

Occupational Safety and Health Management in Selected Industrial Sectors in Sudan

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ABSTRACT

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Introduction: Since Heinrich's early studies, work has been recognized as a substantial contributor to psychological and physical illness. Fast technological, economic, and social advancements have increased the number of occupational fatalities and illnesses in developing nations. Nonetheless, it is demonstrated that the creation, application, and enforcement of Occupational Safety and Health Management Systems (OSHMS) reduce accidents and enhance employees' well-being. This study aims to understand Sudan's current occupational safety and health situation and identify any challenges or gaps in the current system.

Methods: A mixed methods approach deploying a literature review and secondary data was adopted to answer the research question about the status of occupational health and safety in Sudan.

Results: A comparison of the artisanal and organized gold mining sectors over the years 2018-2020 shows an increase in the number of accidents in the artisanal sector but a sharp decrease in both the number and severity of accidents in the organized sector. The frequency rate declined in the organized sector but fluctuated in the artisanal sector. It was also found that many OSH incidents of different types and levels of severity occurred. In 2020, the Fatal Accident Rate (FAR) was 66.48 in artisanal gold mining, 0.55 in organized gold mining, and 0.01 in oil and gas. However, calculating and comparing other sectors' performance indicators to evaluate OSH's status was not possible for many reasons.

Conclusion: Findings were constrained, possibly due to the limited occupational health and safety data. There is an urgent need to strengthen and improve the governance of occupational safety and health in Sudan. A more comprehensive study needs to be undertaken to assess the status of the OSH in formal and non-formal sectors and investigate the correlation of OSH to workers' well-being and the Sudanese economy.

Keywords: Health and Safety Management, Safety Performance, Sudan

Introduction

Work was identified as a significant cause of psychological and physical ill-health since the early research of Heinrich.¹ The rapid economic, technical, and social changes have created a substantial burden of occupational deaths and ill health on governments.¹ However, the development, implementation, and enforcement of Occupational Safety and Health Management Systems (OSHMS) have proven to minimize the number of accidents and improve workers' well-

being.^{1,2} One way of doing that is to calculate safety performance to improve safety management systems. The safety performance can be measured using safety leading or lagging indicators to improve safety management systems,³ and for informed decision-making.⁴ However, the recording of occupational accidents and work-related diseases is considered weak globally.⁵

Despite the efforts put in managing OSHMS, threats to the health and safety of employees continue to exist in the workplace⁶, including in developing countries which are subject to a disproportionate amount of hazardous production and unsafe working condition due to their industrial development conditions.⁷ The International Labour Organization (ILO) statistics note that the world's workforce sustains at least 2.78 million deaths and 374 million non-fatal injuries because of poor OSHMS.⁸ Poor OSHMS contributes to about 5.4% of the global Gross Domestic Product (GDP).⁹

OHS concerns in developing nations are severe, and their effective management has become an essential issue.¹⁰ Workers in developing countries are more likely to be affected by workplace hazards than their counterparts in developed countries.^{11,12} For instance, in Africa, workers' life expectancy is negatively impacted due to poor OHS enforcement compared to the rest of the world.¹³

Masekamani et al. argued that OHS in developing countries lags considerably behind developed countries in delivering OHS services to workers.¹⁴ Nuwayhid reasoned that the limited access to OHS services in low-income countries (LIC) is due to the lack of government interest in occupational health, inadequate data collection methods, and lax implementation of health and safety legislation, besides the challenging social, economic, and political situations.¹⁵ In addition, the growing competition and lack of supervision in some developing countries, where most of the global occupational deaths and injuries happen, are due to minimized labor costs and the standards of workers' protection.¹⁶

Sudan is no different from all developing and Sub-Saharan countries, where workers often work under hazardous conditions, and the status of OHS is ambiguous.¹⁷ The lack of research on occupational health and safety in Sudan¹⁸ and developing countries¹⁹ is a fundamental factor in the ambiguity of OHS in Sudan. Therefore, this study aims to answer the research question: Where does Sudan stand regarding workplace safety and health?

Methods

This study adopted a mixed methods approach to answer the research question about occupational health and safety status in Sudan. Mixed research methods are widely used by researchers where the quantitative and qualitative data gathered and analyzed complement each other.²⁰ The

qualitative data was obtained by searching databases exploring published articles in peer-reviewed journals, technical reports, governmental unpublished reports, and international organizations' websites. The quantitative method adopted a secondary data analysis approach. The quantitative approach is believed to use data already collected for different purposes, and ²¹ provides various options for research across many fields.²²

The authors of this study deployed the network strategy to identify the available secondary data by contacting key OHS practitioners during the summer of 2021. A plethora of literature has noted that networks and previously published data can generate information on primary research to undertake manual library searches and/or locate unpublished material, necessitating contacting appropriate local or national organizations working in the field.²³⁻²⁵ The authors' networks contact resulted in compiling data from accident records for the period between 2018-2020 from the Ministry of Oil and Gas, the Sudanese Mineral Resources Company (SMRC), the Ministry of Labour and Administration Reforms (MLAR), the Ministry of Industry (Industrial Safety Unit), the Pension and Social Insurance Fund (PSIF), and a soap factory in Khartoum, Sudan.

Although the literature criticizes measuring safety performance using accidents, injury, and severity rate (Lagging indicators), it is considered an important indicator to measure workplace safety.²⁶ In fact, many organizations attempt to improve their safety procedures to reduce and eliminate exposure to hazards in the workplace by measuring and reducing the Lagging indicators.²⁶

The primary OSH performance indicators are calculated for three selected Sudanese industrial sectors using the methods included in the WHO manual for direct health care workers of 2002.¹⁷ The secondary data for calculating the primary OSH performance indicators were obtained from several sources. These include the incident summaries of the mining and oil and gas industries provided by the Sudanese Mineral Resources Company (SMRC) and the Ministry of

Energy and Oil. Data on industrial accidents were provided by the Industrial Safety Unit at the Ministry of Industry, in addition to the compensation records provided by the Pension and Social Insurance Fund (PSIF).

Three industries were selected based on the African Development Bank report, which indicates that the leading industrial sectors contributing to the Gross Domestic Product (GDP) in Sudan are mining, agriculture, and manufacturing.²⁷ The agriculture industry is spread across Sudan; nevertheless, no data on agricultural OSH was found. Therefore, it was replaced with the oil and gas industry. In addition, a soap factory with about 260 employees is taken as a case study to assess the status of the HSE performance.

Calculations example:

The incident rate is calculated by multiplying the total number of accidents by 1000 and dividing it by the total number of workers exposed. In contrast, the frequency rate is calculated by multiplying the total number of accidents recorded in a particular year by 1000 and then dividing that number by the total number of hours worked in that year:

Frequency Rate (FR)

$$FR = \frac{\text{Total number of accidents} \times 10^3}{\text{Total number of hours worked}}$$

In certain instances, the severity rate is calculated by determining the number of days absent from work for every 1000 hours spent on the job. In addition, there is a distinction made in accident data between injuries that are temporary and those that are permanent and debilitating.

Results

OHS is defined as the discipline of anticipating, recognizing, evaluating, and controlling hazards arising in or from the workplace, which could impair the health and well-being of workers and impact the surrounding communities and the environment.²⁸ Preventing occupational risks is a complicated task. One of the significant contributors to this complexity is the worldwide reported lack of workers' awareness about their occupational health rights intended to minimize

occupational risks.²⁹

Although OSH fatal and non-fatal accidents are widely reported in the Sudanese newspaper and social media, no official statistics are published. This is obvious in the high numbers of death that occurred because of mine collapses, handling hazardous materials, and fires in different locations around Sudan.

Since the oil boom of the 1970s, the exploitation of minerals, such as oil and gas and mining, is thought to help developing nations by providing employment, economic growth, and public services, reducing poverty. Yet numerous empirical studies highlight the difficulty of transferring resource income and resource-led growth into poverty reduction.³⁰ One of the difficulties discussed in the literature is the impact of oil and gas exploration and processing on the health and safety of workers.³¹

The industrial sectors, including factories, processing facilities, and workshops, need to be evaluated for their impact on OHS as another domain. It is believed that, in the manufacturing industry, terrible and dangerous accidents that put people and businesses in danger are happening more and more often.³² Recent example is the Rana Plaza collapse in Bangladesh in 2013, which resulted in the deaths of over a thousand workers and the injuries of tens of thousands more, highlighting the severity of OSH in developing nations.³³

In this study, the secondary data of different industrial incidents were analyzed, and incident frequency and severity rates were calculated to compare the selected industries and the industry's performance over specific years. Firstly, the average full-time employee working hours in Sudan were estimated. Secondly, whenever possible, the Frequency Rates (FR), Incident Rates (IR), Lost Workdays (LWD), and Severity Rates (SR) were calculated for the organized and artisanal gold mining, oil and gas and soap factory (case study).

However, occupational injury rates vary considerably by country and are rarely comparable in part due to differences in

legislation, availability of injury records (source of lost-time injury claim), and severity of the injury. The type and other characteristics of work-related injuries will vary with the severity of cases, which reflects the duration of workdays lost, and which is distinct from country to country.³⁴

Below is an illustration of the literature review results and the secondary data analysis providing an overview of different industries' occupational health and safety.

Gold Mining in Sudan

Mining continues to be a dangerous activity, whether large-scale industrial or small-scale artisanal mining.³⁵ The World Bank estimates that 100 million children, women, and men work in ASM worldwide, mainly in remote rural areas of LIC and LMIC.³⁶ Nonetheless, the number of artisanal and small-scale miners is unknown worldwide, and it is most likely to be substantially more significant than the World Bank estimate. Furthermore, accurate information on the number, gender and age distribution of artisanal and small-scale miners in all countries is lacking, as there is no information on available health and social services.³⁶

Artisanal Small-Scale Mining (ASM), which is rapidly increasing in Low-Income Countries (LIC) - and Lower-Middle-Income Countries (LMIC), takes place under extreme conditions with a lack of occupational health and safety.³⁶ The hazards in ASM include exposure to dangerous chemicals, particularly mercury, lead, cyanide, arsenic, cadmium, and cobalt, as well as severe injuries such as falls from heights, crush injuries from cave-ins, lacerations and amputations from unsecured machinery, among others. ³⁶ Workers in ASM are also exposed to dust and toxins, along with stress from the working environment or managerial pressures, which give rise to various diseases that affect miners.³⁵ Ergonomic risks posed by using heavy equipment and manual handling in confined spaces contribute to OHS in the mining industry.³⁷ Adding to the occupational hazards identified in the literature concerns about hygiene and sanitation, the rise of sex workers and

associated reproductive health problems in mining communities have been raised by authors.³⁸

Sudan is the third-largest gold producer in Africa. Gold mining in Sudan goes back to 3000 BC.³⁹ In 2017, the director-general of the Geological Research Authority of Sudan (GRAS) declared that more than one million Sudanese are involved in artisanal gold mining,⁴⁰ and about 361 companies are involved in gold mining activities in Sudan, ranging from exploration to tailing mining processes. Due to natural disasters, bad socioeconomic conditions, low literacy rates, and long-lasting conflicts, traditional gold miners in Sudan are at risk for several health problems, especially vulnerable internal migrant miners exposed to short, medium, and long-term health consequences and disparities.⁴¹ Hence, artisanal gold mining in Sudan presents substantial risks to miners.⁴²

Nevertheless, it is believed that in LMIC, governmental oversight is rare, especially in areas where ASM is illegal.³⁶ Sudan, as a lower middle-income country⁴³ is no exception when it comes to ungoverned artisanal mining. Fadlallah (2020) highlighted the experience of the Sudanese internal migrants working as traditional gold miners. He stated that internal gold miners experience increased health risks, a dearth of apparent migration and mining policies and limited awareness of government and healthcare providers of the migrants' needs.⁴¹

Based on the secondary data obtained from the incident summaries of the mining industries provided by the Sudanese Mineral Resources Company (SMRC), the trend of gold mining incidents in the artisanal and organized sections is illustrated (Figure 1). The figure shows that artisanal mining witnessed an increase in the number of accidents while the organized section witnessed a steady decrease in the total number of incidents between 2018-2020. However, comparing the two sectors is impossible because of the lack of information on the number of workers in each.

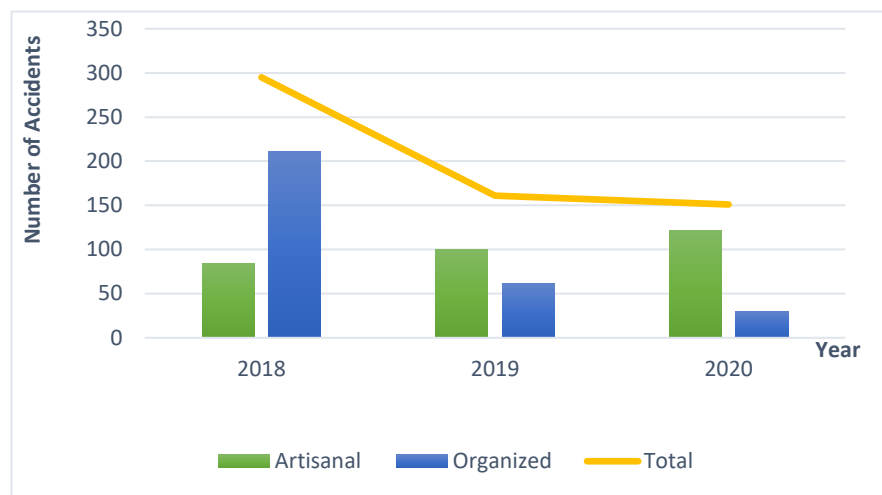


Figure 1: Distribution of gold mining incidents (Source SMRC)

The incidents, frequency, and severity rates were calculated for organized and artisanal gold mining to measure their performance over three years between 2018-2020. It was found that the performance indicators in organized mining experienced a vast decrease over the three years of

the study (Table 1). Although it was difficult to calculate the performance indicators in artisanal mining due to the limited data available, the considerable fluctuations in the frequency rate were obvious (Table 2).

Table 1: Performance indicators of organized gold mining assuming 7.5 hours/day and a five-day week

Year	Total Number of Incidents	Number of Fatalities- Related to the work	Number of Lost Workday Cases (LWDC)	Frequency Rate (FR)	Fatal Accident Rate (FAR)
Organized Gold Mining					
2018	211	15	9	115.93	8.24
2019	61	5	8	33.52	2.75
2020	30	1	8	16.48	0.55

Table 2: Performance indicators of artisanal gold mining assuming 7.5 hours/day and a five-day week

Artisanal Gold Mining				
Year	Total Number of Incidents	Number of Fatalities- Related to the work	Frequency Rate (FR)	Fatal Accident Rate (FAR)
2016	31	DNA ¹	17.03	DNA
2017	134	DNA	73.63	DNA
2018	84	DNA	46.15	DNA
2019	100	DNA	54.95	DNA
2020	121	121	66.48	66.48

¹ Data Not Available

Oil and Gas in Sudan.

Although the oil and gas industry is expected to apply higher standards of corporate governance and even greater transparency in reporting practices when it comes to matters related to OHS principles.³¹ It was noted that the oil and gas sector is among many industries characterized by the

convergence of numerous hazardous exposures that can potentially cause serious catastrophes and work-related accidents.⁴⁴ This was evident in the oil and gas catastrophes accidents like the Piper Alpha disaster in 1988 and the Montara blowout in 2010 that claimed a life and caused damage to properties.⁴⁴ Previous oil and gas

disasters proved that the occupational hazards associated with petroleum refining require impeccable health and safety management systems.⁴⁵

On the other hand, although the Arab region is the largest oil and gas producer globally, minimal research has been done at the sectoral level and across various aspects of the oil and gas value chain. Along the same lines, the literature on oil and gas in Sudan is poor and could not be found in any digital resources searched.⁴⁶

Sudan's oil is estimated at 0.3% of the world's total oil reserves,⁴⁷ most of which are in the separated South. While oil and gas were first discovered in Sudan in the 1970s, the civil war and the lack of infrastructure contributed to the delays in their

production.⁴⁸ Nevertheless, the impact of oil and gas on the Sudanese economy was undeniable before the separation of Southern Sudan in 2011.⁴⁹

The oil and gas business in Sudan is administrated by the Ministry of Petroleum & Minerals.⁵⁰ The authors managed to visit the ministry during the summer of 2021 and received a copy of the HSE annual report of one of the major companies operating in oil and gas in Sudan. The report illustrates that the HSE Key Performance Indicators (KPIs) show exemplary achievements with scope to improve. The report shows that the HSE training in 2020 is more than double that of 2019 (Table 3). The fatal accidents rate for two consecutive years was extracted from the report and is displayed below. (Table 4).

Table 3: Summary of leading and lagging indicators in an oil and gas company
(Source Ministry of Energy and Oil)

Leading HSE Indicators					
No.	Description	Definition/ Formula	2019	2020	Target
1	Management HSE Inspection (MHSEI)	Number of planned visits vs. actual during the current year	8	0	9
2	HSE training	60% of the average population	466	1096	900
3	Unsafe Acts and Conditions + Controlled Hazards	30% of the average population	586	707	650
Lagging HSE Indicators					
No.	Description	Definition/ Formula	2019	2020	Tolerance
1	FAR (Fatal Accident Rate)	Number of fatalities per 100 million man. hr	0	12.44	0
2	Lost Time Incident Frequency (LTIF)	Number of LTI per million man. hr	0	0	<0.5
3	Total Recordable Incident Rate (TRIR)	Number of TRI per 100 million man. hr	0	0.12	<1.5
4	Fire Incidents	Number of incidents	3	5	0
5	Vehicle Accidents	Numbers	1	5	0
Health Performance Indicators HPI					
No.	Description	Definition/ Formula	Actual	Target	
1	Occupational Illness Frequency (OIF)	Number of illnesses* 1,000,000 Total/ actual man-hours worked	0	0	
2	Employee Patients	Employees served	2524	Actual	
3	Health awareness program trainee	First aid and Trauma life support	Ongoing + COVID-19 awareness	Need base	

Table 4: Summary of Fatal Accident Rate (FAR) (Source Ministry of Energy and Oil).

Oil and Gas	
Year	Fatal Accident Rate (FAR)
2019	0.00
2020	0.01

Industry in Sudan

Manufacturing industries commonly see an increase in catastrophic and hazardous events

that put the lives of individuals and companies at risk.³² The international and local legislation mandates the management of occupational health and safety within organizations, yet many organizations in developing countries are negligent at adhering to the safety measures, with no evidence of proper enforcement.⁵¹ However, during the past few decades, the industrial sector in Arab nations has undergone significant growth. However, the sector's significant occupational risks have created great concern and suffering among workers.⁶

In Sudan, manufacturing is still in its infancy and is dominated by the processing of food and beverage products, focusing on sugar refining, vegetable oil, soap, and cotton ginning.²³ Nevertheless, implementing OSH within the Sudanese industry is thought to be challenging due to a lack of resources. The literature identified

numerous industrial hazards, including aging industrial buildings, the absence of emergency exit doors, and inadequate lighting and ventilation. However, if they existed, the welfare and sanitary facilities would be old and not usable.⁵²

Zanko and Dawson noted that the workers' representatives' participation could improve health and safety.¹ However, the dissolution of the workers' trade unions in 1989 did not help the workers' situation. Although it was founded in 1940, the Sudanese trade unions were unable to ensure the protection of the economic and social rights of Sudanese laborers.⁵³

The analysis of the secondary data obtained from the Industrial Safety Unit at the Ministry of Industry and the MLAR indicates that there are several health and safety injuries with different severities, as illustrated below (Figures 2 and 3).

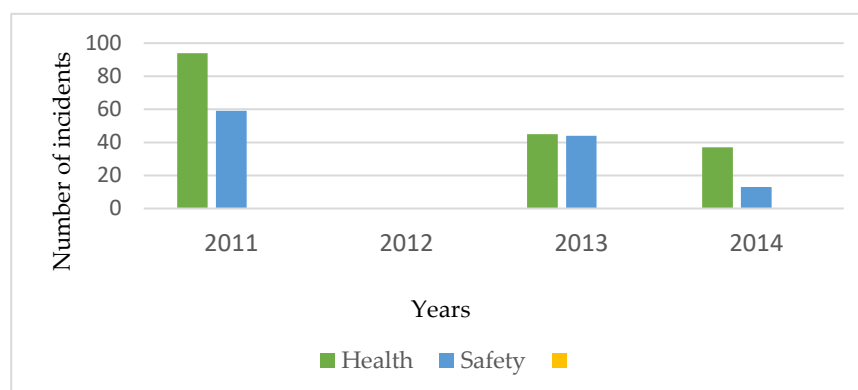


Figure 2: Occupational health and safety incident types 2011-2014, (Source MLAR)

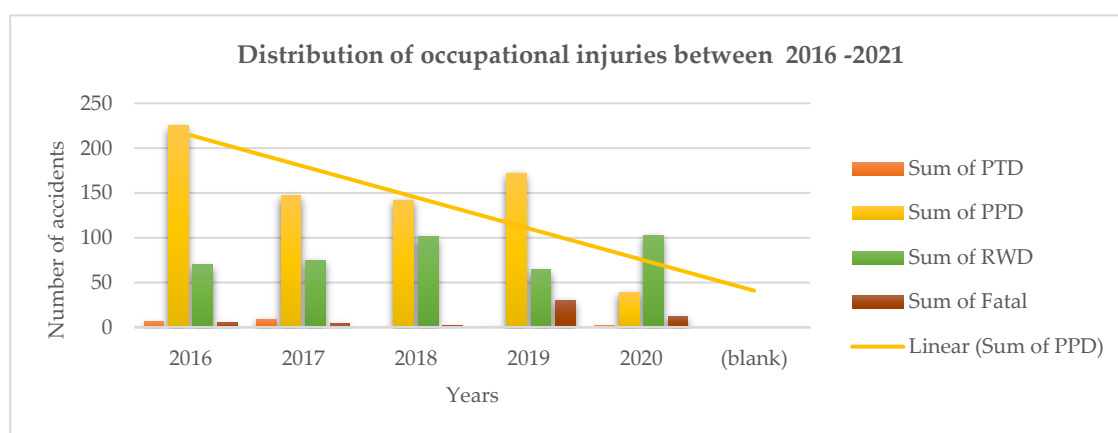


Figure 3: Distribution of occupational injuries between 2016 -2021 (Source MLAR)

The health incidents are higher than the safety incidents in 2011 and 2014, even in 2013; no records for 2012 were found. The severity of the

industrial accidents is categorized as follows:

- i. Permanent Total Disability (PTD)
- ii. Partial Permanent Disability (PPD)

- iii. (Temporary Disability) Restricted Workday (RWD)
- iv. Fatality

The number of Partial Permanent Disabilities (PPT) is always higher than the other three categories followed by the (Temporary Disability) Restricted Workday (RWD).

OHS at a Sudanese Soap Factory

Workers involved in detergents and cleaning products worldwide are exposed to health hazards in manufacturing facilities.⁵⁴ The development of severe lung and skin ailments is linked to detergent manufacturing.⁵⁵ The raw

material, product storage, and waste streams in soap manufacturing are sources of potential odour sources that are considered one of the main atmospheric pollution problems.⁵⁶ The literature notes that in the manufacturing industry, employers should implement and comply with all the guidance and procedures on safety and health at the workplace to minimize the number of accidents.⁵⁷ Enzyme proteins employed in the production of detergents have the potential to trigger occupational allergies or asthma.⁵⁸ The irritant contact dermatitis is one of the occupational health effects of soap detergent manufacturing in Sudan.⁵⁹

Table 5: Performance indicators of a Soap Factory, assuming 7.5 hours/day and a five-day week (Source Factory’s incident data)

Year	Total Number of Incidents	Total Number of Lost Days	Number of Fatalities - Related to the work	Number of Lost Workday Cases (LWDC)	Frequency Rate (FR)	Severity Rate (SR)	Lost Workdays Rate (LWD)	Total Recordable Incident Rate (TRIER)	Fatal Accident Rate (FAR)
2015	5	35	0	5	2.75	7000	19.23	19.23	0
2016	2	8	0	2	1.10	4000	4.40	7.69	0
2017	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
2018	7	49	0	7	3.85	7000	26.92	26.92	0
2019	2	41	0	2	1.10	20500	22.53	7.69	0
2020	4	111	0	4	2.20	27750	60.99	15.38	0

¹ Data Not Available

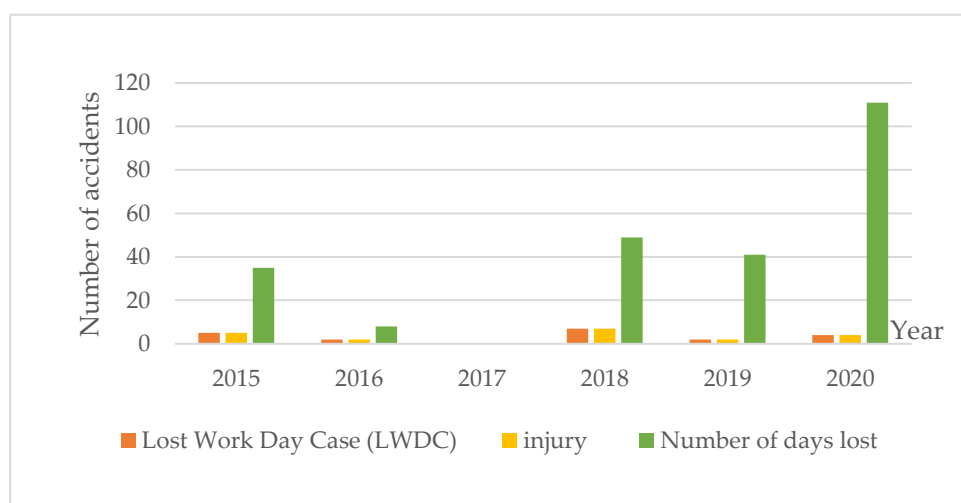


Figure 4: Incidents distribution in the Soap Factory

As can be seen in Table 5, the severity rate, lost worker rate, and total recordable incident rate at a soap factory fluctuate. The severity of accidents in 2020 was greater than

in previous years, with few injuries and lost workday cases, yet much higher numbers of days lost (Figure 4). The highest insurance benefits were paid for partial permanent disability,

followed by health disability and occupational fatality, where the lowest was permanent total disability (Figure 5).

The Socio-Economic Impacts of OSH in Sudan

The International Labor Organization (ILO) estimates that 4% of global GDP is lost owing to occupational accidents and diseases.⁶⁰

In most advanced economies, 2–3% of the global GDP is lost to social insurance expenditure on occupational safety and health, including statutory sick pay, disability allowances, and industrial injuries disability and incapacity benefits, far exceeding the typical expenditure on unemployment benefits.⁶¹

The Socio-Economic Impacts of the Industrial Sector are one of the most fundamental issues affecting most of the world's population, particularly in developing countries and areas where the corporation operates. It is the obligation of every individual, government, non-governmental organization, and business sector worldwide to develop alternative processes that will improve the standard of living and

economics of the world without causing severe environmental and socioeconomic issues.⁶²

The expense for disability payments or pensions provided by health and employee injury insurance plans is eventually borne by society, therefore, the occurrence of workplace accidents and diseases has a substantial effect on the viability of social security systems.⁶³

The total costs of an occupational accident or disease are often underestimated because certain costs are external to the enterprise and because some internal costs may be difficult to quantify or recognize, such as compensated time, lost production, reduced work capacity and lower workforce participation.⁶³

It was determined that disability benefits and early retirement on occupational and health fall within the authority of the Pension and Social Insurance Fund (PSIF) in Sudan. According to the data acquired, between 2016 and 2020, partial permanent disability insurance benefits were paid at the highest rates, followed by health disability and occupational fatality. (Figure 5).

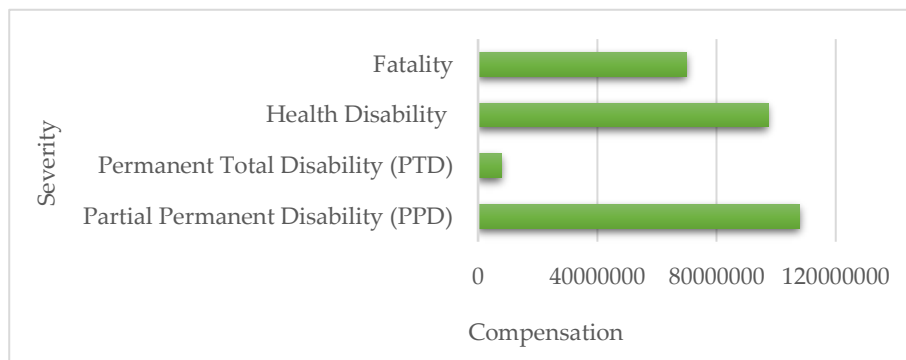


Figure 5: Compensation paid for occupational injuries 2016-2020 (Source PSIF)

Discussion

This preliminary study scrutinized the characteristics of the previous and current Sudanese OSH data found within government and private entities. In addition, this research has sorted out the research undertaken on occupational Safety and Health implementation and scarcities. The results of the literature and the examined data show that many OSH incidents with different types and severities emerged. However, calculating and comparing the

performance indicators of different industries to evaluate the status of OSH was not possible for many reasons. Constraints of calculating industry performance indicators include the absence of the denominator and the number of workers per industry or organization for the selected case studies. Furthermore, the secondary data from governmental and private bodies lacked essential details. Including the causes of the accidents, investigations, corrections and follow-up measures after the occurrences. In Sudan, general

awareness about occupational safety and hazards is not widespread.³³

Occupational risks in the mining industry have received much attention since millions of miners operate in hazardous artisanal and small-scale gold mining worldwide. Although the hazards associated with mining have generally decreased, there is not enough information on how beneficial occupational health interventions are in this industry.³⁸ The authors believe that the decrease in organized mining incidents after 2016 could be due to several measures taken by the Sudanese government, such as establishing the Sudanese Mineral Resources Company (SMRC), under which all registered mining companies operate. Another reason could be the introduction of the mineral exploitation act of 2016 (SMRC).³⁴

However, the measures implemented decreased the fatalities among organized miners but did not eradicate them, as could be seen from the numbers illustrated in the result section. Regarding artisanal mining, the findings indicate that artisanal mining in Sudan desperately needs stringent governance on national, provincial, and local levels.

This study confirms that Sudan's oil and gas industry has occupational health and safety management in place. That is believed to be due to the oil and gas industry development⁶, the involvement of foreign and international investors, and leadership involvement and commitment.

To some extent, the involvement of international investors in gold mining in Sudan contributed to the decrease in the number of accidents in organized mining. However, it was impossible to compare the two sectors due to the lack of information on the number of workers.

In terms of the economy, millions of Sudanese pounds are paid in occupational compensation. Nevertheless, the correlation between OSH accidents and the economy is never investigated in Sudan.

Conclusions

This study aimed to assess the status of occupational health and safety in Sudan. From the

little published work on occupational health and safety status, there is an urgent need for an independent body, at a national level to govern occupational health and safety in Sudan. This body can be modeled, for example, after the British Health and Safety Executive (HSE), which oversees overseeing workplace health and safety, managing workplace data, and promoting relevant research.

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