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A Study of the Relationship between Work Accidents and Production Rates in Libyan Steel Industry

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Abstract- **Steel industry is characterized as one of the dangerous industries due to the nature of its operations. Most of thoese operations are done at high temperatures, such as Electric Arc Furnaces (EAF) and reheating furnaces. in addition to high temperatures, there are high speeds of pulleys and movement of conveyor belts that lead to injuries and damages for equipment and facilities.**

This study aims to identify the relationship between work accidents and production rates on the one hand, and the relationship between work accidents and worker injures on the other in Libyan Iron and Steel Company (LISCO). as well as figure out the reasons that lead to the differences in the results of the relationships compared to the research hypotheses were identified.

The research hypotheses were proved, except for the hypothesis of traffic accidents, which indicates that there is a problem related to changing the company's policy by allowing the entry of workers with their own vehicles to the walls of the complex. This change made it difficult to control the number of traffic accidents. Also, the number of fires was not clearly correlated with the change in production rates during the study period.

Keywords: **work accidents, production rate, steel, correlation.**

I. INTRODUCTION

The hypothesis that work accidents increase with production rates is considered correct if stable safety procedures are followed over the life of the industrial establishment.

In the common sense, an accident is understood as a sudden, unpredictable event, which results ininjuries and losses to people. Accidents at workplace are a serious health, social and economic problem. Accidents are not only consequences of injuries to employees, but also, in the case of seriousand fatal accidents, suspending production , the need to replace an injured worker, the repair or replacement of damaged machines or tools. The problem of understanding accident atworkplace, as well as their causes and consequences, is an important element of planning and organizingwork. Therefore, it seems important to review statistical data on accidents at work and indicate the areasin which these events occur most frequently in order to reduce the likelihood of their occurrence or eveneliminate them through proper work organisation and introduction of preventive measures [1].

Workplace accidents are not events that happen because organisations wish that they occur, much less reoccur, so they must be rigorously analysed and widely discussed whenthey happen. These must be understood as a source of knowledge, as situations that provide learning and production of knowledge for future actions [2].

The causes of an accident at work can be numerous, but are mostly due to a lack or deficiency of planning and organization of production, unsafe conditions in the workplace and human factors, which may have psychological origins or reflect social problems and cultural and / or organizational training. Since human behavior relates to subjective factors, it makes the task of researching them more difficult since the problems and / or psychosocial disorders may be, or not, directly related to work activity[3].

II. LITERATURE REVIEW

According to the definition put forward by World Health Organisation (WHO), work accident is an incidence that is unexpected, and generally causes personal injury, damages

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the machines and equipment's and stops operation. According to the International Labour Organisation, the unexpected incidence that causes a certain damage or hurt is called accident [4].

Over the years, manufacturing industries such as the steel industry have shown a significant increase intheir productivity, this growth highlights themes that make up the development framework of thissegment. In this context, there is a concern with the preservation of the employee's integrity, generatinga state of alert for the risks existing in the production process, and the preventive measures thatorganizations must put in place to eliminate or minimize these risks, avoiding accidents [5].

Iron and steel industries are among the occupations that are labelled with high-risk in the present era. Due to the blend of many reasons, which may include the high-risk working environment (which is typical of iron and steel industry) and low education level of unskilled menial workers [6].

Workplace accident in Addis Ababa is very high and mostly caused bythe absence of and poor culture on PPE usage that requires awareness creation andinterventions from policymakers to improve the working environment. Employees who are working in medium and large sizeindustries have more likely faced exhaustion, dislocation, sprain, fracture, and burn than employees who are working in small size industries [7].

In the libyan iron and steel industry, significant amount of resources will need to be allocated for education and training on the significance of safety and health practices. Most especially, assessment of the safety and health management practices remained the only avenue to check on the effectiveness or otherwise of the system. Hence, having a robust assessment model that is unique for the Libyan iron and steel industry is very crucial and necessary[6].

The rates of danger and fatal accidents are high according to the internationally recognized standards, especially in the furnace department and the casting department in the factory. The research recommended the necessity of applying the management of safety and security in industrial processes, and working on training workers, developing their skills, and spreading a culture of occupational safety among them, because unsafe acts and similar recurring accidents are indicators and signs of accidents that may be destructive in the future [1].

III. RESEARCH HYPOTHESES

H_1 : work accidents are expected to increase with increased production rates if the same preventive measures are taken over a period of time.

- H_{1A}: industrial accidents are expected to increase with increased production rates if the same preventive measures are taken over a period of time.
- H_{1B}: Traffic accidents are expected to increase with increased production rates if the same preventive measures are taken over a period of time.
- H_{1C}: Fires are expected to increase with increased production rates if the same preventive measures are taken over a period of time.

H_2 : worker injuries are expected to increase with the increase in work accidents if the same preventive measures are taken over a period of time.

- H_{2A}: hand injuries are expected to increase with the increase of work accidents if the same preventive measures are taken over a period of time.
- H_{2B}: feet injuries are expected to increase with the increase of work accidents if the same preventive measures are taken over a period of time.
- H_{2C}: head injuries are expected to increase with the increase of work accidents if the same preventive measures are taken over a period of time.

IV. WORK ACCIDENTS

Work accidents in this research were divided into three main types, which are used in the Libyan Iron and Steel Company, as follows:

1. Industrial accidents: This type of accident consists of injuries to workers, damage to equipment and tools, and damage to facilities.
2. Traffic accidents: Due to the employees' use of motorized vehicles within the company's scope for transportation as well as for handling materials, traffic accidents occur that vary in severity from minor injuries to death.
3. Fires: They occur in different places in the company's factories and to varying degrees.

V. WORKR INJURIES

Workr injuries in this research were divided into three main types, which are used in the Libyan Iron and Steel Company, as follows:

1. Hand injuries.
2. Feet injuries.
3. Head injuries.

VI. RESEARCH METHODOLOGY

The study relied on the analysis of data extracted from the archives of accidents that occurred during the period from 2008 to 2020 and publications that were made available to researchers to view in libraries, such as books, magazines and master's thesis. Simple accidents and unsafe applications are the same and identical as the main causes

of serious accidents. If the focus is on unsafe actions and on similar accidents, no serious, devastating or fatal accident will occur. The simple correlation coefficient was used to determine the relationship between production rate and work accidents of its three types (industrial, trafic and fires) and finding the relationship between total work accidents and workers' injuries of their three types (hand , foot and head). The aim of determining the correlation coefficient is to verify the research hypotheses as well as to identify the main causes which led to increasing the work accidents and worker.

6.1 Correlation

Correlation means association - more precisely it is a measure of the extent to which two variables are related. There are three possible results of a correlational study: a positive correlation, a negative correlation, and no correlation.

- A positive correlation is a relationship between two variables in which both variables move in the same direction. Therefore, when one variable increases as the other variable increases, or one variable decreases while the other decreases. An example of positive correlation would be height and weight. Taller people tend to be heavier.
- A negative correlation is a relationship between two variables in which an increase in one variable is associated with a decrease in the other. An example of negative correlation would be height above sea level and temperature. As you climb the mountain (increase in height) it gets colder (decrease in temperature).
- A zero correlation exists when there is no relationship between two variables. For example there is no relationship between the amount of tea drunk and level of intelligence.

6.2 Correlation Coefficient

Correlation Coefficient is a number between +1 and −1 calculated so as to represent the linear interdependence of two variables or sets of data.

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

Where,

r = Pearson Correlation Coefficient

x_i = x variable samples y_i = y variable sample

$\bar{x}$ = mean of values in x variable $\bar{y}$ =mean of values in y variable

VII. RESULTS AND DISCUSION

The company followed a different policy in management after the year 2011, where a number of changes emerged, the most important of which are:

- The decrease in the number of workers, especially those with experience, and moving to work in other cities where their original residence is.
- Employees were allowed to enter with their own vehicles inside the company walls, which contributed to the congestion of roads and intersections.
- Difficulty in supplying spare parts and equipment, especially with regard to industrial protective equipment and firefighting.

Data on production rates, work accidents of all three types (industrial, traffic and fire) and worker injuries of all three types (hand, foot, head) for the period from 2008 were collected.

Table .1 shows production data, work accidents and injuries during the study period.

Table.1 work accidents and injuries.

year	No. of Work accidents			No. of Injuries		
	Industrial	Traffic	Fires	hand	feet	head
2008	148	148	3	58	40	15
2009	140	140	4	60	29	21
2010	155	155	5	72	35	16
2011	0	0	0	0	0	0
2012	46	46	5	16	13	11
2013	117	117	8	51	31	16
2014	82	82	1	42	18	12
2015	47	47	3	22	18	8
2016	59	59	8	22	12	11
2017	86	86	3	44	16	13
2018	82	82	6	36	13	7
2019	81	81	4	32	24	7
2020	75	75	3	22	18	7

Table.2 shows production data, during the study period from 2008 to 2020 [8],[9].

Table.2 production quantities .

Year	Production quantity(Tonne)
2008	1100000
2009	1000000
2010	970000
2011	190000
2012	370000
2013	760000
2014	740000
2015	400000
2016	460000
2017	445000
2018	530000
2019	440000
2020	550000

The relationships between production rates and work accidents were identified to verify the first hypothesis, while the relationships between total work accidents and worker injuries were found to verify the second hypothesis.

7.1 The relationship between production rates and work accidents.

The relationship between production rates and work accidents of its three types (industrial, traffic, and fires) was calculated using the graphic and mathematical methods through determing the linear correlation coefficient, in order to verify the validity of the first research hypothesis (H_1).

H_1: The relationship between total work accidents and production rates were illustrated in figure.1

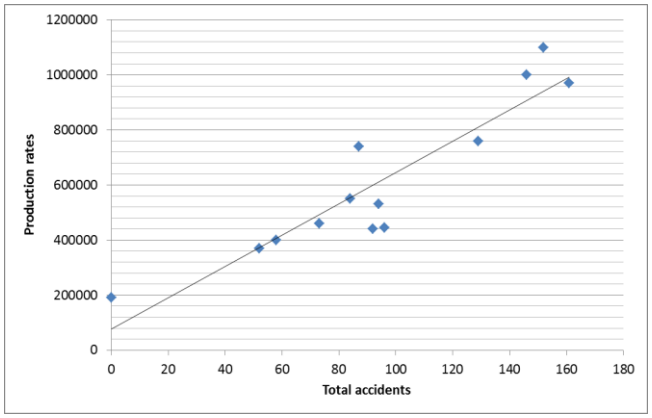

Figure.1 The relationship between total work accidents and production rates

H_{1A}: The relationship between industrial accidents and production rates were illustrated in figure.2

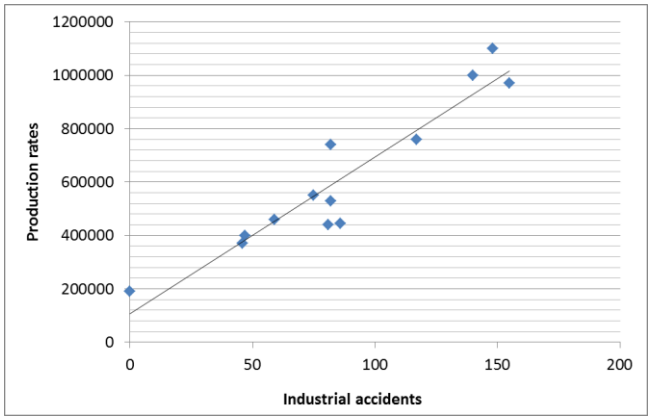

Figure.2 The relationship between industrial accidents and production rates

H_{1B}: The relationship between traffic accidents and production rates were illustrated in figure.3

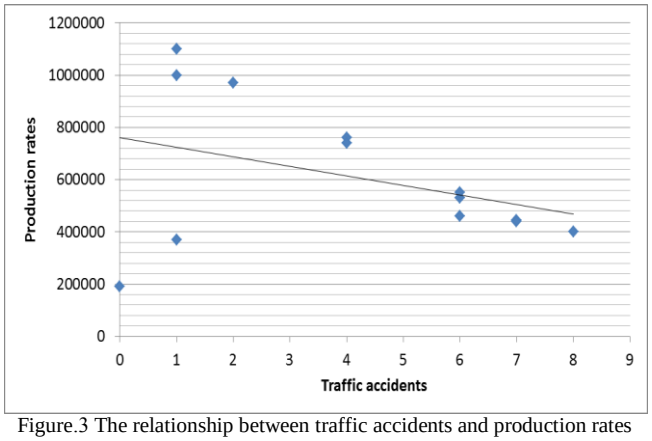

Figure.3 The relationship between traffic accidents and production rates

H_{1C}: The relationship between fires and production rates were illustrated in figure.4

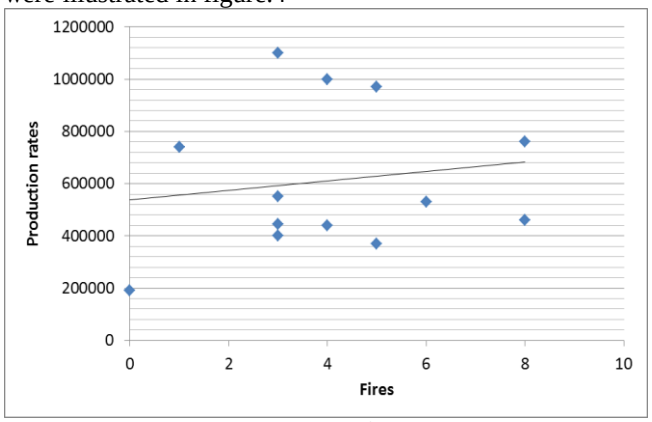

Figure.4 The relationship between fires and production rates

7.2 The relationship between total work accidents and worker injuries.

The relationship between total work accidents and worker injuries of its three types (hand, feet, and head) was calculated using the graphic and mathematical methods through determing the linear correlation coefficient, in order to verify the validity of the second research hypothesis (H_2).

H_2: The relationship between total work accidents and total worker injuries was illustrated in figure.5

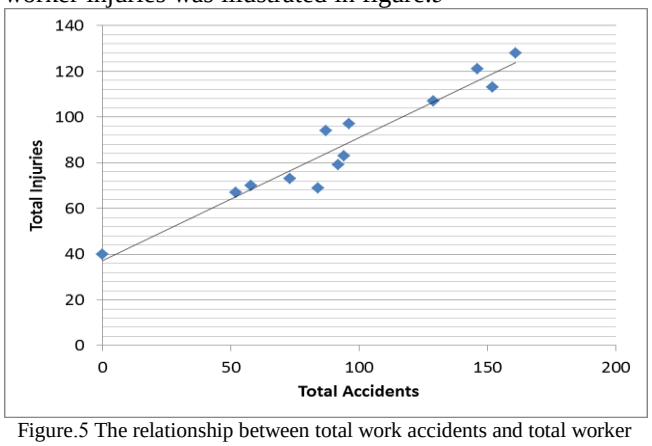

Figure.5 The relationship between total work accidents and total worker injuries

H_{2A}: The relationship between total work accidents and hand injuries was illustrated in figure.6

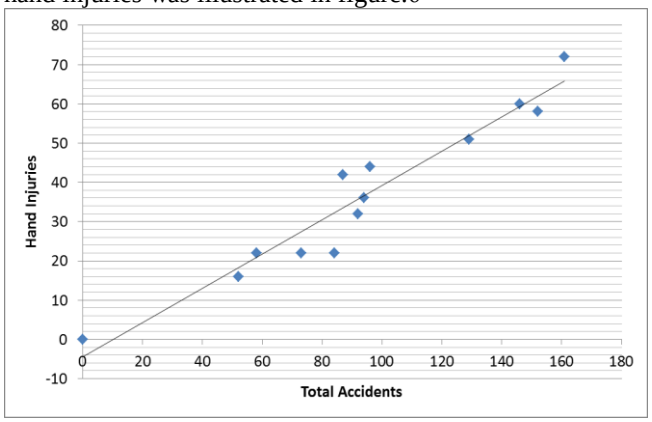

Figure.6 The relationship between total work accidents and hand injuries

H_{2B}: The relationship between total work accidents and feet injuries were illustrated in figure.7

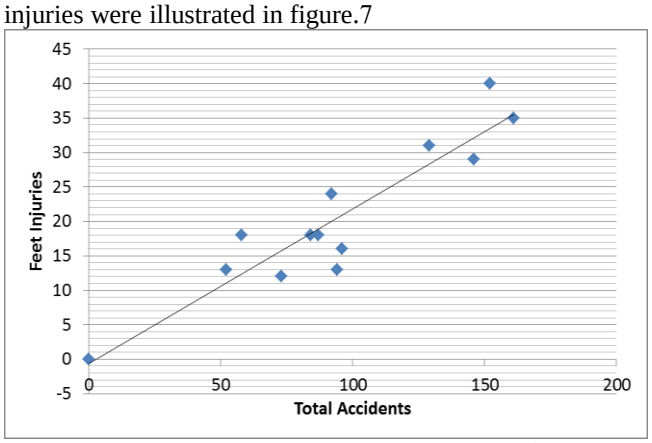

Figure.7 The relationship between total work accidents and feet injuries

H_{2C}: The relationship between total work accidents and head injuries were illustrated in figure.8

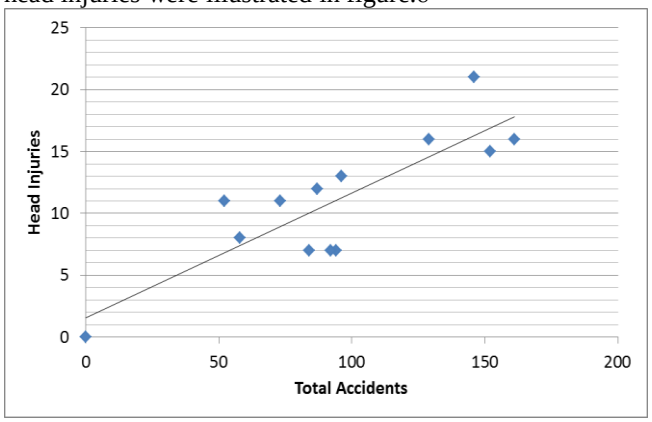

Figure.8 The relationship between total work accidents and head injuries

The relationships between production rates and work accidents on the one hand, and the relationships between work accidents and worker injuries on the other, are summarized in the following framework in figure.9 :

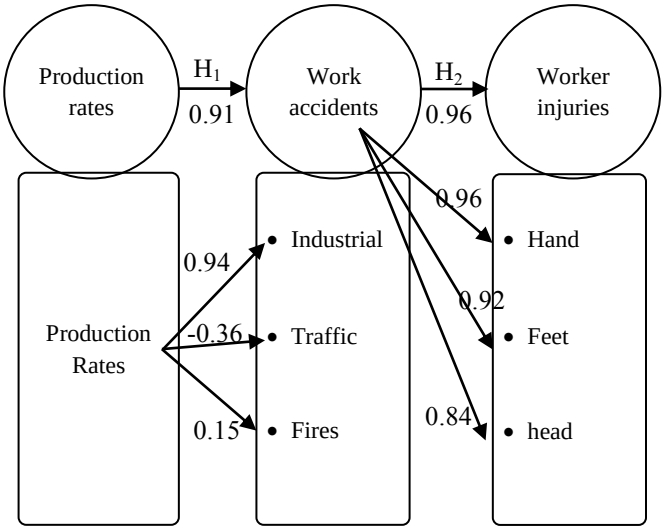

Figure.9 Framework of hypotheses

The matrix of correlation coefficients for the research hypotheses as shown in table.3

Table. 3 The matrix of correlation coefficients of the hypotheses.

	Production rate	Work accidents	Industrial accidents	Traffic accidents	fires	Wokrers injuries	hand	feet	head
Production rate		0.91	0.94	- 0.36	0.15	--	--	--	--
Work accidents	0.91		--	--	--	0.96	0.96	0.92	0.84
Industrial accidents	0.94	--		--	--	--	--	--	--
Traffic accidents	- 0.36	--	--		--	--	--	--	--
Fires	0.15	--	--	--		--	--	--	--
Worker injuries	--	0.96	--	--	--		--	--	--
Hand	--	0.96	--	--	--	--		--	--
Feet	--	0.92	--	--	--	--	--		--
head	--	0.84	--	--	--	--	--	--	

The results showed that the first hypothesis H_1 and the sub-hypothesis H_{1A} were verified, with a correlation coefficient of (0.91) and (0.94), respectively, while the sub-hypothesis H_{1B} was not verified by the weak negative correlation coefficient. which was (- 0.36) also, the H_{1C} hypothesis was not fully verified, with the correlation coefficient indicating a very weak positive correlation (0.15).

The results also showed that the second hypothesis H_2 and its sub-hypothesis H_{2A}, H_{2B} and H_{2C} were fully verified by strong positive correlation coefficients. with correlation coefficient (0.96), (0.96), (0.92) and (0.84) respectively.

VIII. CONCLUSION

The study period witnessed important changes in the history of the Libyan Iron and Steel Company, as it is noticeable that during the period before the year 2011 the company was able to achieve high levels of production through its various factories, due to the stability of the general conditions in the country and the flow of raw materials, spare parts and production requirements in addition to the stability Providing the company with basic utilities such as electricity, water and natural gas, while the company's factories stopped working completely during the year 2011 as a result of the events in the country. This was followed by a relative rise in production quantities during the years 2013 and 2014, while it returned to decline again starting from the year 2015, as a result of the instability conditions that the country witnessed, and this situation continued until the year 2020.

The research hypotheses were achieved, except for the hypothesis of traffic accidents, which indicates that there is a problem related to changing the company's policy by allowing the entry of workers with their own vehicles to the walls of the complex. This change led to an increase in traffic accidents and the difficulty of controlling and monitoring those accidents, especially in the post-2011 period.

IX. RECOMMENDATIONS

Updating occupational safety and prevention guidelines, as well as traffic lights on roads and intersections within the company's scope, according to the latest developments in this field, and renewing damaged ones and keeping pace with the times, especially with regard to the use of electronic signboards and other modern technologies in this field.

Carry out periodic maintenance of equipment, stairs, corridors, entrances, exits and roads, which can be a cause of work injuries of all kinds.

Raising awareness and educating employees about the importance of following the rules of security and safety in the workplace.

Intensification of specialized training courses in the field of occupational safety and the use of expertise in this field from inside and outside the company.

Developing the company's systems, devices and equipment for detection and firefighting and providing it with the latest programs to enhance its role in serving the company's factories, facilities and employees alike.

Carrying out other similar studies and focusing on the severity of injuries and their impact on the performance of workers.

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