of the questionnaire was about comments and recommendations that these workers thought should be considered to further help understand the relationship among the most important causes of construction accidents. Testing the questionnaire as a tool to collect the needed data was accomplished with two safety engineers before a full-scale data collection effort. These two engineers provided helpful insight in finalizing the questionnaire as illustrated in the appendix attached with this paper.

Data analysis using a statistics package:

The first and second parts of the survey were analyzed using statistical analysis to describe the main characteristics surrounding accidents in construction sites. To determine the ranking of the different factors or attributes causing construction accidents as outlined in the third part, the "Relative Important Index: (RII) developed by Kometa *et al.* (1994) was adopted. This method, which was applied to rank causes of delays in construction projects by Chan and Kumaraswamy (1997), transforms the five-point scale mentioned earlier to determine the ranking of each factor using the following expression:

$$RII = \frac{\sum_{i=1}^5 a_i x_i}{5 \times N}$$

Where a_i is a constant expressing the weight of the i th response, x_i is the frequency of the i th response of the total responses for each cause, i is the response category index where $i = 1, 2, 3, 4$ and 5 respectively; N is the total number of respondents. RII value is ranged between 0 to 1.

RESULTS

The total number of the workforce in the construction industry was 107,463 as reported in June 1999, of which 1,182 individuals were involved in accidents in 1998. A total number of 154 questionnaires were collected from the workers involved in accidents at different construction sites in Kuwait as referred by the two main organizations that supervised safety and worker's security, i.e. WAD and AOS. The collection of these questionnaires occurred during the period of April to August 1999. Assuming that accidents which occurred during 1999 in the construction industry were evenly distributed monthly (i.e. 98.5 accidents per month), then the sample collected for the 5-month period would constitute $(154/492.5 = 31\%)$. Most of the answers to the questionnaires were filled by conducting interviews with these workers, as some workers have reading and writing disabilities. 17 questionnaires were filled by supervisors or on behalf of the laborers involved in accidents, as they were not available to respond.

Part 1. Characteristics of the injured worker

Figure 1 shows the distribution of the sample in terms of their nationality. It shows the five main nationalities that constitute the labor force in the construction industry. These nationalities along with their number and percentage are Egyptians at 90 cases (58.4%), Indians at 16 cases (10.4%), Syrians at 11 cases (7.1%), Pakistanis at 8 (5.2%), Iranians at 4 (2.6%), and 5 cases (3.2%) are Bangladeshis. There is an error of about 3.2% due to missing data. Figure 2 shows the distribution according to age. It shows that 69 cases (i.e. 44.8% of the sample) involved in accidents are in the age range of (25-35) years old, while 43 cases (27.9%) are (35-45) years old, 24 cases (15.6%) are between 18-25 years old, and only 1 case (0.6%) is younger than 18 years old.

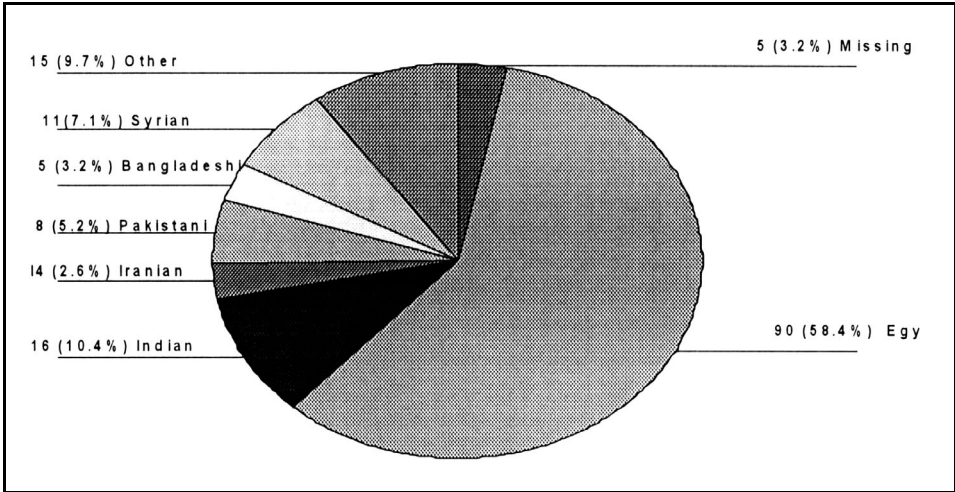


Figure 1 Distribution according to nationalities of the workers involved in accidents.

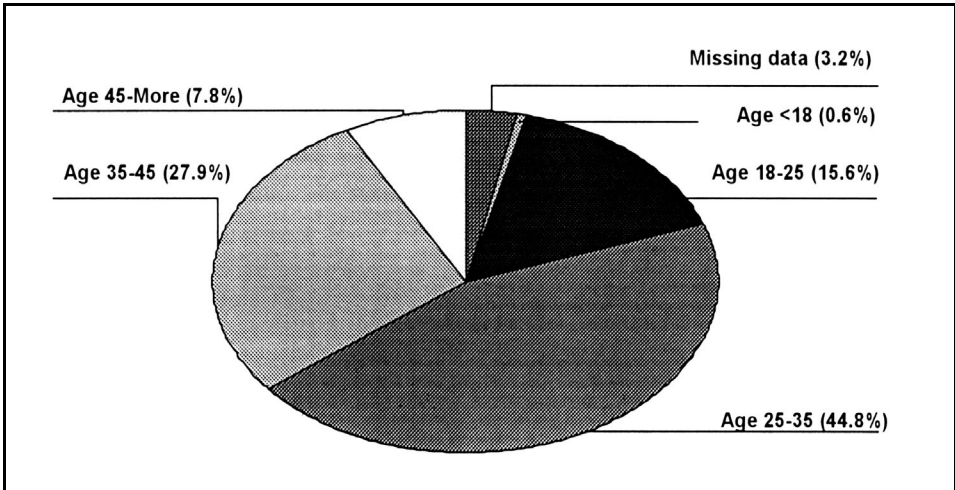


Figure 2. Distribution according to age of the workers involved in accidents.

Table 3 shows the distribution of the sample in terms of their *marital status, job-title, level of education, upbringing, years of experience, level of training and pay per day*. Each item describes the main characteristics of injured workmen. It depicts the pattern of personnel involved in construction accidents. The following sections provide a description of these patterns.

Table 3. Distribution of Accidents in terms of Personal Data

		Frequency	Percentage (%)
Marital Status	Married	113	73.4
	Single	35	22.7
	Divorced	4	2.6
	Widower	2	1.3
Upbringing	City	43	27.9
	Countryside	109	70.8
Job Title	Technician	54	35.1
	Foreman	21	13.6
	Worker	78	50.6
Years of experience	1-10	86	55.8
	11-20	53	34.4
	21-30	11	7.1
	31-more	2	1.3
Level of Education	Can't read or write	25	16.2
	Primary	45	29.2
	Secondary	43	27.9
	High School	18	11.7
	Diploma	19	12.3
	College	4	2.6
Income/day	< 5 KD	84	54.5
	5-10 KD	48	31.2
	10-20 KD	20	13
	20 KD and more	2	1.3
Faced similar accidents	Yes	62	40.3
	No	88	57.1
Permanent Disease	Diabetes	9	5.8
	High blood pressure	6	3.9
	Heart attack	1	.6
	Other	19	12.3
	None	118	76.6

Social status and upbringing:

The results concerning *marital status* shows that 113 (73.4%) of the sample involved in accidents are married, 35 (22.7%) are single, and 6 (3.9%) are divorced or widower. The fact that most of the workers involved in accidents are married does not seem to be unusual since the majority of these workers come to Kuwait without their families, and they stay in labor camps within their contractor's facilities. The average stay in Kuwait without going back to their countries in 2 years. This period is intolerable to many of the workers that were interviewed and can be a contributing factor to accidents. Another interesting result as Table 3 illustrates is the role of *upbringing*; 109 (70.8%) are from countryside and 43 (27.9%) were raised in the city. There is an error about 1.3% due to missing data. This factor is in agreement with the level of education as the majority of people raised in the countryside have low levels of education.

Job title:

Distribution of the sample in terms of their *job title* shows that 78 (50.6%) are unskilled laborers while 54 (35%) are tradesmen and 21 (13.6%) are foremen. This results is compatible with the data shown in Table 1, where 4% of the total workforce are technicians, 35.7% are tradesmen, and 60% are unskilled labor.

Work experience:

Table 3 shows that as the years of experience decreases, accident occurrences tend to increase. The results, as shown in the work experience section of this table show that 86 (55.8%) of the sample involved in construction accidents have (1-10) years of experience, 53 (34.4%) have (11-20) years of experience, 11 (7.1%) have (21-30) years of experience, 2 (1.3%) have (31 or more) years of experience. Since no information was available regarding the age categories of the workforce, it was difficult to assess whether this frequency actually related to the years of experience or was a reflection of the number of workers in this category. However it remains a significant result that 55.8% of the cases that had accidents in this survey had less than 10 years of experience.

Education and training:

The distribution of the sample in terms of *level of education* shows that the majority of the workers were either illiterate 25 (16.2%) or have only basic reading and writing abilities 45 (29.2%). This illustrates the role of education as a factor in accidents, the less educated the more accident-prone. As the level of education increases the exposure to accidents decreases as shown in Table 3 (e.g. 43 (27.9%) have a secondary degree, 18 (11.7%) have a high school degree, 19 (12.3%) have a diploma degree, and 4 (2.6%) have a college degree.

Income status:

Table 3 shows the distribution of the sample in terms of *income/day*, where 84 (54.5%) of the sample have less than 5 KD income/day, 48 (31.2%) have (5-10) KD/day, 20 (13%) have (10-20) KD/day, 2 (1.3%) have 20 KD/day and more. It is obvious the less income that you get the more accidents that will probable.

Although it may be conducted from the above results that the less skillful the labor the more frequent the accidents, the results also indicate that general practice by the management is to hire unskilled labor, where 60% of total work force are considered to be unskilled. There are no labor unions in Kuwait that can monitor the recruitment of skilled labor. Also there are no written government regulations or clear enforcement of selecting skilled or certified labor by the contractors. This eventually will result in unskilled labor coming from poor countries to enter into the construction workforce market. On the other hand, the concept of selecting lowest bidders to a construction job will motivate contractors to recruit the unskilled labor that normally accept lower wage rates.

Accident proneness:

Table 3 shows the distribution of the sample in terms of *facing similar accidents*. It shows that 62 (40.3%) of the injured workers experienced similar accidents, while 88 (57.1%) did not. This data agrees with the accident proneness theories that hypothesize that some people are more prone to have accidents than others because of a particular set of constitutional characteristics, such as age, sensory functions, etc.

Health status:

Table 3 shows the distribution of the sample in terms of their *permanent diseases*. It shows that 9 (5.8%) of the sample have diabetes, 6 (3.9%) have high blood pressure, 1 (.6%) have heart related problems, and 19 (12.3%) have other diseases.

Part 2. Accidents and site conditions

Type of accidents:

Table 4 shows the distribution of accident types and numbers. The most common types are tool accidents 26 (16.9%), fall from ladder 23 (14.9%), and fall from scaffolding 13 (8.4%). As shown in this table many injuries result from unsafe or improper use of tools, which could suggest that tools were not

properly inspected before use for their suitability for the proposed work. Furthermore, many serious accidents result from the misuse of ladders.

Table 4. Distribution of accident types and numbers

Types of Accident	Frequency	Percentage (%)
Contact with electricity	9	5.8
Exposure to fire	3	1.9
Hazardous material	3	1.9
Struck by material	9	5.8
Trench accident	7	4.5
Fall from ladder	23	14.9
Struck against fixed object	6	3.9
Slip/trip fall same level	9	5.8
Asphyxiation	3	1.9
Tool accident	26	16.9
Crane accident	2	1.3
Failure of lift device	3	1.9
Natural causes	4	2.6
Fall from height	9	5.8
Fall from scaffolding	13	8.4
Falling object from height	3	1.9
Fall from roof opening	4	2.6
Machinery & vehicle	4	2.6
Other	14	9.1
Total	154	100

Time of accidents:

Although injuries may be regarded as random occurrences, a statistical review of injuries suggests that they are not always random. Injuries may be more likely to occur during certain hours of the day. Table 5 shows the time of accident. It shows that 91 (59.1%) of construction accidents happened during normal working hours, 33 (21.4%) happened in the last hour of the working day, 19 (12.3%) in first hour of the working day, 7 (4.5%) happened during overtime and 4 (2.6%) during break hours. It is most common for construction work to be performed during regular daytime hours. Most construction projects have a similar workday from 7.00 a.m. to about 4.00 p.m., with one hour lunch around 12 noon. In the sequence of the work, it is evident that the least productive periods are those just before lunch and just before quitting time. It is most

common for accidents to occur during the last hour of the working day, as shown in the Table 5.

Table 5. Time of accident

Time	Frequency	Percentage (%)
First hour of the working day	19	12.3
During normal working hours	91	59.1
Last hour of working day	33	21.4
During over time	7	4.5
During break hours	4	2.6
Total	154	100

Season during accidents:

Accidents may also be related to the period of year. Table 6 shows that injury occurrence was highest during the summer and winter and was lowest during autumn and spring. It shows that 81 (52.6%) of the construction accidents happened in summer, 52 (33.8%) happened in winter, 11 (7.1%) happened in autumn, 10 (6.5%) happened in spring. Kuwait is very hot during the summer season and tends to be extremely hot during the months of May to September. When the summer temperatures are extreme, the safety and health of construction workers can be seriously jeopardized. Heat exhaustion and dehydration are really dangerous, and care must be exercised to minimize those ill effects. Furthermore, cold weather does affect the ability to perform certain tasks, particularly those that require considerable manual skills.

Table 6. Season during accident.

Season during the accident	Frequency	Percentage (%)
Summer	81	52.6
Winter	52	33.8
Autumn	11	7.1
Spring	10	6.5
Total	154	100

Part 3. Causes of construction accidents in Kuwait

Table 7 shows the relative importance indices and the ranks of the accidents' factors as postulated by the workers on construction projects in Kuwait. The top ten factors attributed to accidents were mainly management-related with six factors in the management group, three factors related the nature of the job, and one factor related to the workers. These top factors are as follows:

Table 7. The Ranking of Factors Contributing to Construction Accidents

ACCIDENT FACTOR		Highly Disagree	Disagree	Neutral	Agree	Highly Agree	RII	RANK	
		(lowest effect)				(highest effect)			
		1	2	3	4	5			
Management Related Factors	M1	Appropriate Personal Safety procedures were not specified.	26	33	15	46	31	0.63	11
	M2	Correct tools were not used for the specific task.	21	30	17	41	40	0.67	10
	M3	Lack of supervision and control on worker's adherenced to wear safety items.	6	3	13	63	61	0.83	2
	M4	Safety regulations were not followed	15	14	13	71	40	0.74	5
	M5	No safety engineer at site.	16	14	13	67	40	0.73	6
	M6	Safety items were not available on site.	16	42	21	41	29	0.63	11
	M7	The management is pushing work regardless of labourer's abilities.	21	46	45	17	22	0.56	19
	M8	No or lack of weekly safety meetings.	8	19	18	61	47	0.76	3
	M9	No training program for the worker to implement the job.	7	24	39	46	32	0.70	8
	M10	No written/known procedure for the assigned job is available.	21	44	37	29	20	0.58	16
	M11	Lack of appreciation after completion task	27	22	44	43	14	0.59	15
Worker Related Factors	W1	The worker was suffering from health problems.	49	59	18	13	13	0.44	26
	W2	The worker was not in an acceptable physical condition	37	72	32	6	5	0.43	28
	W3	Physical fatigue caused the accident.	16	57	23	37	20	0.58	16
	W4	The worker was suffering from mental fatigue at the job.	30	53	27	29	12	0.52	23
	W5	Worker was rushing the work	16	44	54	24	13	0.57	18
	W6	The accident occurred due to misjudgment from the worker.	29	55	21	31	14	0.53	21
	W7	The worker had no satisfaction with the nature of the job.	28	78	31	9	4	0.44	26
	W8	The worker had not enough sleeping hours.	29	55	46	13	10	0.50	24
	W9	Worker was not wearing personal protection items.	17	12	15	55	54	0.75	4
	W10	The worker was always taking overtime	10	42	48	43	10	0.60	13
	W11	The worker was overconfident.	52	75	19	3	3	0.38	30
	W12	Lack of knowledge by worker on wearing personal safety items.	26	63	21	19	23	0.53	21
	W13	The worker was delaying the accomplishment of the orders.	50	59	24	11	5	0.41	28
Job, Environmental and Social Factors	E1	No cohesiveness among job crew.	5	11	52	54	31	0.72	7
	E2	Not enough rest time during the task.	30	47	52	16	8	0.50	24
	E3	Weather conditions were extreme.	0	10	11	52	80	0.86	1
	E4	The social life in Kuwait is uncomfortable to the worker.	19	30	51	31	19	0.60	13
	E5	Unsuitable living, housing and transportation facilities for the worker	13	20	60	32	27	0.70	8
	E6	Job or task was too difficult to perform.	23	49	44	24	11	0.54	20

1. E1	: Weather conditions were extreme	0.86
2. M3	: Lack of supervision and control on worker's adherence to wear safety items.	0.83
3. M8	: No or lack of weekly safety meetings.	0.76
4. W9	: Workers were negligent regarding wearing personal protection items	0.75
5. M4	: Safety regulations were not followed.	0.74
6. M5	: No safety engineer at site.	0.73
7. M12	: No cohesiveness among job crew.	0.72
8. M9	: No training program for the worker to implement the job.	0.70
9. M2	: Correct tools were not used for the specific task.	0.67
10. E3	: Unsuitable living, housing and transportation facilities for the worker	0.65

The following is a discussion of the results on each of the three different groups of accidents as deduced from this Table:

Factors attributed to the management

This group of accidents' factors were ranked high by the respondents. It had six of the top ten factors causing accidents. Lack of supervision and control on worker's adherence to wear safety items was considered the top cause of accidents in this group. It is ranked as second over the 30 factors. The workers indicated that the contractors were weak on enforcing safety issues and requirements at the construction sites. They have rated lack of periodical safety meetings, the contractor's non-compliance of governmental safety regulations, no assignment of a safety engineer, and no training programs available to the workers as very important causes of construction accidents.

It is evident that the workers are calling for the contractors to fulfill their duties by providing safety instructions and training programs as necessary steps to ensure safety at the site. These acts or omissions by the employers affect laborers' performance. The first inquiries after an accident occurs should be "Were the workers and operators competent? Have they been properly trained?" To satisfy the general duty of safety training, employers in the construction industry find it is necessary to provide training at several levels from a basic introduction to safety for everyone on their site to safety training courses for managerial staff. Safety should form part of all training for construction activities. Furthermore safety meetings should be used as a vehicle to review the effectiveness of the project safety efforts, to resolve current health and safety problems, to provide a forum for planning safe construction activities, to plan

ahead for new or changed operations, and to update the accident prevention program.

Another factor that the workers attributed to be a high cause of accidents is the lack of cohesiveness among the job crew. This is understandable especially in the Gulf countries where workers come from different nationalities and cultures and speak different languages. Some contractors prefer to assign specific jobs to crews from the same culture or nationality for better communication and productivity.

Worker-related factors

This group was ranked lower by the respondents. The only factor that can be attributed to causing accidents is that the worker was not wearing personal protection or safety items. This could be related to the education level and the culture that many of these laborers come from, where the concept of safety is under-appreciated. As it was indicated previously, 45% of the workers were either illiterate or have only basic reading and writing abilities, and 70% of the workers are from countryside areas in their countries. Wearing protective clothing and the use of safety tools are crucial in reducing the impact of accidents. The other factors in this group have scored lower than the factors in the other two groups. The results in this group clearly indicate that human and behavioral factors are not the main causes or reasons leading to construction accidents in Kuwait as previously thought before conducting this research.

Project-related factors

The workers ranked this group of factors high. The top factor among the 30 factors given to the workers was the extreme weather and environmental conditions. The respondents ranked the weather as a very important cause of accidents. This result is consistent with the statistical result listed in Table 6 which shows that injury occurrence is highest during the summer season, where 52.6% of the construction accidents happened. Few studies have investigated the relationship between weather and construction site accidents.

These results are expressed by the workers and the first insight is that these workers were shifting the blame for accidents toward the management of the contractors. It is worth mentioning that the 17 supervisors who filled the survey on behalf of the workers that had accidents agreed with the general results of this survey. Table 8 illustrates the RII and the rankings of these factors by the supervisors and it is notably consistent with the worker's results listed in table 7.

Table 8. The Ranking of Factors Contributing to Construction Accidents

		RII	Rank by Management
M1	Appropriate personal safety procedures were not specified.	0.63	11
M2	Correct tools were not used for the specific task.	0.67	14
M3	Lack of supervision and control on worker's adherence to wear safety items.	0.83	2
M4	Safety regulations were not followed.	0.74	4
M5	No safety engineer at site.	0.73	4
M6	Safety items were not available on site.	0.63	15
M7	The management is pushing work regardless of laborer's abilities.	0.56	25
M8	No or lack of weekly safety meetings.	0.76	7
M9	No training program for the worker to implement the job.	0.70	8
M10	No written/known procedure for the assigned job is available.	0.58	15
M11	Lack of appreciation after completion of the task	0.59	13
W1	The worker was suffering from health problems.	0.44	23
W2	The worker was not in an acceptable physical condition.	0.43	27
W3	Physical fatigue caused the accident.	0.58	12
W4	The worker was suffering from mental fatigue at the job.	0.52	17
W5	Worker was rushing the work	0.57	19
W6	The accident occurred due to misjudgment from the worker.	0.53	22
W7	The worker had no satisfaction with the nature of the job.	0.44	28
W8	The worker had not enough sleeping hours.	0.50	20
W9	Worker was not wearing personal protection items.	0.75	3
W10	The worker was always taking overtime.	0.60	9
W11	The worker was overconfident.	0.38	29
W12	Lack of knowledge by worker on wearing personal safety items.	0.53	19
W13	The worker was delaying the accomplishment of the orders.	0.41	30
M12	No cohesiveness among job crew.	0.72	6
M13	Not enough rest time during the task.	0.50	20
E1	Weather conditions were extreme.	0.86	1
E2	The social life in Kuwait is uncomfortable to the worker.	0.60	10
E3	Unsuitable living, housing and transportation facilities for the worker.	0.70	26
E4	Job or task was too difficult to perform	0.54	24

CONCLUSIONS AND RECOMMENDATIONS

A survey was conducted in order to find the main causes of construction accidents in Kuwait as seen by workers involved in accidents. Statistical and factor analyses were employed to understand the characteristics and determine these factors that contribute to construction accidents. The following results were obtained:

- The most common accidents types in Kuwait are tool accidents, falls from ladders and falls from scaffolding. Both WAD records and the results from this project agree on the fact that falls and tools continue to be the major causes of construction accidents in Kuwait.
- Most of the accidents happened during normal working hours and during summer season.
- Most of injuries affect the upper half of the body, while lower half injuries were the second most injured body part.
- The main causes of construction accidents in Kuwait are related to management and project nature factors; while the workers or human-related factors have no large effect, which is an unexpected result. Both workers and supervisors agreed on the ranking of the accident factors.
- The top ten most important factors that affect construction safety are (1) Extreme weather conditions; (2) Lack of supervision and control on worker's adherence to wear safety items; (3) No or lack of weekly safety meetings; (4) Workers were not wearing personal protection items; (5) Safety regulations were not followed; (6) No safety engineer at site; (7) No cohesiveness among job crew; (8) No training program for the worker to implement the job; (9) Correct tools were not used for the specific task; (10) Unsuitable living, housing and transportation facilities for the worker. These factors should be considered as important elements in any company safety program and should be used as means for overcoming and reducing construction safety problems in Kuwait.

Increased attention should be directed toward determining the effects of weather on construction site accident frequency. Dealing with the extreme weather conditions in Kuwait can be done through reorganizing the business hours to suit the difficult weather conditions, especially in summer, and adopting the two shifts at construction sites. There is a call for WAD and AOS to establish safety standards and codes suitable for the Kuwait environment and workforce based on the latest international standards and codes of practice.

Another factor that contractors could consider is that cohesiveness among the workforce could also mean better safety. As for improving workers'

performance and hence their safety at the sites, it is important to educate and explain safety principles and their importance in every industry and workplace. Also employers should provide training courses and programs to increase attention to safety and to prepare plans for sudden accidents and disasters. The management should observe the performance of inexperienced workers to see if they need further orientation and/or training. Specific strategies for reducing the likelihood or negative consequences of human errors can be achieved by selecting people with the capabilities and skills required to perform a job. This will result in fewer errors being made and proper training of personnel. Improving the design of equipment, procedures, and environments can improve the performance of people, including reducing the likelihood and consequences of errors. Other recommendations are directed toward the institutional level, encouraging coordination and sharing of information with all safety departments in the governmental authorities and insurance companies.

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Appendix Accident Survey

I. Personal Data:

- 1 Name: (Optional):
- 2 Nationality:
- 3 Age: less than 18 18-25 26-35 36-45 more than 46
- 4 Marital status: Married Single Divorced/Widower
- 5 Job Title Tradesmen foreman Labor Other
- 6 Education illiterate Primary Secondary High school Diploma
- 7 Upbringing City Countryside
- 8 Years in Kuwait less than 5 years 5-10 years 10-15 years More than 15 years
- 9 Years of Experience 1-10 11-20 21-30 more than 30
- 10 Level of training low medium High
- 11 Income/day less than 5 KD 5-10 KD 10-20 KD More than 20 KD
- 12 Health History no Yes
- 13 If yes then what Diabetes High blood pressure Heart problem Other
- 14 Did the worker experienced similar accidents? Yes No

II. Accident and Site Information:

- 15 Type of Accident Contact with electricity Crane accident Gas explosion Tool accident
 Failure to lift device Exposure to fire Structure failure Fall from height
 Exposure to hazardous material Trench accident Struck against fixed material Struck by material
 Fall from ladder Slip/trip fall same level Scaffolding Natural causes
 Falling object from height Fall from roof opening Machinery vehicle Drowning
 Asphyxiation Other (Give details)
- 16 The Injured worker was working: First hour of the working day During the working day Last hour of the working day During break hours During overtime hours
- 17 Weather conditions during the accident Hot Cold Moderate Humid Windy
 Foggy Rainy
- 18 Season Summer Winter Fall Spring
- 19 Does the contractor have any insurance policy toward the workers Yes No

III. Please indicate your degree of agreement or disagreement with each statement:

	Highly Agree	Moderate Agree	Neutral	Moderate Disagree	High Disagree
1 Appropriate personal safety procedures were not specified.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 Correct tools were not used for the specific task	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 Lack of supervision and control on worker's adherence to wear safety items.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4 Safety regulations were not followed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5 No safety engineer at site.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6 Safety items were not available on site.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7 The management is pushing work regardless of laborer's abilities.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8 No or lack of weekly safety meetings.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9 No training program for the worker to implement the job.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10 No written/known procedure for the assigned job is available.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11 Lack of appreciation after completion of the task.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12 The worker was suffering from health problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13 The worker was not in an acceptable physical condition.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14 Physical fatigue caused the accident.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15 The worker was suffering from mental fatigue on the job	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16 Worker was rushing the work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17 The accident occurred due to misjudgment from the worker.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18 The worker had no satisfaction with the nature of the job.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19 The worker had not enough sleeping hours.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20 Worker was not wearing personal protection items.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21 The worker was always taking overtime.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22 The worker was overconfident.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23 Lack of knowledge by worker on wearing personal safety items.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24 The worker was delaying the accomplishment of the orders.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25 No cohesiveness among job crew.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26 Not enough rest time during the task.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27 Weather conditions were extreme.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28 The social life in Kuwait is uncomfortable to the worker.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29 Unsuitable living, housing and transportation facilities for the worker	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30 Job or task was too difficult to perform.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

تحليل أسباب الحوادث في مواقع التشييد

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خلاصة

تستعرض هذه الورقة العلمية تحليل للحوادث التي تقع في مواقع التشييد مسبباتها وذلك من خلال تقارير الجهات الحكومية المعنية في جمع هذه البيانات وتناقش هذه الورقة العلمية نتائج مسح ميداني تم القيام به مع 154 عامل تشييد وقعت لهم حوادث في مواقع إنشائية مختلفة في دولة الكويت والبحث الميداني تم توزيعه على هيئة استبيان مقسم إلى ثلاث أجزاء. الجزء الأول يتعرف على مواصفات العامل الذي حصل له الحادث والجزء الثاني يهدف إلى التعرف على وصف وطبيعة الحادث والجزء الثالث يتعرف على مسببات الحادث من خلال 30 سببا تم اختيارهم تتعلق بإدارة الموقع الإنشائي وأسباب تتعلق بعامل التشييد نفسه وسلوكه في الموقع وأسباب تتعلق بطبيعة بيئة العمل أو المشروع الإنشائي. ولقد تم قياس وترتيب هذه الأسباب بطريقة إحصائية ولقد كانت نتيجة هذه الأسباب في الغالب لها علاقة بإدارة الموقع الإنشائي أكثر منها أسباب تتعلق بالعامل نفسه.