

Comparative study for assessing the OSH relationship to the quality of construction projects in Egypt

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ABSTRACT

Background: Construction and architectural projects (CAPs) play a significant role in the economic development of most countries. The construction industry in Egypt has significantly grown in recent years. Due to this growth, the number of occupational accidents in the country's construction industry has also increased.

Methods: This study aimed to assess the Occupational Safety and Health (OSH) field. Then, the assessment effects on the construction project quality are evaluated. The statistical analysis of the questionnaire surveys conducted on project safety, quality, and executive management at construction companies based on the Statistical Package for the Social Sciences (SPSS).

Results: After comparing two sites, the research results indicated differences in completion times and overall costs between the two sites. 70% of the respondents agreed that the completion times, costs, and project qualities vary between the two sites. About 92% of the sample completely agreed and were willing to follow the international laws, which stipulate the principles of OSH in construction sites. They also agreed that there should be an increased understanding of the importance of OSH management in sites, which can help prevent clashes between the two departments.

Conclusions: Companies should hire a social worker to take care of the workers, help them solve their problems, and ensure that safety standards are being met in the construction sites. In addition, regular medical examinations of all workers must be conducted to ensure that they are free from any occupational, non-infectious, or infectious diseases, such as the coronavirus.

Keywords:

Construction management; Construction Safety; Occupational safety and health (OSH), Occupational risk assessment; risk assessment; total quality management (TQM).

1. Introduction

The increasing of accidents and deaths in building construction projects is classified as hazardous industries in the world [1]. The accidents ratio of construction sector in the U.S. is more than 50% comparable with other industries [2]. Construction contractors have traditionally been held responsible for Occupational Safety and Health (OSH) on construction sites [3]. In 1992, the EU Construction Sites Directive (92/57/EEC) [4] put heavy responsibility for OSH on the client. Many occupational accidents are maybe due to several reasons such as organization, planning and co-ordination [5]. There is a lack of studies about the OSH costs in construction industry. OSH costs and accidents during a construction project were compared by [6] in Turkey. Korkutan [7] studied the overall costs of 25 building construction projects with OSH costs. The International Labor Organization (ILO) stated that the numbers of deaths and accidents were 2.3 and 313 million workers respectively in (2015). The global cost in OSH was about 2.8 trillion US dollars with ratio of 4% of the world's gross domestic product per year [8]. The OSH management in the construction fields must be concerned. However, a lot of research had been interested of the workers physical health. Chartered Institute of Building [9] reported that most construction workers are exposed to stresses and depression due to a continuously work like complicated work, inadequate conditions, time pressed and other factors [10]. Stress is closely related to physical health [11]. The occupational risk assessment in construction sites was performed using various methods to reduce and prevent subjectivity in estimating occupational accident severity [12-15]. Most researchers interested of the occupational hazards and the hypothesis testing of explanatory dependent variables. However, occupational injury risks have not been significantly reduced. This long-standing problem can be seen in the traditional practices which approach construction safety [16]. The safety culture and training can be reduced the occupational risks [17]. The utilizing of numerous emerging technologies such as sensing technologies and cyber-physical systems are contributed to reduces the dangerous statues. Alerts are playing a significant role to care and avoid the danger zones [18-21]. OSH has been improved on a worldwide range at construction society based on publications, relevant standards, and implementation of stringent regulations and laws [22, 23]. Nevertheless, the accidents in the construction sectors are occurred increasingly compared with other industries [24]. Razuri, et al [25] suggested that developed a safety performance using a combination of practices. Hence, meaning that there is no single formula to prevent accidents. The scaffolding, staging, portable ladders and floor openings are the main problems to fall injuries from heights [26-28]. Due to the lack of fall protection of OSH administration, most procedures cited in construction standards in 2014 [29]. Achieve zero accidents and ultimate safety performance is the recent topic of industry [30].

Despite the amount of substantial research and improvements that have been made through the years, accident rates in construction are still high [31]. Practical tools directed towards enhancing safety performance in the construction industry are still lacking [32]. The construction industry in Europe (EU-28) had the highest share of fatal occupational accidents in 2015, with more than one in five accidents [33]. The construction industry in Egypt provides employment opportunities for over 120 thousand workers in the public sector and their likes of that number in the private sector; one of the most important causes of accidents in the construction sites according to studies: the weakness of application of OSH in construction companies [34].

2. Research methodology

This study examines the evaluation of construction and architectural projects of the OSH impact on the quality and management of the projects in Egypt. This research is hypothetical to prove that OSH has a direct relationship with the quality of projects based on the theoretical and practical approach. The objective of the theoretical approach is to be used in the practical approach, so that research have the approach of theoretical-practical comparison.

2.1 Research tools:

A quantitative questionnaire was used to verify the hypotheses and over 100 forms were excluded because the answer is doubtful, and the OSH and quality were involved in the questionnaire. The reconnaissance works demo on the number of questionnaires, and

it was missing the questionnaire a set of questions to be evaluated and added as was missing the extra part of the study, demographic and modify the survey. Based on this, the final form was reached, and the results of the survey were analyzed by statistical methods and the conclusion of the reality of construction companies in Egypt through their projects. The survey sample was conducted on a site, quality, OSH and executive managers at construction companies that have construction projects in Egypt. SPSS statistical analysis was used to determine the results of the questionnaire as follows:

a) Study method

Based on the nature of the research and information, the descriptive method was used where this method depends on the phenomenon study as it actually exists in reality. It is interested in an accurate description and is expressed in a qualitative and quantitative expression. The qualitative expression is explaining the characteristics of the phenomenon. The quantitative parameter is providing a descriptive number which attributes the phenomenon or size and association degrees with different phenomena.

b) Study sample

A random sample directed representative of the community study includes the 120 engineers and managers working in construction and architectural sites in Egypt. The engineers and managers were selected according to statistical equations specified for the appropriate minimum sample size representing the community study.

Cronbach's Alpha coefficient was used to measure the stability and truthfulness of the study tools as shown in [Table 1](#). The self-truthfulness is measured by calculate the square root of the stability coefficient. The truthfulness of the current study sample is reached up to 0.883, which indicates that the questionnaire has a high degree of the honesty.

c) Statistical method

Five responses were included in the questionnaires and were assigned numerical values: 5 for "strongly agree" 4 for "agree" 3 for "often" 2 for "sometimes" and 1 for "disagree" The results based on the 5-items Likert scale are shown in [Table 2](#).

d) Results and discussions

The demographic analysis of the questionnaires prepared in this study involved various parameters, including job type, age, years of experience, educational level, social status, and gender. [Table 3](#) presents the demographic analysis of the study sample. The questionnaire surveys were conducted on all the project sites and involved safety and quality engineers in different locations. Therefore, the results represent a cross-section of construction sites throughout Egypt. The percentages according to job type were 13.3%, 8.3%, 15.8%, 26.7%, and 35.8% for safety director, quality director, implementation engineer, quality engineer, and safety engineer, respectively. About 48.3% were over 40 years old and 51.7% were between 22 to 40 years old. In terms of years of experience, 48.3%, of the respondents had over 10 years of experience, 35% have 5 to 10 years, and 16.7% have less than 5 years. In terms of educational level, 9.2% had a Ph.D. degree, 11.7% had an M.Sc. degree, and 79.2% had a B.Sc. degree. As for the social status, 82.5% were married and 17.5% were single. Moreover, in terms of gender, 95.8% were male and 4.2% were female. The statistical analysis was conducted by calculating the main and standard deviations for each question in order to analyze each question's accuracy, as shown in [Table 4](#). After analyzing the results of the 64 questions that the questionnaire worked on. [Figs.1](#) and [2](#) show the questionnaire results and illustrate the effect of the application of OSH on the quality of construction and architectural projects in Egypt. [Fig. 3](#) presents the statistical analysis results for each question given by 120 respondents.

The companies must promote a “safety first” organizational culture in all projects and working locations, create a database for the different types of accidents and their causes in order to avoid similar events in the future, and provide sufficient information and data about risk types surrounding each worker and the appropriate protection methods. Before beginning their work, all workers must also sign a safety document to signal their awareness and willingness to comply with the OSH requirements and instructions. The reasons for project loss include low quality and increased accidents. About 92% of the sample agreed to the idea that there should be an independent OSH management team in each construction company. In addition, over 80% strongly agreed to the idea that the OSH management must develop high efficiency in terms of injury treatment without any delayed medical support. Consequently, the application of OSH standards in a company would improve project quality.

Meanwhile, the OSH department must organize awareness lectures for the employees. About 80% of the sample completely agreed that studies must be conducted to come up with the best and safest methods to perform various tasks, thus reducing the psychological effects caused by accidents and industrial diseases. At the same time, this will strengthen relations between workers and the management, who will be perceived as caring for the safety and well-being of the workers by giving them importance in the workplace.

The OSH department must clarify with each worker the nature of the risks surrounding him/her depending on the construction site where he/she works. About 92% of the sample completely agreed and were willing to follow the international laws, which stipulate the principles of OSH in construction sites. They also agreed that there should be an increased understanding of the importance of OSH management in sites, which can help prevent clashes between the two departments. This is especially needed when, for example, the implementation department insists on executing a job without the application of OSH to the detriment of the company's reputation, while also increasing the risk of accidents and reducing project quality.

About 86 respondents agreed that the application of OSH standards in construction sites saves money and promotes the company's reputation. Meanwhile, according to 105 persons who completely agreed, adherence to OSH standards reduce litigation cases. For 96% of the sample who completely agreed, such standards increase the chances of meeting project schedules and deadlines. These also change the prevailing organizational culture regarding accidents and risks according to 91 persons. When comparing two different sites (same specifications and start times, but only one applied OSH standards), 70% of the respondents agreed that the completion times, costs, and project qualities vary

between the two sites.

Companies must have an independent quality department according to 105 persons, as this reduces the pressures associated with the projects. Meanwhile, about 8% of the study sample completely agreed that having a deterrent law that obliges contractors to apply safety standards may have positive effects on the application of OSH standards in Egyptian companies. In fact, around 97% of the sample completely agreed that one of the reasons for poor project quality is that there is no independent quality department in the companies. In addition, preventive measures should be increased for the workers coming back from holidays and going to holidays, because chances of accidents in construction sites increase during those times. Therefore, companies must also review the wages and salaries to improve the workers' satisfaction and, in turn, increase the quality of their work. It is necessary to maintain an Internet connection in the OSH department so that it can benefit from the experiences of others by communicating with global specialists and keeping up to date with the latest methods and safety systems. The OSH department must also cooperate with the Ministry of Manpower, review and/or approve proposals regarding construction sites, and accommodate the need to hire someone who can oversee OSH standards compliance, thus reducing possible penalties.

Aside from the above, companies should hire a social worker to take care of the workers, help them solve their problems, and ensure that safety standards are being met in the construction sites. In addition, regular medical examinations of all workers must be conducted to ensure that they are free from any occupational, non-infectious, or infectious diseases, such as the coronavirus. Companies should also allow staff from international and local scientific magazines to visit construction sites, identify weaknesses, and allow researchers and universities to conduct scientific research regarding the project sites. In this way, companies can use their findings to improve their operations and increase the quality of projects.

It is necessary for the company management and OSH department to follow up OSH compliance in sites, keep pursuing developments, and continue using modern methods. Furthermore, they must have sufficient information to achieve quality standard requirements and increase the efficiency of information exchange between the various departments, thus improving the quality of the CAPs. Quality-related problem-solving processes must be done quickly as it can reduce the proportion of losses in the construction projects. All workers must be included in the process of development, and their suggestions must be duly considered to increase project quality. Moreover, tools to measure the performance of processes in CAPs must be developed. Companies should employ the principle of quality and consider it as the responsibility of each worker in addition to having a special system meant to raise project quality, such as examination of materials and endorsement of inspection reports, as mentioned by more than 80% of the respondents.

The company management must recognize the importance of TQM in terms of the speed of construction, quality of performance, and economic cost of developing a proposed system as quickly and as effectively as possible. There should be a technical college devoted to applied sciences and OSH as well as secure work environments and TQM to qualify the skilled inspectors in the market. It is also necessary to develop a special OSH department in the universities and increase the amount of teaching materials

and credit hours for college students to further promote awareness of OSH and TQM. There should be a university condition to study OSH and train everyone according to his/her specialization so that no student receives a graduation certificate without having appropriate training on safety. The classification of construction companies under the Egyptian Federation for Construction and Building Contractors must consider the companies' experiences in striving for safe and secure work environments, preventing accidents and injuries, and maintaining TQM.

Finally, companies must review the complaints of office for workers and contractors, apply safety systems at work, and even do unannounced visits to different construction sites so that the workers know of their existence.

Table 1: Reliability statistics	
Cronbach's Alpha	No. of items
0.883	64

Table 2: Weight of the answers		
Response	Weight	The weighted average
Disagree	1	From 1 to 1.80
Sometimes	2	From 1.81 to 2.60
often	3	From 2.61 to 3.40
Agree	4	From 3.41 to 4.20
Strongly agree	5	Bigger than 4.20

Table 3: Members distribution of the study sample according to the different variables

	Frequency	Percent
Job type		
1- Director of the Department of safety	16	13.3
2- Director of quality management	10	8.3
3- Engineer implementation	19	15.8
4- Quality engineer	32	26.7
5- Safety engineer	43	35.8
Total	120	100.0
Person age		
1- larger from 40	58	48.3
2- from 22 to 40	62	51.7
Total	120	100.0
No. of experience years		
1- Higher than 10	58	48.3
2- From 5 to 10	42	35.0
3- Less than 5	20	16.7
Total	120	100.0
Education level		
1- Ph.D.	11	9.2
2- M.Sc.	14	11.7
3- B.Sc.	95	79.2
Total	120	100.0
Social status		
1- Married	99	82.5
2- Single	21	17.5
Total	120	100.0
Gender		
1- Male	115	95.8
2- Female	5	4.2
Total	120	100.0

Table 4: Statistical analysis of questionnaire results

	Valid Percent					Mean	Standard div.	Result
	(1)	(2)	(3)	(4)	(5)			
Q1	0	0	15.8	0	84.2	4.68	0.73	(5)
Q2	0	0	4.2	12.5	83.3	4.79	0.50	(5)
Q3	0	39.2	5.0	7.5	48.3	3.65	1.41	(4)
Q4	0	31.7	42.5	18.7	9.2	3.03	0.93	(3)
Q5	0	0	23.3	13.3	63.3	4.40	0.84	(5)
Q6	0	0	30.8	21.7	47.5	4.17	0.87	(4)
Q7	0	7.5	5	20.8	66.7	4.47	0.90	(5)
Q8	0	20	4.2	13.2	82.5	4.18	1.20	(4)
Q9	0	0	4.2	9.2	86.7	4.83	0.48	(5)
Q10	0	13.3	11.7	21.7	53.3	4.15	1.08	(4)
Q11	0	25	8.3	32.5	34.2	3.76	1.17	(4)
Q12	0	21.7	25.0	53.3	0	3.32	0.81	(3)
Q13	0	9.2	7.5	38.3	45.0	4.19	0.93	(4)
Q14	0	41.7	30.8	28.7	0.8	2.87	0.84	(3)
Q15	0	7.5	52.5	27.5	12.5	3.45	0.81	(4)
Q16	0	19.2	18.3	20.8	41.7	3.85	1.16	(4)
Q17	0	43.3	22.5	25.0	9.2	3.00	1.03	(3)
Q18	0	0.8	15.8	45.8	37.5	4.20	0.73	(4)
Q19	0	0	0	8.3	91.7	4.92	0.28	(5)
Q20	0	0	0	19.2	80.2	4.81	0.40	(4)
Q21	0	11.7	20.8	0.8	88.7	4.23	1.14	(5)
Q22	0	7.5	33.3	13.3	45.8	3.98	1.05	(4)
Q23	0	0.8	32.5	16.7	50.0	4.16	0.92	(4)
Q24	0	0	4.2	19.2	78.7	4.73	0.53	(5)
Q25	0	11.7	25.0	14.2	49.2	4.70	0.68	(5)
Q26	0	20.8	29.2	4.8	9.2	4.69	0.87	(5)
Q27	0	16.7	35.8	12.5	35.0	4.64	0.97	(5)
Q28	0	8.3	14.2	14.2	83.3	4.92	0.40	(5)
Q29	0	12.5	0.8	15.0	71.7	4.35	0.97	(5)
Q30	0	0	0.8	11.7	87.5	4.22	1.34	(5)
Q31	0	0.8	11.7	7.5	80.0	3.81	1.27	(4)
Q32	0	0.8	0	41.7	57.5	4.26	1.10	(5)
Q33	0	12.5	7.5	4.2	75.8	4.29	1.15	(5)
Q34	0	9.2	35.0	15.8	40.0	4.27	0.95	(5)
Q35	0	0	48.7	4.2	49.2	3.96	1.16	(4)
Q36	0	4.2	0	17.5	78.3	4.52	0.63	(5)
Q37	0	7.5	4.2	0	88.3	4.01	1.10	(4)
Q38	0	11.7	0	0.8	87.5	3.38	0.92	(3)
Q39	0	0	4.2	0	95.8	3.66	1.13	(4)
Q40	0	11.7	0	30.0	58.3	4.33	1.01	(4)
Q41	7.5	11.7	0	13.3	67.5	4.46	1.01	(5)
Q42	0	30.0	0.8	27.5	41.7	4.87	0.37	(5)
Q43	0	9.2	23.3	0	67.5	4.67	0.71	(5)
Q44	9.2	0	0	34.2	56.7	4.56	0.55	(5)
Q45	0	11.7	0	38.3	50.0	4.43	1.08	(5)
Q46	0	13.3	28.3	7.5	50.8	3.87	1.05	(4)
Q47	0	0	7.5	33.3	59.2	4.03	0.98	(4)
Q48	0	7.5	9.2	38.7	48.7	4.23	0.90	(5)
Q49	0	7.5	12.5	35.8	44.2	4.17	0.92	(4)
Q50	0	7.5	11.7	0	80.8	4.54	0.97	(5)
Q51	0	11.7	18.7	0	71.7	4.32	1.12	(5)
Q52	0	18.3	4.2	25	52.5	4.12	1.14	(4)
Q53	0	11.7	21.7	32.5	34.2	3.89	1.01	(4)
Q54	0	13.3	13.3	11.7	61.7	4.22	1.12	(5)
Q55	0	4.2	20.8	35.0	40.0	4.11	0.88	(4)
Q56	0	4.2	20.0	13.3	62.5	4.34	0.94	(5)
Q57	0	35.0	0	7.5	57.5	3.88	1.41	(4)
Q58	0	0	23.3	13.3	63.3	4.40	0.84	(5)
Q59	0	14.2	9.2	30.8	45.8	4.08	1.06	(4)
Q60	0	0	22.5	24.2	53.3	4.31	0.82	(5)
Q61	0	0	26.7	20.8	52.5	4.26		(5)
Q62	0	11.7	14.2	8.3	85.8	4.28	1.09	(5)
Q63	0	5.0	19.2	23.3	52.5	4.23	0.93	(5)
Q64	0	0	47.5	19.2	33.3	3.86	0.89	(4)

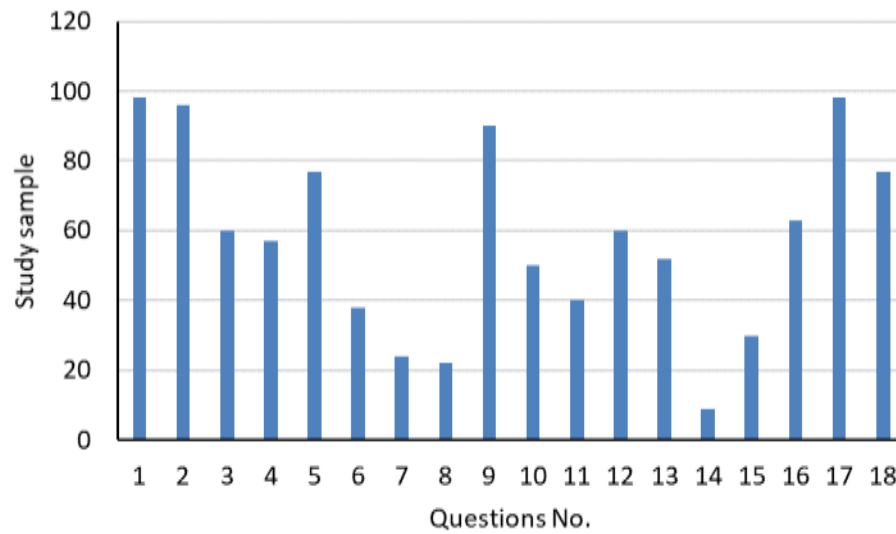


Fig. 1. Questionnaires results of accident reasons

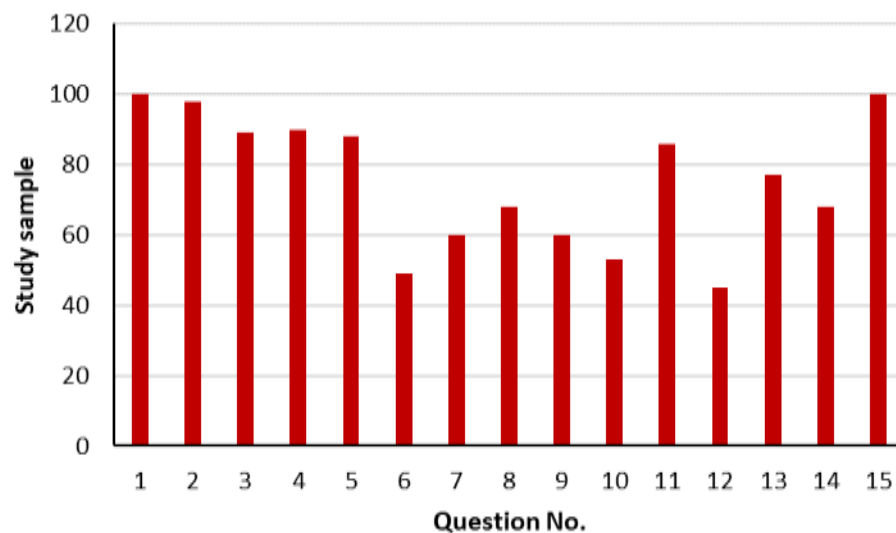
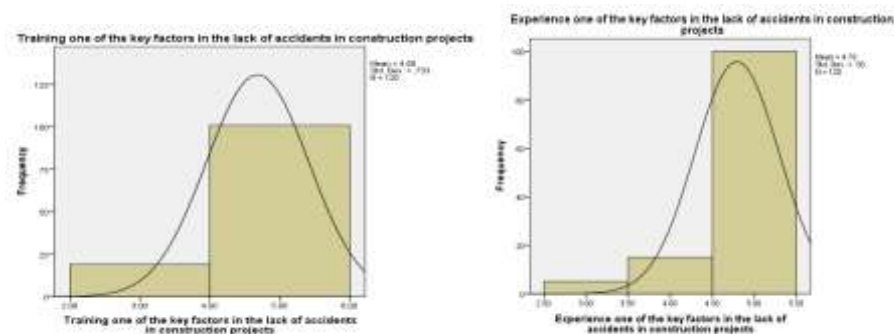
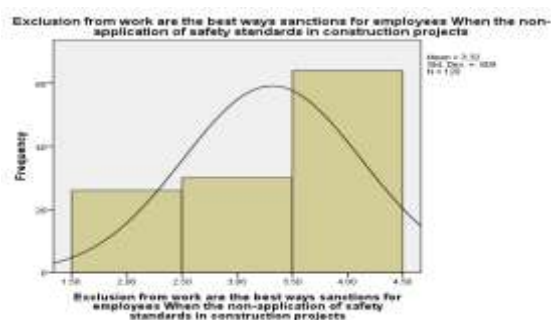
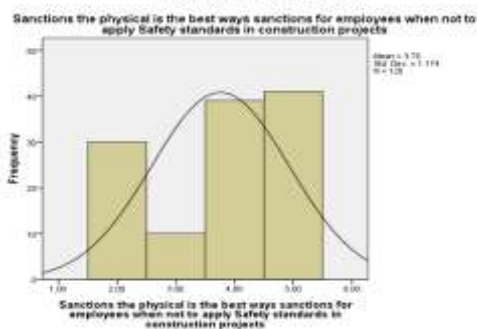
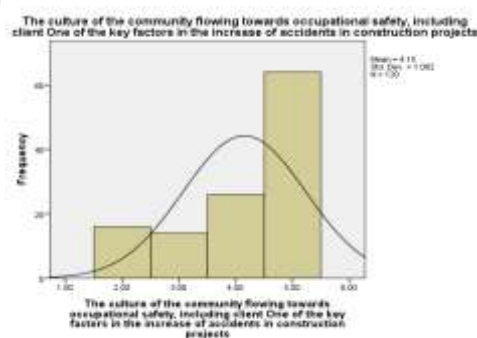
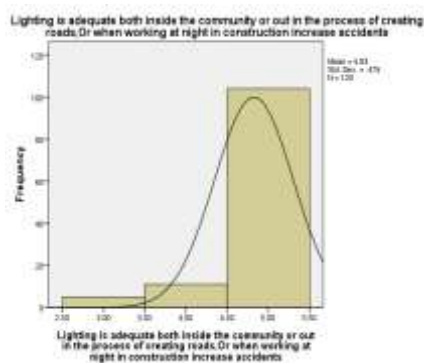
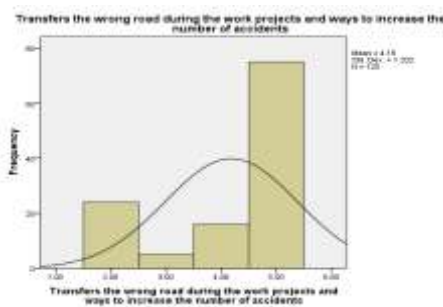
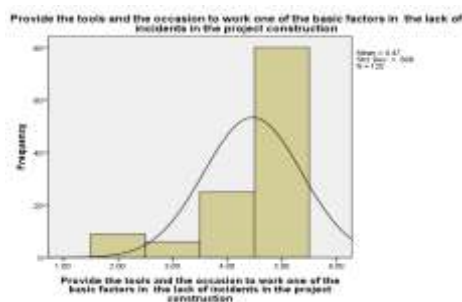
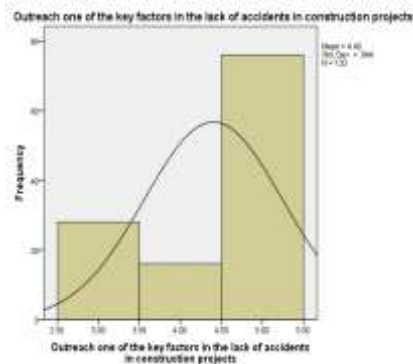
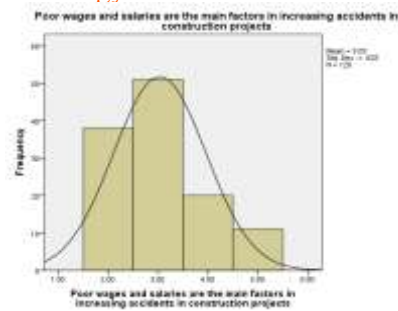
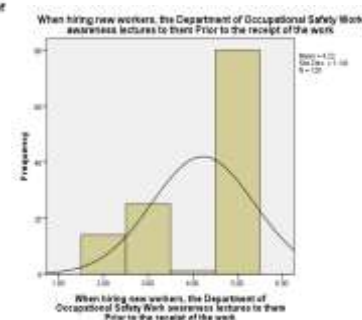
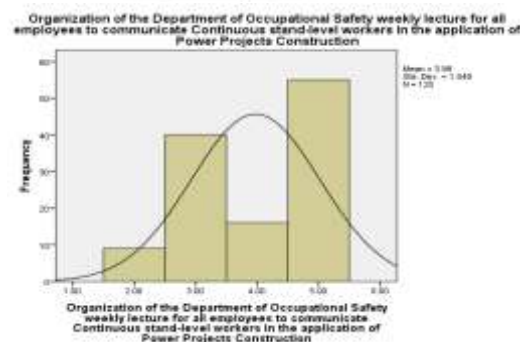
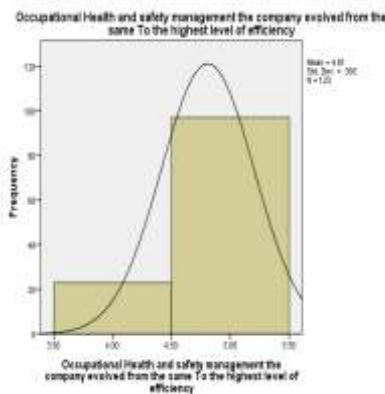
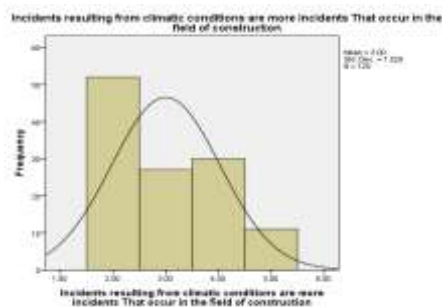
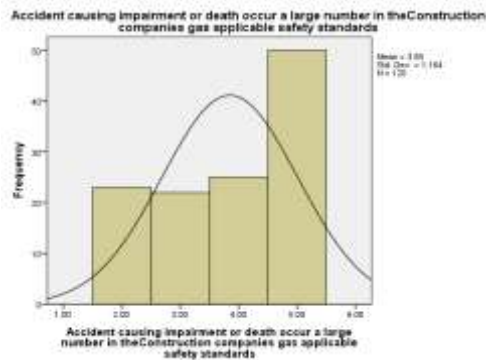
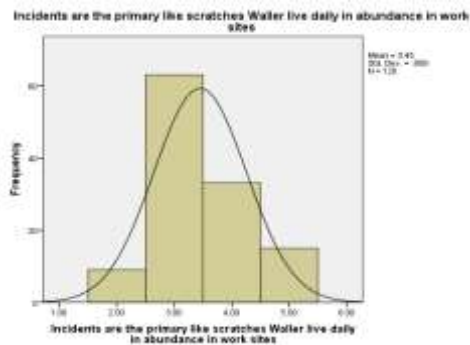
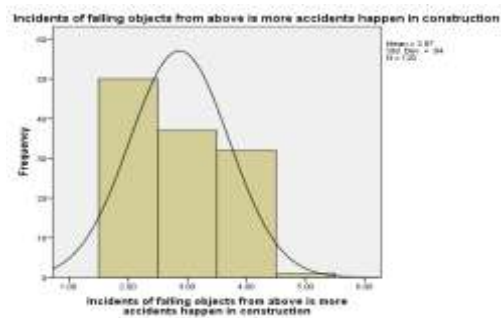
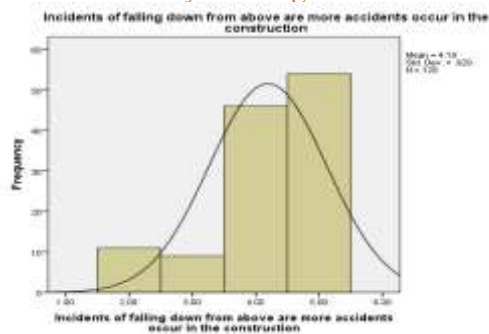


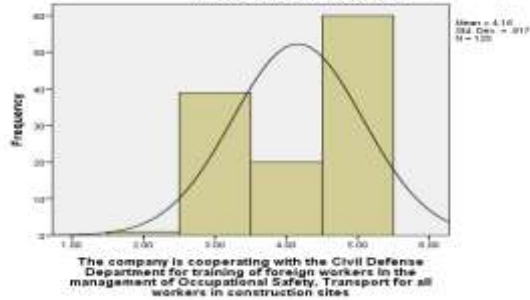
Fig. 2. Questionnaires results of quality



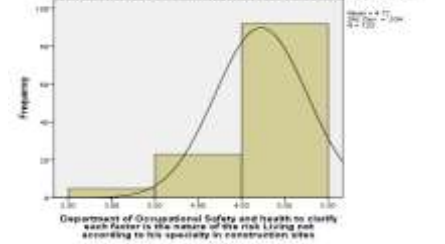




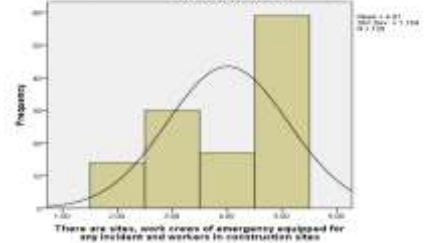
The company is cooperating with the Civil Defense Department for training of foreign workers in the management of Occupational Safety. Transport for all workers in construction sites



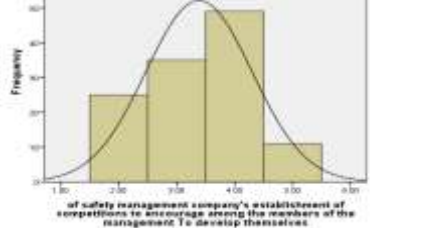
Department of Occupational Safety and health to clarify each factor is the nature of the risk Living not according to his specialty in construction sites



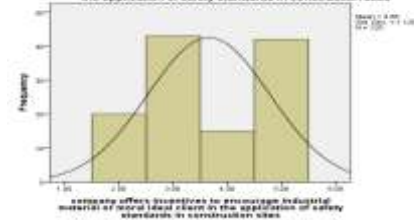
There are sites, work crews of emergency equipped for any incident and workers in construction sites



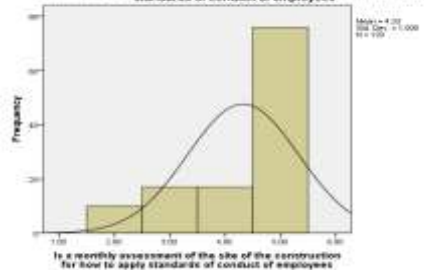
of safety management company's establishment of competitions to encourage among the members of the management To develop themselves



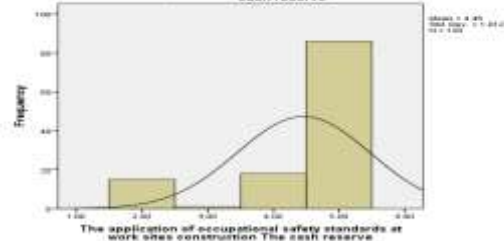
company offers incentives to encourage industrial material or moral ideal client in the application of safety standards in construction sites



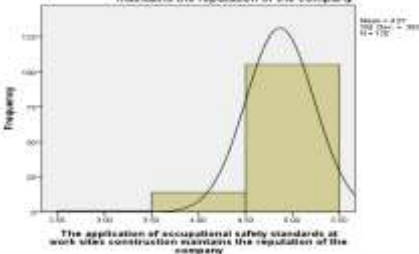
Is a monthly assessment of the site of the construction for how to apply standards of conduct of employees



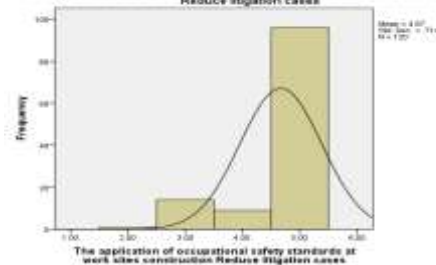
The application of occupational safety standards at work sites construction The cash reserve



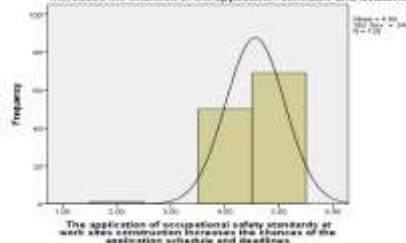
The application of occupational safety standards at work sites construction maintains the reputation of the company



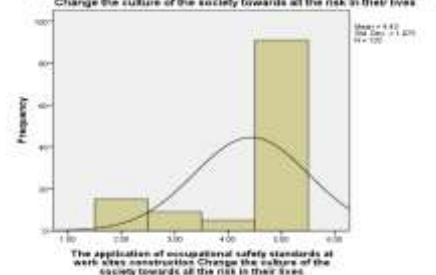
The application of occupational safety standards at work sites construction Reduce litigation cases



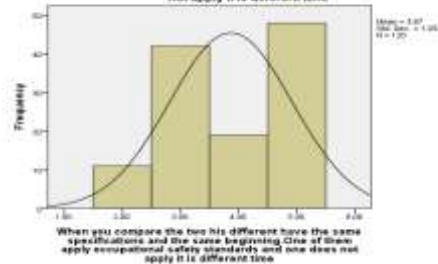
The application of occupational safety standards at work sites construction increases the chances of the application schedule and deadlines



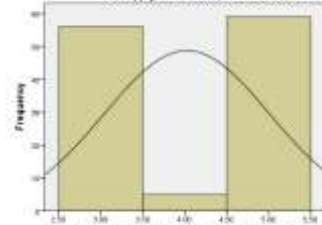
The application of occupational safety standards at work sites construction Change the culture of the society towards at the risk in their lives



When you compare the two his different have the same specifications and the same beginning One of them apply occupational safety standards and one does not apply it is different time

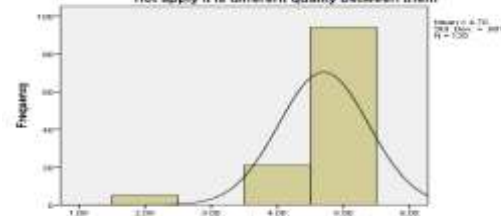


When you compare the two his different have the same specifications and the same beginning One of them apply occupational safety standards and One does not apply it is the cost value between them

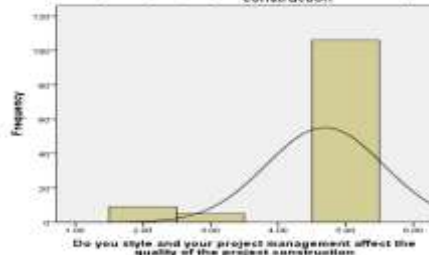


When you compare the two his different have the same specifications and the same beginning One of them apply occupational safety standards and One does not apply it is the cost value between them

When you compare the two his different have the same specifications and the same beginning One of them apply occupational safety standards and One does not apply it is different quality between them

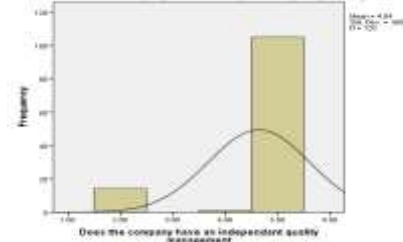


Do you style and your project management affect the quality of the project construction



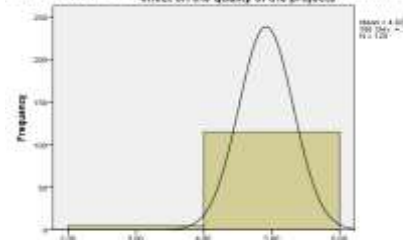
Do you style and your project management affect the quality of the project construction

Does the company have an independent quality management



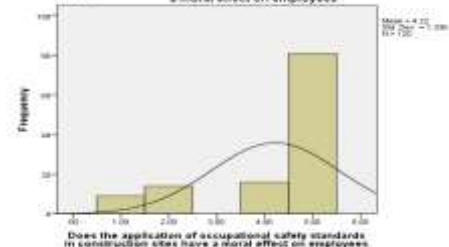
Does the company have an independent quality management

Do you apply the standards of Occupational Safety in construction sites Obvious effect on the quality of the projects



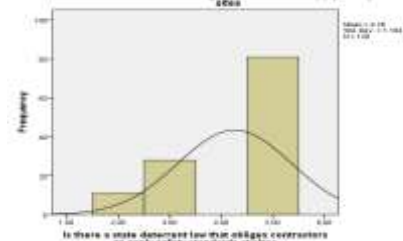
Do you apply the standards of Occupational Safety in construction sites Obvious effect on the quality of the projects

Does the application of occupational safety standards in construction sites have a moral effect on employees



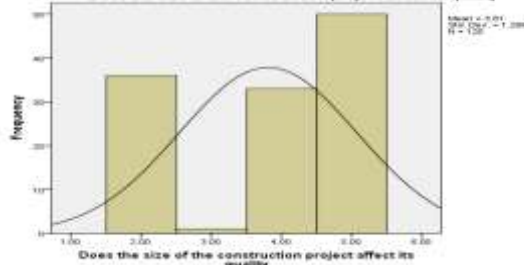
Does the application of occupational safety standards in construction sites have a moral effect on employees

Is there a state document law that obliges contractors to apply safety standards at sites



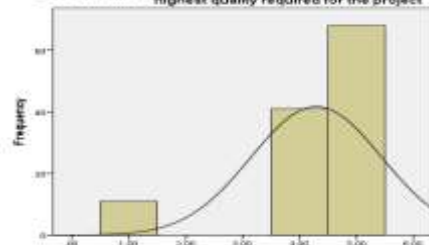
Is there a state document law that obliges contractors to apply safety standards at sites

Does the size of the construction project affect its quality



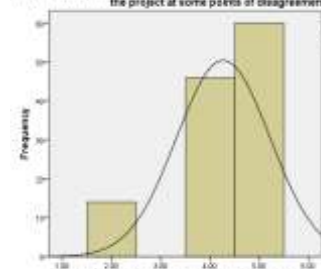
Does the size of the construction project affect its quality

Does the company's quality management have all the powers to reach the highest quality required for the project



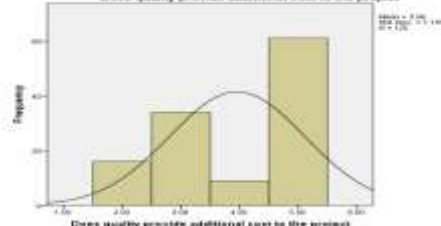
Does the company's quality management have all the powers to reach the highest quality required for the project

Can the Quality Manager retain the Senior Management the execution Manager of the project at some points of disagreement



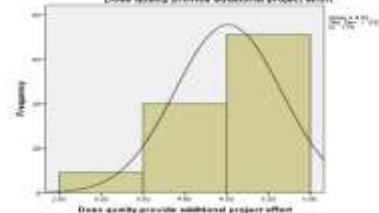
Can the Quality Manager retain the Senior Management the execution Manager of the project at some points of disagreement

Does quality provide additional cost to the project

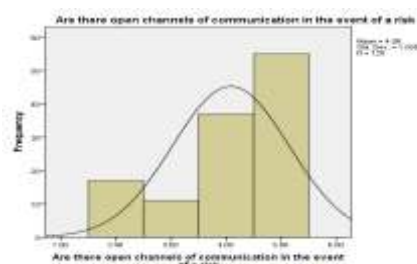
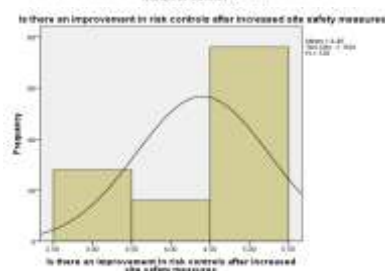
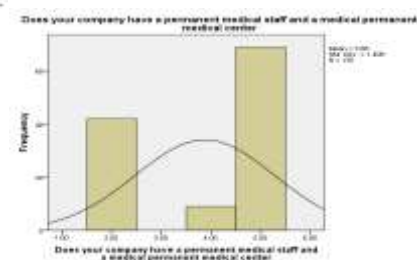
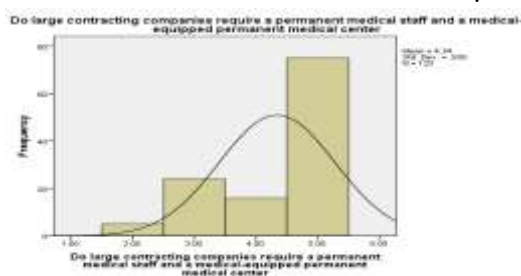
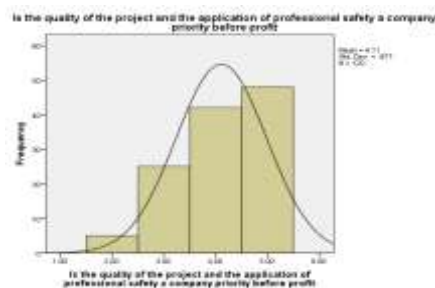
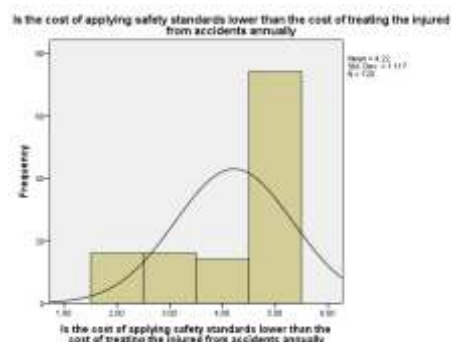
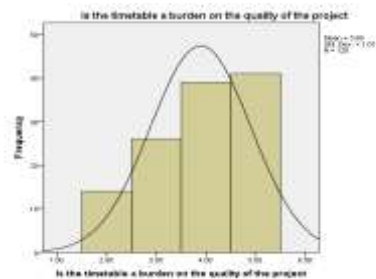
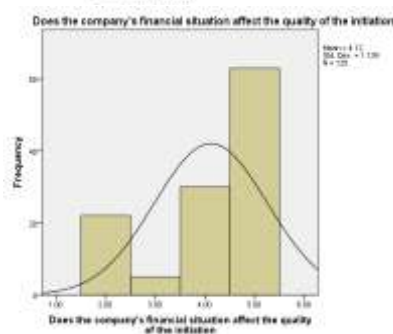
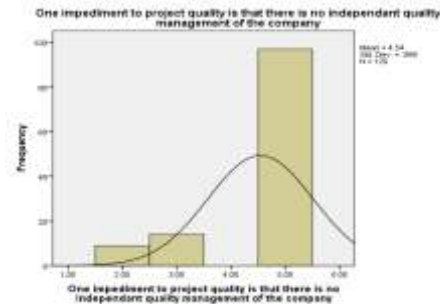
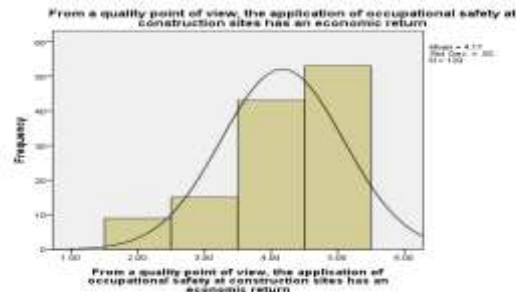
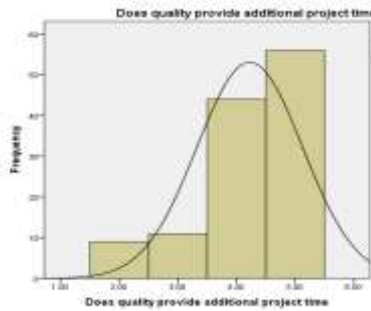


Does quality provide additional cost to the project

Does quality provide additional project effort



Does quality provide additional project effort



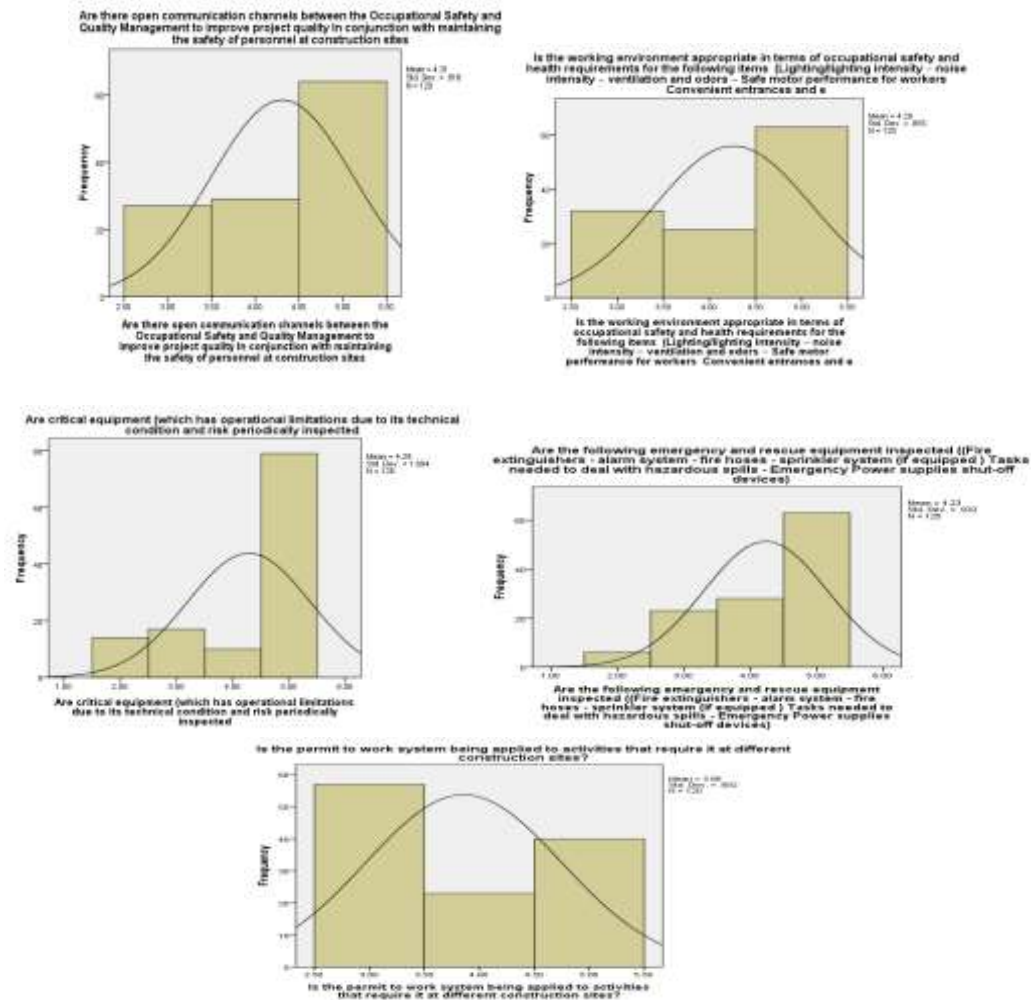


Fig. 3. Statistical analysis results for each question

e) Conclusions

The following conclusions were obtained for this work:

- 1- A deterrent law that obliges contractors to apply safety standards at sites may have positive effects on the implementation of OSH standards among Egyptian construction companies.*
- 2- Chances of accidents in construction sites are higher at the end of the month than at the beginning of the month due to poor wages and salaries given to workers, which drive them to do poor-quality work. Therefore, companies must review the wages and salaries to improve the workers' satisfaction and, therefore, the quality of their work.*
- 3- It is necessary to maintain an Internet connection for the OSH department so that it can communicate with global specialists and keep up to date with the latest methods and safety systems, thus benefiting from the experiences of others. The OSH department must cooperate with the Ministry of Manpower and review relevant proposals to improve work conditions in construction sites.*
- 4- Companies should hire a social worker to take care of the workers, help them solve their problems, and ensure that safety standards are being met in the construction sites. In addition, regular medical examinations of all workers must be conducted to ensure that they are free from any occupational, non-infectious, or infectious diseases, such as the coronavirus.*
- 5- There should be clear set of criteria on the appropriate work procedures as well as the acceptance or rejection of work outcomes. The stages of project construction must be documented from the conceptualization stage up to the maintenance operation. There should also be a trusted program for each company's internal audit.*
- 6- There should be a technical college devoted to applied sciences and OSH as well as secure work environments and TQM to qualify the skilled inspectors in the market. It is also necessary to develop a special OSH department in the universities and increase the amount of teaching materials and credit hours for college students to further promote awareness of OSH and TQM.*
- 7- The application of occupational safety standards in construction sites saves money, promotes the company's reputation, reduces litigation cases, increases the chances of completing schedules and deadlines, and changes the organizational culture regarding safety and various kinds of risks.*

f) **Recommendations**

The following are the recommendations arising from this work:

1. Establish an application program to assess the impact of OSH on the quality of construction and architectural projects using artificial intelligence.
2. Establish a program to assess the impact of corporate management behavior on quality.
3. A study to compare the cost results when using OSH standards and the costs of occupational accidents in engineering projects.

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