International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Analysis of Occupational Injuries in a Large Construction Project in Saudi Arabia

Ayman A. Khojah[1], Mohamed A. Zytoon[2], Abdulrahman M. Basahel[3]

[1, 2, 3]Department of Industrial Engineering, King Abdulaziz University, Jeddah, Saudi Arabia

Abstract: ***Construction is one of the most hazardous industries as revealed by the high recorded injury rates all over the world. The objective of the current study was to analyze the non-fatal occupational injuries in one large construction project in Saudi Arabia and to investigate the factors behind the occurrence of these injuries. The data were analyzed in terms of the occupation of the injured worker, time of injury, injured body part and cause of injury. The results show that there were some patterns in the characteristics of non-fatal occupational injuries in the project. About 51% of the recorded injuries were major requiring three or more days away from work, while the remaining (49%) were minor. The occupations with the highest number of injuries were steel fixer (35.6%), carpenter (32%) and laborers (19.6%). The body parts most vulnerable to injury were the hand (40.9%), foot (15.3%) and leg (12%). The most common causes of injury were falling objects (28.6%), struck against objects/equipment (16.8%) and slips/trips (16.7%). The time between 7:00 to 11:00 a.m. appeared to be the most dangerous hours of the day with 48% of the accidents. The outcomes of this analysis suggest that those factors known to be related to accidents should be considered in the design of accident prevention programs.***

Keywords: Non-fatal injuries; Construction industry; Occupational safety; Saudi Arabia.

1. Introduction

Construction industry has achieved vast growth worldwide particularly in the past few decades (Kanchana et al., 2015). It has been noticed that construction is one of the most hazardous industries, with high rates of fatal and non-fatal injuries. For instance, the U.S. Bureau of Labor Statistics (BLS) reported in 2016 that 970 out of 5190 fatal occupational injuries (18.69%) were recorded in construction industry (BLS 2017).

Construction workers face a risk of fatal and non-fatal injuries higher than any other groups of workers. Occupational injuries and disease may affect the workers either economically or socially. The BLS reported that the total costs of fatal and nonfatal injuries in construction industry were estimated at $11.5 billion in 2002. The average cost per case of fatal or nonfatal injury is $27,000 in construction, almost double the per-case cost of $15,000 for all industry in 2002 (Waehrer et al., 2007).

The economic boom in the Kingdom of Saudi Arabia has increased the number of major construction projects of both the government and private sectors leading to a high increase of accidents rate in construction industry. For instance, the Saudi General Organization for Social Insurance (GOSI) reported that the fatal and nonfatal occupational injuries in 2016 reported in construction industry were about 46% of the total reported injuries (GOSI, 2017). Most of these accidents were caused by the employee's safety culture due to the fact that majority of the employees (95%) in construction are from migrant workers (Alasamri et al., 2012).

There is no doubt that these high accident rates form a major concern and is to be taken into serious consideration with great responsibility by officials to avoid losses of lives and properties. However, the research on accident analysis in the Saudi construction sector is scarce and more studies are needed to understand the accident factors and the root causes for finding the best practices to prevent them.

The objective of this paper is to analyze the non-fatal occupational injuries in one large construction project in Saudi Arabia to understand the pattern of accident occurrence and injury characteristics. The selected project is one of the mega projects in Saudi Arabia. The work is ongoing continuously 24 hours a day and throughout the year. The workforce was about 11000 workers at the time of the study. Due to increased number of workforce and different type of critical activities like working at height, lifting operations and heavy vehicle movements, there is a high probability of workers to be injured.

2. Methods

The data were provided by the safety administration of the main contractor of the project. Each record included the name and occupation of the injured worker; type, cause and time of the injury; injured body part; and brief description of the accident. A total of 1422 non-fatal injuries, representing 2015/2016 records, were considered for analysis in this study. Of these injuries, 724 (51%) were major injuries and 698 (49%) were minor. Minor accident is defined as the accidents that need immediate treatment or care given to the injured worker, usually in the clinic inside the project, until more advanced care is provided or the person recovers, while major accident is defined as the accidents that need to transfer the injured worker to the hospital to receive the proper treatment to recover and normally results more than three days away from work.

3. Results and Discussion

The collected data were analyzed in terms of occupation of the injured worker, cause of the injury, injured body part, and time of injury.

3.1 Injured worker occupation

An essential variable in the accident record was the occupation of the injured worker in the construction project. The data presented in Table 1 shows that out of a total of 1422 injured worker, 506 (35.6%) steel fixers, 455 (32.0%) carpenters and 279 (19.6%) laborers were injured. The remaining injuries (182 or 12.8%) were distributed among all other occupations. The possible reason behind this high percentage of injuries amongst steel fixers and carpenters is that the project was at early stages at the time of study where such injuries are known to be common based on the nature of the work.

The results of the current study agree with those of Hola and Szóstak (2017) in that steel fixers and carpenters are the most injured construction workers. The results partially agree with those of Ling et al. (2009), where it was found that unskilled workers (laborers) have the highest accident rate (23.7%) in Singapore, followed by substructure worker, plumber and carpenter (10.5%) for each. Ling et al. (2009) found also that in the U.S (2003-2006), the most injured workers were unskilled workers with (35.9%), followed by carpenter with (11.8%) and electrician with (10%). The possible reason behind this high percentage of injuries amongst steel fixers and carpenters in this study is at early stages where such injuries are common based on the nature of the work.

Table 1: Distributions of injuries according to occupation

Occupation	*Frequency*	*%*
Steel fixer	506	35.6
Carpenter	455	32.0
Laborer	279	19.6
Foreman	38	2.7
Plaster	27	1.9
Electrician	22	1.5
Safety Foreman	18	1.3
Grinder	16	1.1
Mason	13	0.9
Plumber	12	0.8
Engineer	6	0.4
Timekeeper	5	0.4
Driver	4	0.3
Other	4	0.3
Welder	4	0.3
Painter	3	0.2
Paver	3	0.2
Rigger	2	0.1
Security Support	2	0.1
Surveyor	2	0.1
Mechanic	1	0.1
Total	1422	100

3.2 Injured body parts

Table 2 shows that the most frequent injured body part was the hand (40.9%) followed by foot (15.3%) and leg (12.0%). This applies for both major and minor injuries. Significant portions of the injuries also affected the arm, eye, head, back and chest. Other body parts were less affected. Overall, the upper limbs were more affected by injuries than lower limbs.

The results of this study may be compared with results from other selected studies. Al-Humaidi and Tan have made a study in Kuwait (2010) showed that most injuries have happened to upper limb (54%) followed by lower limb with (36%) of all injuries (Al-Humaidi and Tan, 2010). A similar finding of a study made in Egypt by Abbas and colleagues were they found that most injuries also happened to the upper limb (31%) followed by the lower limb (26.2%) (Abbas et al., 2013). On the other hand a study in Korea showed that most body sites exposed to non-fatal injuries are lower limp (21.1%), followed by upper limb (20.5%), trunk and back (17.2%) (Jeong, 1998).

Table 2: Distributions of injuries according to injured body part

Injured Body Part	*Minor*	*Major*	*Total*	*%*
Hand	403	179	582	40.9
Foot	87	131	218	15.3
Leg	69	101	170	12.0
Arm	46	61	107	7.5
Eye	33	52	85	6.0
Head	29	41	70	4.9
Back	6	51	57	4.0
Chest	5	23	28	2.0
Stomach	2	17	19	1.3
Stress	9	7	16	1.1
Mouth	2	12	14	1.0
Nose	5	5	10	0.7
Teeth	2	7	9	0.6
Fever	1	6	7	0.5
Ear	1	5	6	0.4
Not Clear	2	4	6	0.4
Elbow	0	4	4	0.3
Neck	0	4	4	0.3
Genitals	1	3	4	0.3
Diabetes	1	2	3	0.2
Throat	0	1	1	0.1
Epilepsy	0	1	1	0.1
Allergic	0	1	1	0.1
Total	704	718	1422	100

3.3 Cause of injury

Causes of injuries are presented in Table 3, which shows that falling objects is the most common cause of accidents in terms of major (38.1%) and all injuries (28.6%). Most of the injuries caused by falling objects were major (68%). In terms of all injuries, struck by/against objects or equipment (16.8%) came after falling objects, followed by slips/trips (16.7%), hand tools (12.9%), manual handling (8.5%), caught in/between (4.9%) and fall of person (4.0%) all causing 63.8% of all injuries. However, the order of the latter six causes changed a little bit considering major injuries only, where slips/trips came second after falling objects, followed by struck by/against, hand tools, manual handling, fall of person and caught in/between. Unlike other studies, falling person accidents caused only 4% of the injuries; however, most of fall injuries (72%) were major.

Table 3: Distributions of injuries according to cause of the injury

Cause of injuries	*Minor*	*Major*	*Total*	*%*
Falling objects	130	276	406	28.6
Struck by/against	143	96	239	16.8
Slips/Trips	97	140	237	16.7
Hand tools	133	50	183	12.9
Manual handling	79	42	121	8.5
Caught in/between objects	59	10	69	4.9
Fall of person	16	41	57	4.0
Other	15	17	32	2.3
Pain	3	25	28	2.0
Dizziness	9	8	17	1.2
Violence	8	5	13	0.9
Fever	2	8	10	0.7
Electrocution	2	1	3	0.2
Chemical	0	3	3	0.2
Diabetes	1	2	3	0.2
Explosion	1	0	1	0.1
Total	698	724	1422	100

The injury causes found in this study were almost the same found by other with some variations in the order of prevalence. Jeong (1998) found that the main causes of injury were falls from a height (19.2%), awkward/sudden movement (16.7%), slip and falls on the level (14.5%), and struck by falling and moving objects (14.4%). He found also that caught in/between (4.9%), striking against (4.4%) and other (16.6%) were less prevalent. Moreover, falls (47.6%) and injuries by manual tools (23.8%) were the major causes of injury among construction workers in Egypt (Abbas et al., 2013). An Australian statistic showed that the most cause of injuries is body stressing (37%) while falls, trips and slips represents (28%) and hit by moving objects is (14%) (Australia, 2015). In Saudi Arabia, GOSI (2017) showed that falling accidents came in the top of accidents list (28%), followed by struck and collision with (26.9%) of all injuries. It was noticed that most falls occurred from the temporary construction or fabrics, e.g. scaffolding and through roof openings (Sorock et al., 1993). Also, working at height might be the reason behind the prevalence of falling accidents. Long working hours causing lack of concentration and tiredness may cause the accidents of being struck against objects or equipment.

3.4 Time of accident

The data of this study collected information about the accidents during day hours in the construction sites. The morning time, i.e., the time between 7:00 to 11:00 a.m. (i.e., a length of 5 hours) appeared to be the most dangerous hours of the day for construction workers with 48% of the accidents (Figure 1). In details, 46.8% of falling objects, 40.1% of struck against objects/equipment and 53.1% slip/trip accidents took place during this period. Most of the work is accomplished during this period. Furthermore, the night shift, especially the time between 9:00 p.m. and 3:00 a.m. (i.e., a length of 7 hours), recorded about 28.4% of the injuries. A significant portion of the work is accomplished during night shift because of the thermal conditions during daytime. This means that about three-fourths of the injuries occurred during these twelve hours. The remaining fourth was recorded during the remaining 12 hours, where long breaks were usually given and/or minor tasks were implemented.

One of the reasons of this high rate of accidents during the morning time may be the workers' tendency to rush to finish the tasks given to them before the break and, therefore, to work quickly rather than safely. Other possible reasons are hunger, fatigue, weakness, and dizziness causing loss of concentration. Accidents before lunchtime are very common as found in other studies in Makkah Holy Mosque Expansion Project (Alqadhi, 2018) and Hong Kong where around 50% of accidents happened at similar periods of time (OSHC, 2003).

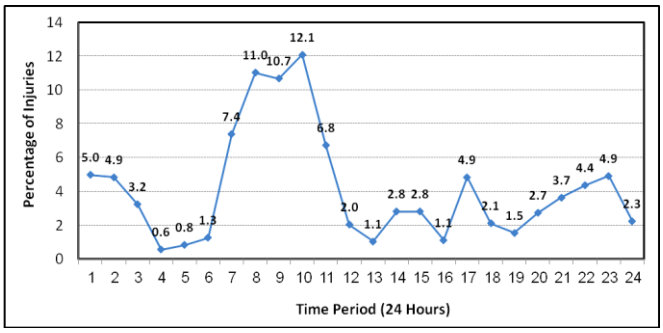

Figure 1: Distribution of injuries according to time of the day

4. Conclusions

The purpose of this study was to analyze the important factors behind non-fatal injuries in a mega project in Saudi Arabia. It was found that the most vulnerable workers to injuries were steel fixers, carpenters and laborers (low skilled workers). The workers of these types of occupations need more training and workload assessment to redesign their jobs to prevent or at least reduce their vulnerability to injuries.

It was noticed that the most prevalent causes of major injuries were falling objects, slips/trips, struck by/against, hand tools, manual handling and falling persons. This indicates that safe work procedures, safe and properly maintained equipment, and personal protective equipment are urgently required to control the root causes of injuries. Furthermore, the main affected body parts were upper limbs, followed by lower limbs. This result should be considered in the selection of personal protective equipment.

The high percentage of injuries during the morning shift necessitates considering organizational actions to distribute the workload over the 24 hours of the day.

Besides the aforementioned actions, tight supervision is urgently required to ensure that workers are restricted to safety procedures. Furthermore, the workers are recommended to be extremely cautious when they use tools and equipment on construction site, and to consult their supervisors or the more experienced coworkers once faced with a complicated task.

There are some limitations to the use of these results such as;

the missing information about age, nationality, education level, experience and type of injury. Despite these data are necessary for more deep understanding of the pattern of injuries, the results of the study provide a good overview of work-related non-fatal injuries occurring in construction sites and the main factors that influence them. The outcomes of this analysis suggest that those factors known to be related to accidents should be the main target of accident prevention programs.

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