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Review

The Illusive Pipedream of Zero Harm: A South African Mining Industry Perspective

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Abstract: Mining industry activities are fraught with inherent exposure to occupational health and safety hazards, often with fatal outcomes, injuries and occupational diseases. This occurs amidst the introduction of contemporary mining methods and targeted health and safety regulation. This historical study evaluated company annual reports through document analysis, on a textual level, to evaluate the extent of OHS performance reporting, a measure of the attainment status of the zero-harm aspirational goal. The reporting of OHS performance indicators in annual reports by South African mining companies is widespread, though variable in format, content and context. There were variances in the reporting of OHS indicators by the case mining companies which obfuscate attempts for intra- and inter-company comparisons of OHS performance. The case companies included have not attained the stated goal of zero harm in view of the historically reported and protracted incidences of fatalities, injuries and occupational diseases, a direct threat to the decent work principle. The status quo challenges all affected stakeholders, including regulators, employers, employees and unions alike, to continuously investigate measures for arresting the situation.

Keywords: fatality; injury; leading indicator; lagging indicator; occupational disease

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1. Introduction

The "crisis of health and safety" associated with mining is a longstanding matter worldwide [1] and is historically fraught with fatalities, injuries and occupational diseases (ODs) [2]. This crisis requires prompt action through the use of available preventive measures by affected stakeholders [3]. The 2023 Impala mine accident in South Africa wherein 12 mineworkers were fatally wounded occurred amidst a prolonged lull in major fatal accidents from the mining industry and highlighted the known fact of the ever-present or lingering hazards of mining work. Attention to occupational health and safety (OHS) will, however, continue to generate interest in South Africa due to the hazardous nature of work performed in industries such as mining [4]. The anxiety and fear for survival associated with hazardous work are, however, historical and are still prevalent in contemporary workplaces [5,6]. This then calls for renewed investments directed towards the improvement of OHS [7]. For governments, the availability of employment within the lens of social justice offers an objective indicator from which economic policies can be judged on the one hand and the guarantee of health and safety at work on the other [8]. From a governance lens, this calls on company directors to appraise themselves with OHS matters inherent to their operations. In addition, company directors should continuously update their skill and knowledge levels concerning OHS matters [9].

1.1. OHS Performance Metrices

The implementation of variables that contribute to a safe and healthy workplace inclusive of training, OHS programmes and exposure control vary between companies [1]. The OHS metrices reported by industry should not be construed to represent the absolute

objective measure for safety. Historic OHS metrices can, however, be analysed to pinpoint root causes of past accidents. The OHS metrices help in the isolation of specific mining sectors where targeted intervention can be directed. The incidence of fatalities, injuries and ODs is a cause for concern [10]. Fatalities, injuries and ODs are calculated using different formulae for determining incidence rates, including the Occupational Safety and Health Administration (OSHA) (Formula (1)) and International Labour Organisation (ILO) (Formulae (2) and (3)) [11], with the implication that a company's incidence rate is the function of the formula adopted.

$$\text{Incidence rate} = \frac{\text{Number of injuries and illnesses} \times 200,000}{\text{Employee hours worked}} \quad (1)$$

$$\text{Fatal occupational injuries incidence rate} = \frac{\text{Number of new cases of fatal occupational injuries during the reference period}}{\text{Number of workers in the reference group} \times 100,000} \quad (2)$$

$$\text{Non-fatal occupational injuries incidence rate} = \frac{\text{Number of new cases of non-fatal occupational injuries during the reference period}}{\text{Number of workers in the reference group} \times 100,000} \quad (3)$$

The Mine Health and Safety Inspectorate (MHSI) prescribes Formula 4 for computing fatality or injury rates for the mining industry in South Africa [12].

$$\text{Fatality or injury rate} = \left\{ \frac{\text{number offatalities or injuries for a calendar year}}{\text{number of persons at work} \times 2200} \right\} \times 10^6 \text{ hours} \quad (4)$$

The OHS metrices are prone to fluctuations and are highly influenced by a number of "disasters" that occur during a given reporting period [10]. Metrices for measuring decent work for a healthy and safe work environment include occupational injury frequency rate, fatal (fatal work-related accident or work-related illness) injuries, occupational injury frequency rate, non-fatal (non-fatal work-related accident or work-related illness) injuries, time lost per occupational injury (days lost by cases of temporary incapacity), hazard exposures and/or overexposures (rates) and labour inspection rate (labour inspections) [13,14]. Comparably, the South African mining industry has the highest fatality rates for underground mining operations and collieries [10]. Disasters, fatalities, occupational diseases and injury rates provide affected stakeholders an opportunity to thoroughly investigate all aspects of work from which future preventive measures can be instituted [10]. Trade unions especially have an important role to play in solving the OHS issues associated with the mining sector [4,5]. In South Africa, labour unions are, however, distracted by other pressing matters such as negotiating for better wages and staving off retrenchments for their membership, limiting the impact of their advocacy role. Furthermore, organisers within labour unions as well as union members have limited awareness levels about OHS. To compound the problem, labour unions hardly employ OHS subject matter experts within their structures to increase effectiveness and reach [4]. In South Africa, the tripartite structure in the mining sector has committed to attaining zero harm for ongoing operations [15]. In this regard, company health and safety policies incorporate the aspirational zero-harm principle to guide OHS management.

In view of the historic OHS statistics reflecting fatalities, injuries and ODs, it remains unclear whether affected stakeholders are fulfilling the constitutional mandate of providing and maintaining a safe and healthy workplace afforded by the OHS legislation. The impact of these legal instruments on improving working conditions remains largely unexplored as inspectorates' primary focus is persuasion rather than prosecution [2]. The OHS statistics also point to the extent of the threat to life and health from work conducted in the mining industry which threatens this universal right [1]. LaDou, London [16] posits that the prevalence of unacceptable working conditions remains unchallenged worldwide.

Unlike in the United States, where the inspection manuals used by the OSHA and MSHA are available to all stakeholders, guiding the entire inspection process, the situation in South Africa is shrouded in ambiguity [17,18]. Joint collaborative efforts between unions,

employers and regulators are thus required to tackle the challenge of fatalities, injuries and ODs in the mining sector [5].

1.2. Business Ethics and OHS Regulation

The management of OHS is integral to effective business management and, when correctly recognised by management, can lead to heightened awareness of corporate responsibility for health and safety [19]. Ethical business requires the provision of a healthy and safe work environment for all workers [20]. The topical issue of OHS and ethics has been largely treated as a secondary issue, in part due to the agenda-setting sway of both employers and employees. However, the issue resurfaces with the occurrence of publicised workplace accidents [21]. Workplace accidents can result in reputational damage for affected companies and the industry as a whole. Other associated risks include physical, financial, legal and operational risks [22]. Ethical conduct promotes health and safety at work [21]. The duty of care clause, which applies to both employers and employees, ethically bounds both parties to adopt work practices that would not harm either party [21]. Mineworkers impacted by workplace infirmities bear the indirect costs associated with disability, sick leave and productivity loss [7]. Affected workers also have to grapple with the physical and mental aspects associated with workplace infirmities both on a short- and long-term basis [22]. In the case of fatalities, families entirely lose a source of income. The organisational and societal costs also extend to employing additional workers, equipment damage, medical care and hospitalisation [21]. Current debates about OHS and ethics relate to the accountable person regarding facing risk [21]. Although OHS laws also place responsibility on employees, employers have been assigned even greater responsibility above and beyond that of employees [21].

Employers operating in industries such as mining are familiar with associated risks and therefore have an expected ethical obligation for mitigating these risks. The company's response to deal with such risks speaks directly to business ethics, often documented in policies. The public declaration of ethical principles alone will, however, fall short of addressing prevailing inherent risks [23].

1.3. Decent Work, and Views from a South African Regulatory Context

The concept of decent work has been introduced by the International Labour Organisation (ILO) with the objective of promoting rights at work, working conditions/employment, social security and social dialogue [24]. Numerous ILO forums such as the 1999 conference [25] resulted in the reaffirmation of OHS as a pillar of decent work [26]. The ILO's convention No. 161 (C161) [27] and Recommendation No. 171 [28] provide guidance to member countries on the development of an OHS system. Some countries [26] and companies, however, still lag behind in developing decent work policies [29]. Specifically, the ILO's decent work policy fully embraces OHS, an important aspect covered under working conditions. As per the ILO's definition, working conditions also include aspects such as night work, hours of work, weekly rest and paid leave [30]. A common indicator of working conditions relating to OHS includes the "number of accidents and deaths at work in relation to the employed population", information which is lacking in some countries [30], including South Africa. These indicators are, however, expected to vary from country to country in view of variances in the institutional and regulatory arrangements [30]. The task of determining such metrices is even more daunting in developing countries due to the presence of a huge informal sector which often remains unregulated [30]. Similar to OHS metrices, there also remains no universal convention on the determination of the indicators for decent work [31]. The promotion of decent work in developing countries thus requires strong scientific evidence to justify its value proposition [32].

The South African constitution [33] enshrines the universal right of every worker to return home from work alive and healthy. To give effect to this right, the Mine Health and Safety Act was enacted to give employers the minimum standards for enabling the preservation of this right [34]. The Department of Mineral Resources and Energy (DMRE)

inspectorate enforces this legislation through inspections. There exists, however, other numerous inspectorates within South Africa for conducting inspection and enforcement of labour laws [35]. For a country like South Africa, these OHS legislative pieces mark an important milestone for achieving social justice at work [8]. However, workers are hamstrung by these restrictive laws in that they are unable to force the employer to improve working conditions through injunctions. This is so in that the legislation currently assigns inspectors the sole right of regulatory inspection and enforcement through the use of accommodative improvement and prohibition notices [36]. Other legislation governing decent work includes the Employment Equity Act, 1998 [37], Basic Conditions of Employment Act, 1997 [38] and Labour Relations Act and Amendments, 1995 [39]. In spite of the protective nature of these labour laws, non-compliance is prevalent in both developed and developing countries, notwithstanding the enforcement variances from respective countries [35].

The reporting of OHS performance in a South African context is incorporated in company annual reports for compliance with the listing requirements and the Companies Act, 2008 [40]. More recently, the Johannesburg Stock Exchange (JSE) sustainability disclosure guidelines provide companies with a reporting structure of the items to be included in annual reports [41]. Companies that are signatories to international initiatives such as the UN Global Compact, UN Sustainable Development Goals (SDGs) [25], ILO decent work principles [14] as well as industry affiliations such as the ICCM [42] are required to publish annual OHS performance in line with stated requirements. The existence of various guidelines on reporting results in different report structures as a function of guidelines adopted including the publication of databooks containing report-specific OHS metrices. This historical study evaluated company annual reports through document analysis, on a textual level, to evaluate the extent of OHS performance reporting, a measure of the attainment status of the zero-harm aspirational goal.

2. Materials and Methods

2.1. Search Strategy

This historical study considered companies (available on request) classified in the basic material sector (mining sector) by the Johannesburg Stock Exchange (JSE), available at https://www.listcorp.com/jse/sectors/basic-materials (accessed 27 December 2023). The included companies are publicly traded and have regulatory reporting mandates including both the operational and financial aspects. The reporting is included in the companies' annual sustainability or annual integrated or Environmental Social and Governance (ESG) reports, freely available to the public, which were downloaded from each respective company website, covering a 5-year period from January 2018 to December 2022. Privately owned mining companies, which have no reporting mandates, were excluded from the study. Apart from the company's websites as a data source for the targeted reports, alternative databases such as annual reports (https://www.annualreports.com/, (accessed on 27 December 2023)) and sustainability reporting (https://www.sustainability-reports.com/ (accessed on 27 December 2023)) were also considered. Company annual reports contain a narrative of a company's performance including OHS performance metrices [43], a departure point for this current study. The PRISMA statement guided the selection process for the excluded and included reports and databooks and is illustrated in Figure 1 [44].

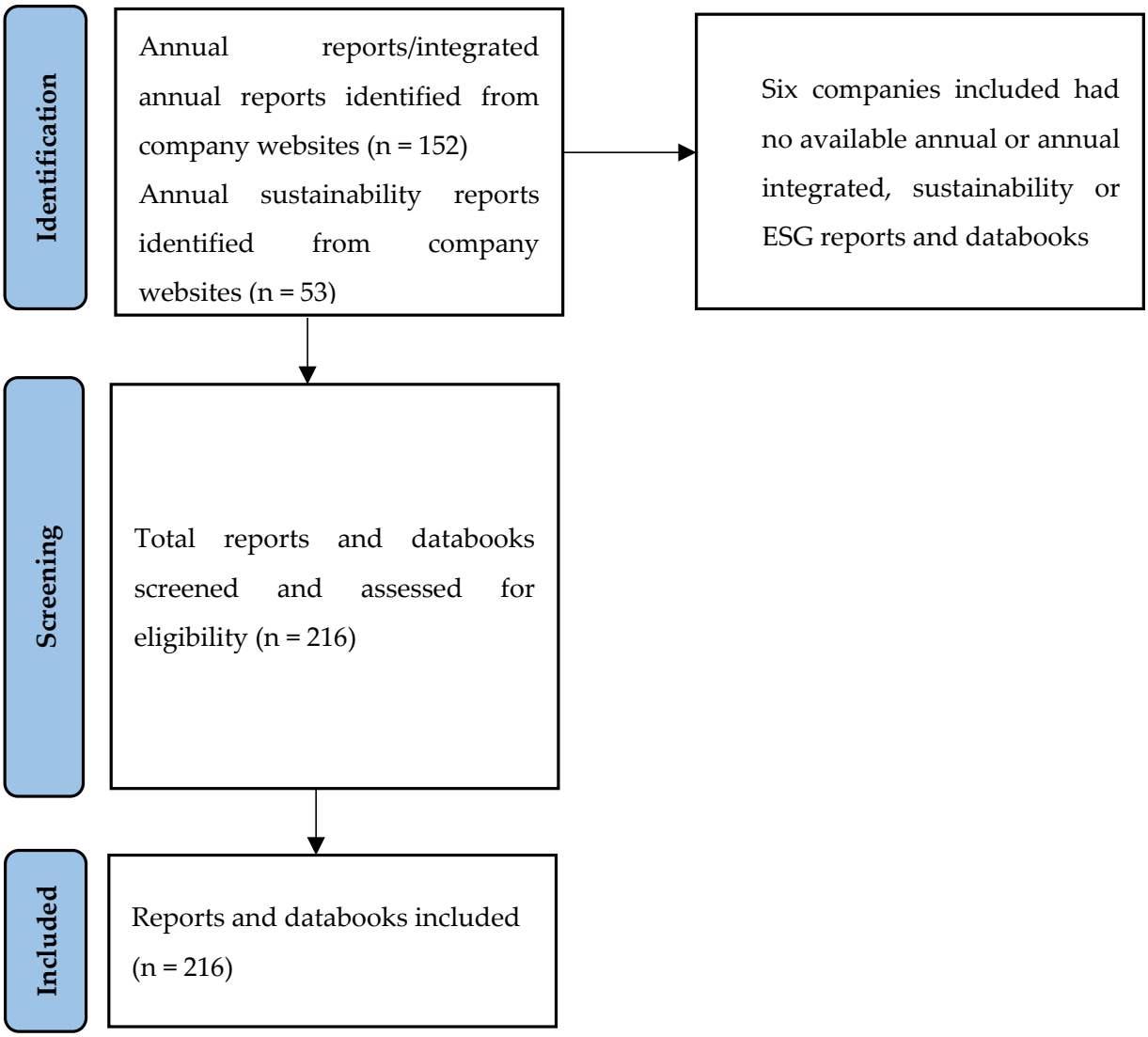


Figure 1. The Preferred Reporting Items for Systemic Review and Meta-Analyses (PRISMA) flow diagram.

2.2. Data Management and Analysis

A total of 152 annual/integrated reports, 53 sustainability/ESG reports and 11 databooks were included in the analysis. Document analysis at the text level was conducted to extract both qualitative and quantitative data inclusive of company name, reporting context, document type and OHS performance indicators. The qualitative data were tabulated and input into WordItOut [45], a word cloud generator. Word clouds provided images of the text where the size of the words represented their frequency of use in the reports [46]. The quantitative data were captured on Microsoft Excel for trend analysis.

3. Results

3.1. Reporting Context and Format

Company reporting context and format included in annual reports varies and is influenced by adopted standards and frameworks which informed the use of a word cloud to determine the shared themes across these reports, as depicted in Figure 2. Compliance with regulatory requirements (listing regulations and the Companies Act) was by far the most cited reporting context.

Figure 2. Reporting context, guidelines and frameworks.

Companies listed on the JSE and those subscribing to voluntary local and international standards are required to publish annual reports showing performance in prescribed elements. The format, scale and scope of the documents varies between annual or integrated annual reports, sustainability and ESG reports (Table 1). The choice of reporting supplementary information on the separate sustainability or ESG reports apart from annual reports reflects the reporting requirements of the adopted standards. Databooks provide the granular detail of the data that fed into the annual or integrated annual reports, sustainability and ESG reports. Six of the thirty-eight companies included had no available annual or annual integrated reports, sustainability or ESG reports.

Table 1. Overview of performance documents.

Company Name (City, Country)	Report Title			Supplementary Databook
	Annual Report/ Integrated Annual Report	Sustainability Report	Environmental, Social and Governance Report	
Anglo American PLC (London, UK)	✔	✔	-	✔
Anglo American platinum LTD (Rosebank, South Africa)	✔	✔	-	✔
AngloGold Ashanti (Denver, USA)	✔	✔	-	✔
African Rainbow Minerals (Johannesburg, South Africa)	✔	✔	-	-
BHP Group Limited (Melbourne, Australia)	✔	✔	-	✔
DRDGold Limited (Johannesburg, South Africa)	✔	✔	✔	✔

Table 1. *Cont.*

Company Name (City, Country)	Report Title			
	Annual Report/ Integrated Annual Report	Sustainability Report	Environmental, Social and Governance Report	Supplementary Databook
Exxaro Resources Limited (Pretoria, South Africa)	✔	✔	✔	✔
Glencore PLC (Baar, Switzerland)	✔	✔	-	✔
Gold Fields Limited (Johannesburg, South Africa)	✔	✔	-	✔
Harmony Gold Mining Company (Queensland, Australia)	✔	-	✔	✔
Impala Platinum Holdings Limited (Johannesburg, South Africa)	✔	✔	✔	-
Jubilee Metals Group PLC (Pretoria, South Africa)	✔	-	-	-
Kumba Iron Ore (Johannesburg, South Africa)	✔	✔	-	-
MC Mining Limited (Johannesburg, South Africa)	✔	-	-	-
Merafe Resources Limited (Johannesburg, South Africa)	✔	-	-	-
Northam Platinum Limited (Johannesburg, South Africa)	✔	✔	-	✔
Orion Minerals Limited (Melbourne, Australia)	✔	-	-	-
South32 Limited (Perth, Australia)	✔	✔	-	✔
Thungela Resources Limited (Johannesburg, South Africa)	✔	-	✔	-
SibanyeStillwater (Johannesburg, South Africa)	✔	-	-	-
Royal Bafokeng Platinum Limited (Johannesburg, South Africa)	✔	-	-	-
Pan African Resources (Johannesburg, South Africa)	✔	✔	✔	-
Salungano (Johannesburg, South Africa)	✔	✔	-	-
Wesizwe Platinum (Johannesburg, South Africa)	✔	-	-	-
Tharisa PLC (Paphos, Cyprus)	✔	-	✔	-
Gemfields Group Limited (London, UK)	✔	-	-	-
Kore Potash PLC (London, UK)	✔	-	-	-
Southern Palladium Limited (Sydney, Australia)	✔	-	-	-
Chrometco Limited (Johannesburg, South Africa)	✔	-	-	-

Table 1. *Cont.*

Company Name (City, Country)	Report Title			Supplementary Databook
	Annual Report/ Integrated Annual Report	Sustainability Report	Environmental, Social and Governance Report	
Europa Metals Limited (Perth, Australia)	✔	-	-	-
Randgold and Exploration Company (Johannesburg, South Africa)	✔	-	-	-
Bauba Resources Limited (Pretoria, South Africa)	✔	-	-	-

✔ Confirmed/available.

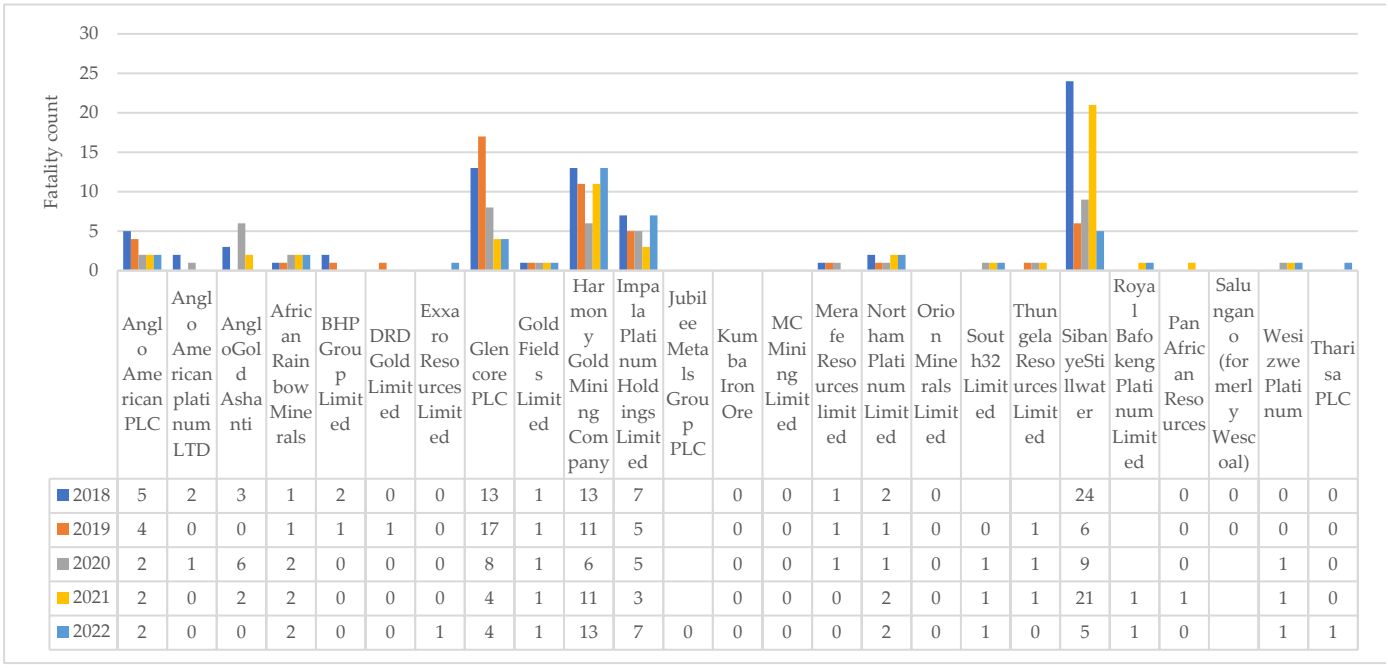
3.2. OHS Performance

The OHS performance data are based on computed frequency rates and can include both retrospective and current accidents and incidents that occur over a specified time period. Frequency rates also require the specification of a base number of hours worked and are used as a key performance indicator of an industry-implemented OHS management system. The actual OHS metrices have reported weaknesses nonetheless, and they should be interpreted with other supplementary data [47]. The current study reports fatalities, Fatal Injury Frequency Rate (FIFR), Reportable Injury Frequency Rate (RIFR), Lost Time Injury (LTI), Lost Time Injury Frequency Rate (LTIFR), Medical Treatment Cases (MTCs), Total Recordable Case Frequency Rate (TRCFR) and occupational disease counts. These performance measures are invariably influenced by the adopted computation formulae and number of employees employed in a company during a reporting period.

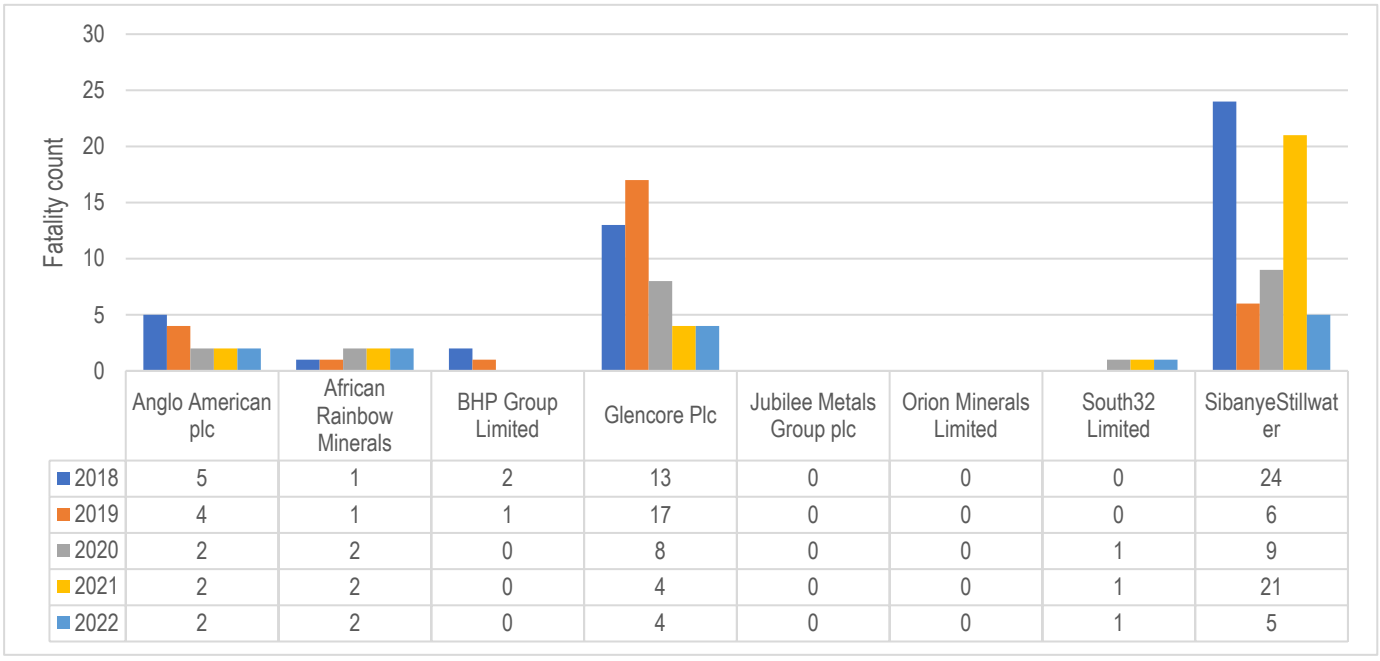
3.2.1. Fatalities

The majority of companies included in the study (20 of the 32 companies) reported a fatality for the periods under review. Combined, the fatalities amounted to 263, averaging 53 fatalities per year (Figure 3). The highest total fatalities were recorded during 2018 at 75. The top three companies reporting fatalities (Glencore, Harmony Gold and SibanyeStillWater) operate deep underground mines. Multiple fatalities occur in single events associated with rock falls, explosions and gas poisonings, amongst others. Figure 3a (conglomerate miners), Figure 3c (platinum group metal miners) and Figure 3e (gold miners) differentiate the fatality counts per commodity type, whereas Figure 3b (conglomerate miners), Figure 3d (platinum group metal miners) and Figure 3f (gold miners) show the FIFR per commodity type.

Companies use the fatality counts in Figure 2 for computing the FIFR (Figure 3b,d,f), which depicts a rate of fatal injuries standardised per million hours worked. The FIFRs (Figure 3b,d,f), segregated per mineral/commodity mined, mirror Figure 3 for each company. The FIFR was adopted as an OHS performance measure by 14 of the 20 companies that had reported fatalities for the period under review. The highest FIFRs emanate from the gold and platinum mining companies. The lowest FIFRs emanated from the coal and chrome mining companies. Glencore and SibanyeStillWater, companies with a high fatality count, reported higher fatality rates as performance measures.



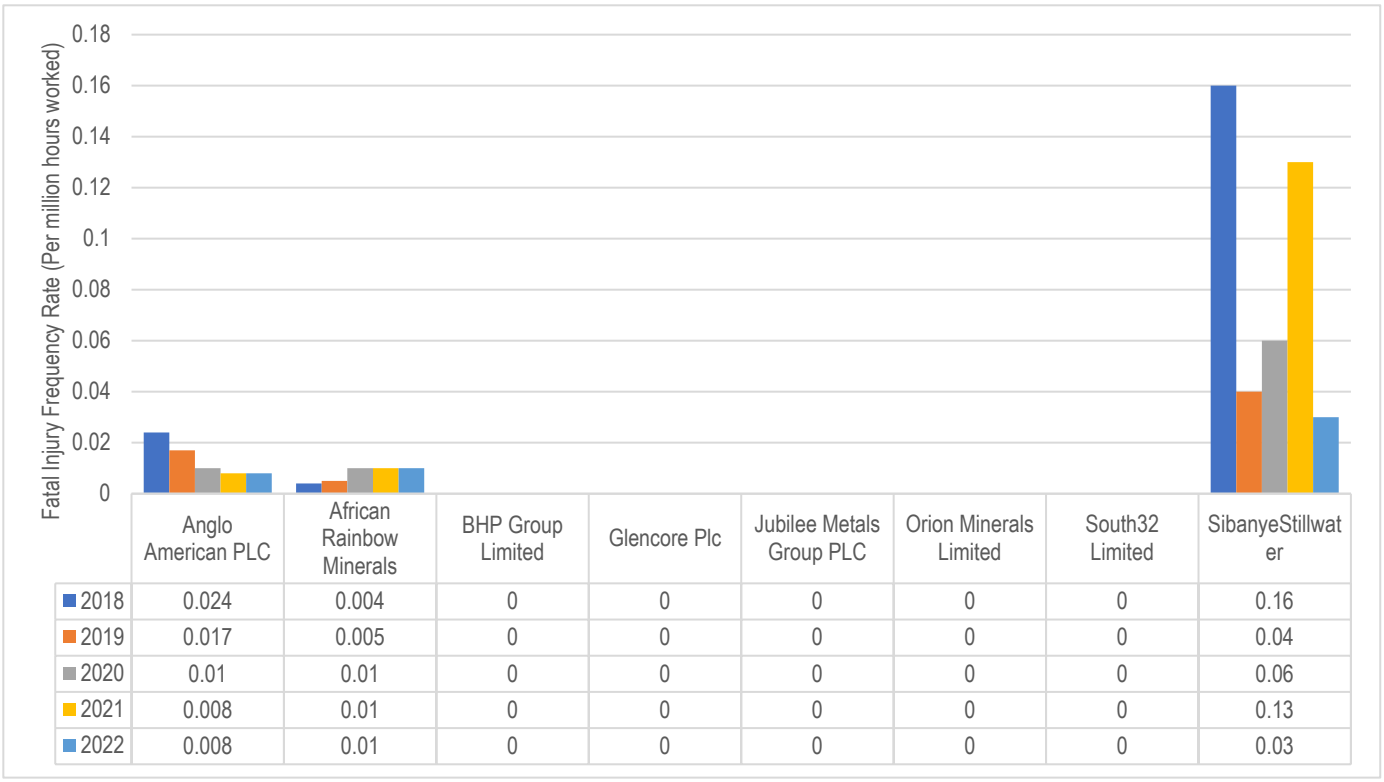
	Anglo American PLC	Anglo American platinum LTD	AngloGold Ashanti	African Rainbow Minerals	BHP Group Limited	DRD Gold Limited	Exxaro Resources Limited	Glencore PLC	Gold Fields Limited	Harmony Gold Mining Company	Impala Platinum Holdings Limited	Jubilee Metals Group PLC	Kumba Iron Ore	MC Mining Limited	Merafe Resources limited	Northam Platinum Limited	Orion Minerals Limited	South32 Limited	Thungela Resources Limited	SibanyeStillwater	Royal Bafokeng Platinum Limited	Pan African Resources	Salungano (formerly Wescoal)	Wesizwe Platinum	Tharisa PLC
2018	5	2	3	1	2	0	0	13	1	13	7		0	0	1	2	0			24		0	0	0	0
2019	4	0	0	1	1	1	0	17	1	11	5		0	0	1	1	0	0	1	6		0	0	0	0
2020	2	1	6	2	0	0	0	8	1	6	5		0	0	1	1	0	1	1	9		0		1	0
2021	2	0	2	2	0	0	0	4	1	11	3		0	0	0	2	0	1	1	21	1	1		1	0
2022	2	0	0	2	0	0	1	4	1	13	7	0	0	0	0	2	0	1	0	5	1	0		1	1



	Anglo American plc	African Rainbow Minerals	BHP Group Limited	Glencore Plc	Jubilee Metals Group plc	Orion Minerals Limited	South32 Limited	SibanyeStillwater
2018	5	1	2	13	0	0	0	24
2019	4	1	1	17	0	0	0	6
2020	2	2	0	8	0	0	1	9
2021	2	2	0	4	0	0	1	21
2022	2	2	0	4	0	0	1	5

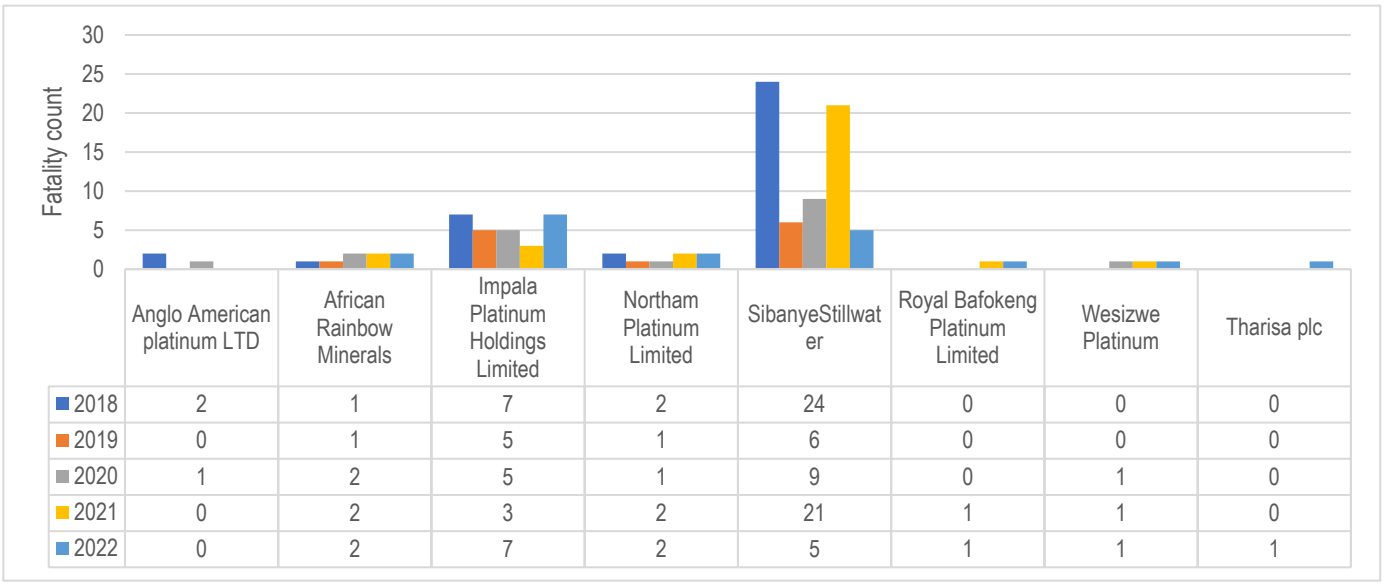
(a)

Figure 3. *Cont.*



	Anglo American PLC	African Rainbow Minerals	BHP Group Limited	Glencore Plc	Jubilee Metals Group PLC	Orion Minerals Limited	South32 Limited	SibanyeStillwater
2018	0.024	0.004	0	0	0	0	0	0.16
2019	0.017	0.005	0	0	0	0	0	0.04
2020	0.01	0.01	0	0	0	0	0	0.06
2021	0.008	0.01	0	0	0	0	0	0.13
2022	0.008	0.01	0	0	0	0	0	0.03

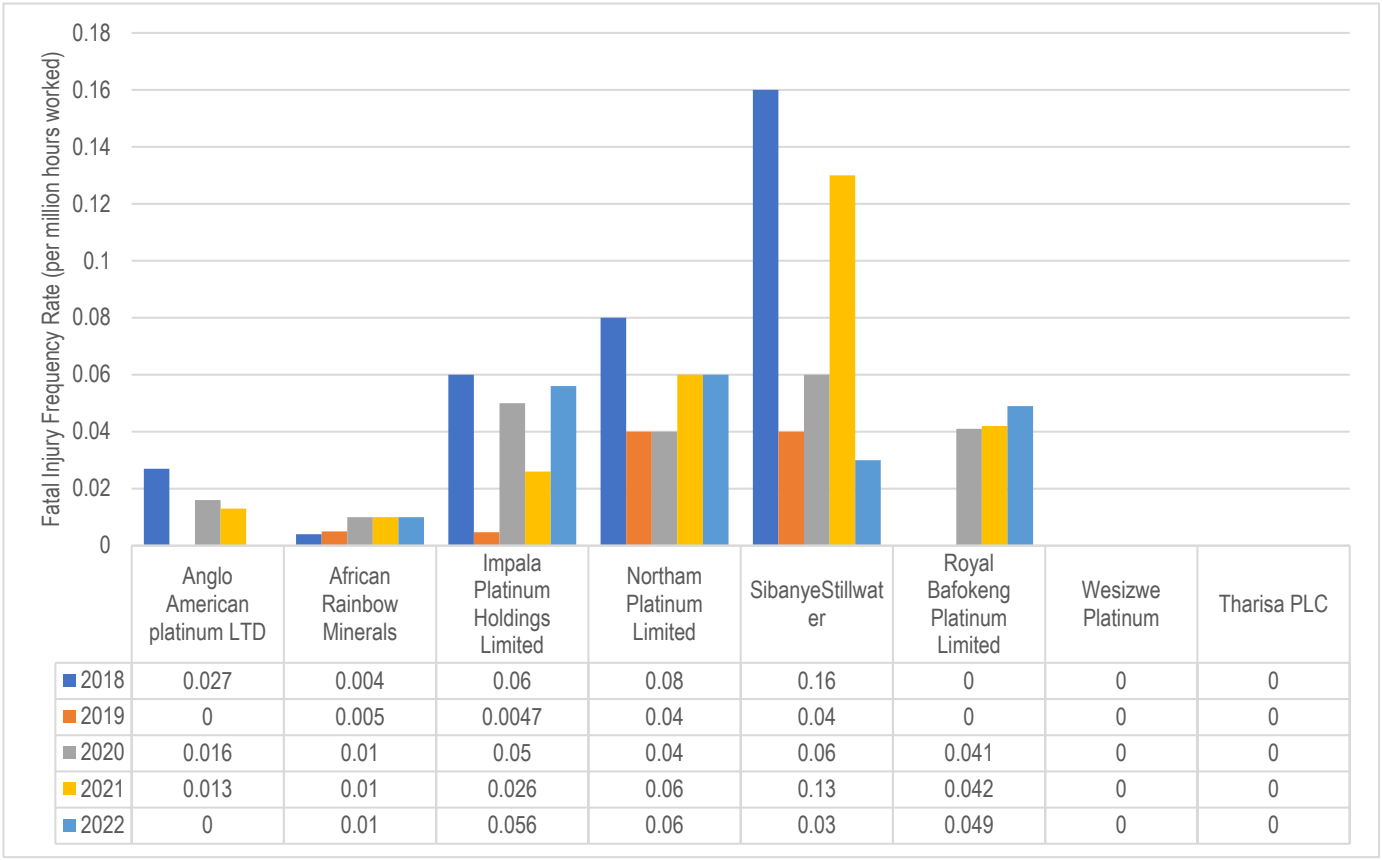
(**b**)



	Anglo American platinum LTD	African Rainbow Minerals	Impala Platinum Holdings Limited	Northam Platinum Limited	SibanyeStillwater	Royal Bafokeng Platinum Limited	Wesizwe Platinum	Tharisa plc
2018	2	1	7	2	24	0	0	0
2019	0	1	5	1	6	0	0	0
2020	1	2	5	1	9	0	1	0
2021	0	2	3	2	21	1	1	0
2022	0	2	7	2	5	1	1	1

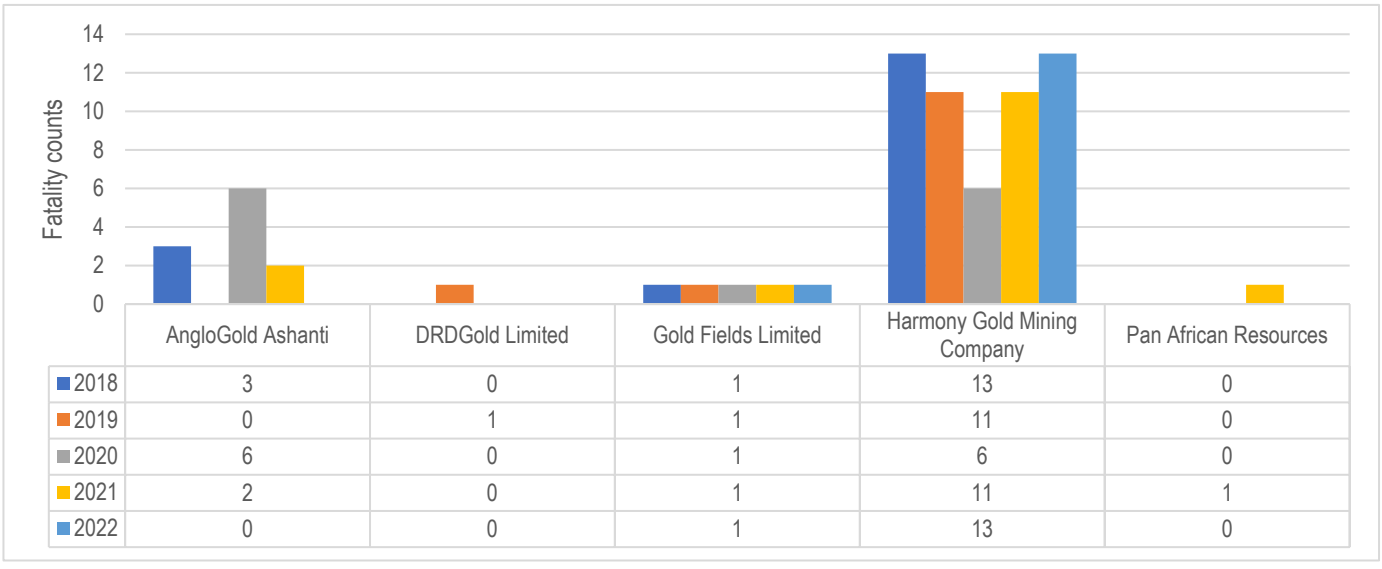
(**c**)

Figure 3. *Cont.*



	Anglo American platinum LTD	African Rainbow Minerals	Impala Platinum Holdings Limited	Northam Platinum Limited	SibanyeStillwater	Royal Bafokeng Platinum Limited	Wesizwe Platinum	Tharisa PLC
2018	0.027	0.004	0.06	0.08	0.16	0	0	0
2019	0	0.005	0.0047	0.04	0.04	0	0	0
2020	0.016	0.01	0.05	0.04	0.06	0.041	0	0
2021	0.013	0.01	0.026	0.06	0.13	0.042	0	0
2022	0	0.01	0.056	0.06	0.03	0.049	0	0

(**d**)



	AngloGold Ashanti	DRDGold Limited	Gold Fields Limited	Harmony Gold Mining Company	Pan African Resources
2018	3	0	1	13	0
2019	0	1	1	11	0
2020	6	0	1	6	0
2021	2	0	1	11	1
2022	0	0	1	13	0

(**e**)

Figure 3. *Cont.*

	AngloGold Ashanti	DRDGold Limited	Gold Fields Limited	Harmony Gold Mining Company	Pan African Resources
2018	0.03	0	0	0.016	0
2019	0	0	0	0.13	0
2020	0.07	0	0	0.08	0
2021	0.03	0	0	0.11	0
2022	0	0	0	0	0

(**f**)

Figure 3. Five-year view of fatality counts reported for all companies included. (**a**) Five-year overview of fatality counts—conglomerate miners. (**b**) Five-year overview of Fatal Injury Frequency Rate (per million hours worked)—conglomerate miners. (**c**) Five-year overview of fatality counts– platinum group metal miners. (**d**) Five-year overview of Fatal Injury Frequency Rate (per million hours worked)—platinum group metal miners. (**e**) Five-year overview of fatality counts—gold miners. (**f**) Five-year overview of Fatal Injury Frequency Rate (per million hours worked)—gold miners.

3.2.2. Reportable Incidence Frequency Rate (RIFR)

In South Africa, certain occupational accidents are reportable in terms of Chapter 23 of the Mine Health and Safety Act, 1996 [34]. The choice of reporting RIFR was variable, with 6 of the 32 companies reporting this performance indicator. As indicated in Figure 4, only 6 of the 32 companies reported RIFRs, which were from the gold and platinum mining sector.

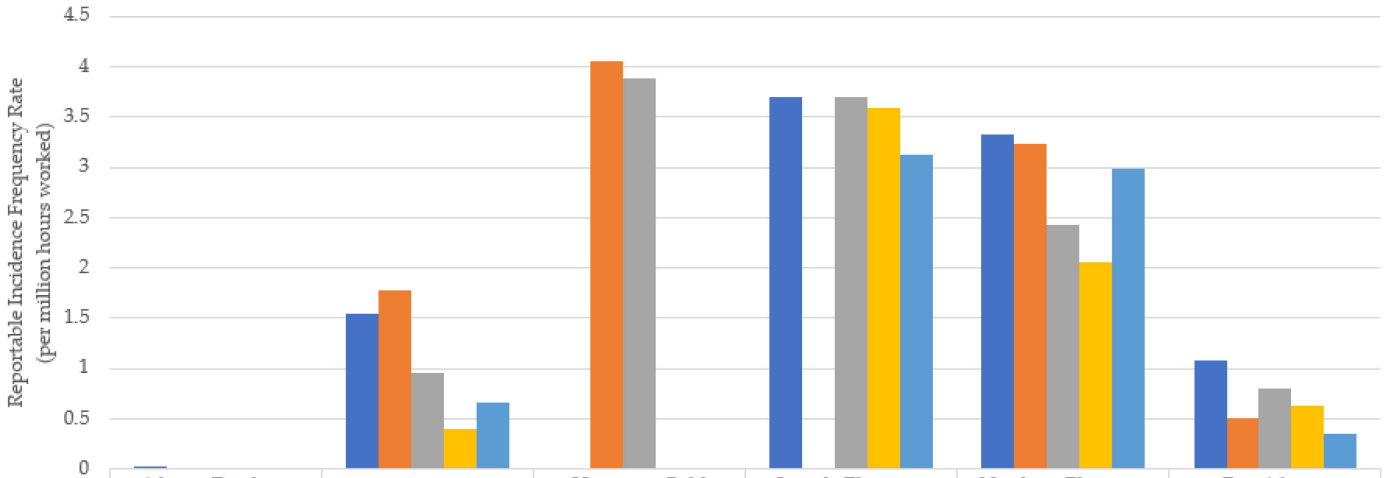
3.2.3. Lost Time Injury (LTI)

"A lost time injury is any injury that results in a fatality, permanent disability or time lost from work" [47]. The total LTI count (Figure 5) for all included companies was 15,157, with the highest number of counts reported during the year 2018, constituting 3564, whereas the lowest LTIs, at 2277, were recorded during 2022. Of the 22 companies that reported LTI counts, SibanyeStillwater, a platinum and gold miner, reported the highest total LTIs at 4216. Orion Minerals and MC Mining reported the lowest LTI counts at 1 and 10 cases, respectively.

3.2.4. Lost Time Injury Frequency Rate (LTIFR)

The LTIFR is calculated to depict a rate of all Lost Time Injuries per million hours worked. Of the 22 companies that report the LTIFR, 17 of the companies failed to achieve an LTI-free year for the review period. As indicated in Figure 6, 5 of the 17 companies had an LTIFR above 3, indicating the severity of injury prevalence. Figure 6a–e compare the LTIFR per commodity mined. The highest LTIFRs were recorded in the conglomerate platinum group metal and gold miners. The lowest LTIFR was recorded in the chrome

miners, a function of the small scale of the sector compared to the gold and platinum group metal miners.



	African Rainbow Minerals	DRDGold Limited	Harmony Gold Mining Company	Impala Platinum Holdings Limited	Northam Platinum Limited	Pan African Resources
2018	0.004	1.55		3.7	3.32	1.08
2019		1.78	4.05	0	3.24	0.51
2020		0.96	3.88	3.7	2.42	0.8
2021		0.4		3.59	2.06	0.63
2022		0.66		3.13	2.99	0.35

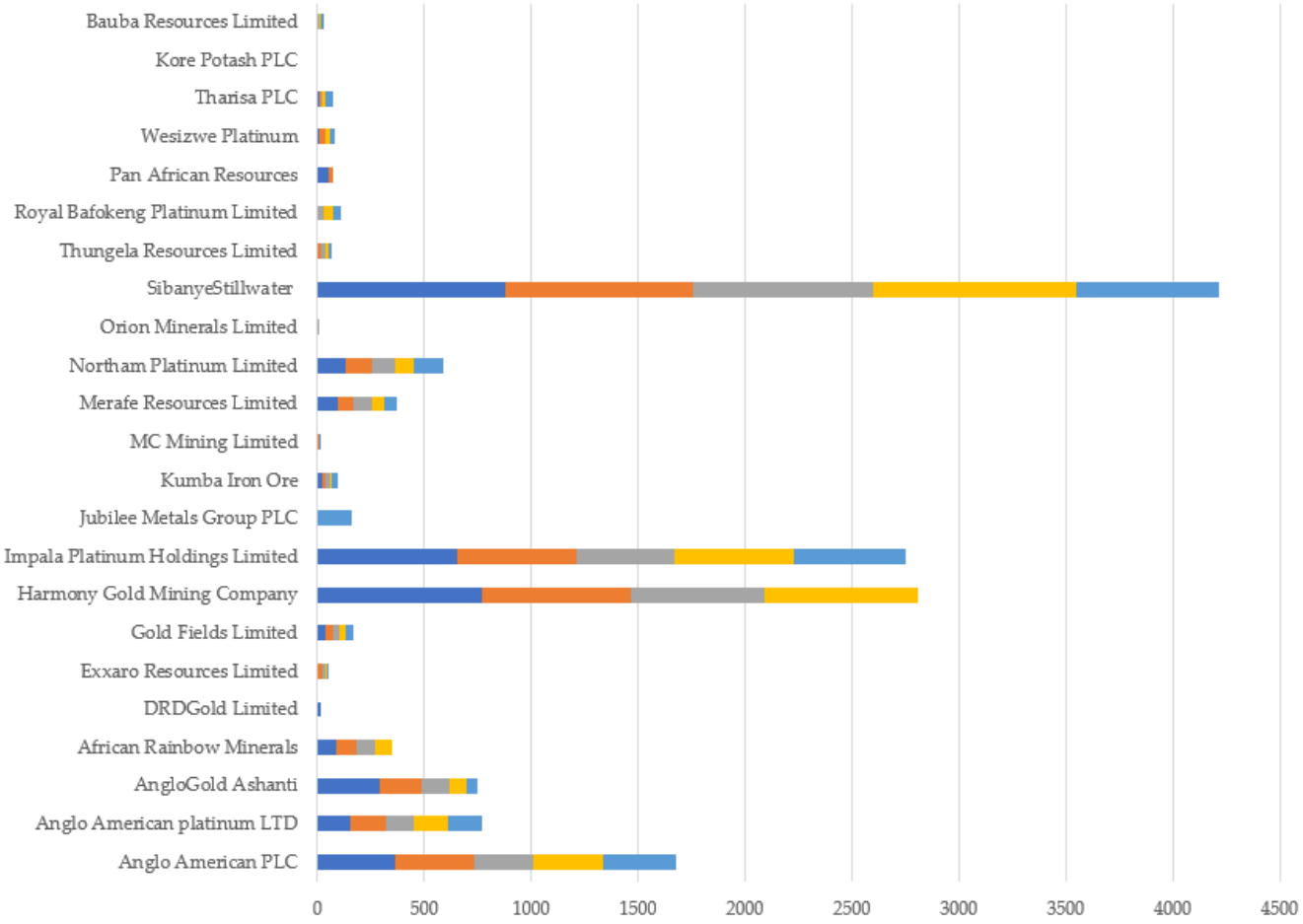
Figure 4. Five-year Reportable Incidence Frequency Rate (RIFR) (per million hours worked).

3.2.5. Occupational Diseases

An occupational disease is "any health disorder including a compensatable disease as contemplated by the Occupational Diseases in Mines and Works Act, 1973 (Act 78 of 1973), and an occupational disease contemplated by the Compensation for Occupational Injuries and Diseases Act, 1993 (Act 130 of 1993)" [34,48]. Twenty-two companies reported OD cases, compensable in cases contracted within South African operations. In total, 13,733 ODs were reported (Figure 9). SibanyeStillWater had the highest reported number of ODs at 6638 cases, whereas Wesizwe Platinum had the lowest reported ODs at 5. The highest total ODs were recorded during 2019 at 3261. Noise-Induced Hearing Loss, pulmonary tuberculosis (PTB) and silicosis were the main ODs reported. The reported ODs, however, exclude MSDs for most companies and may well underestimate the true extent of ill health incidence.

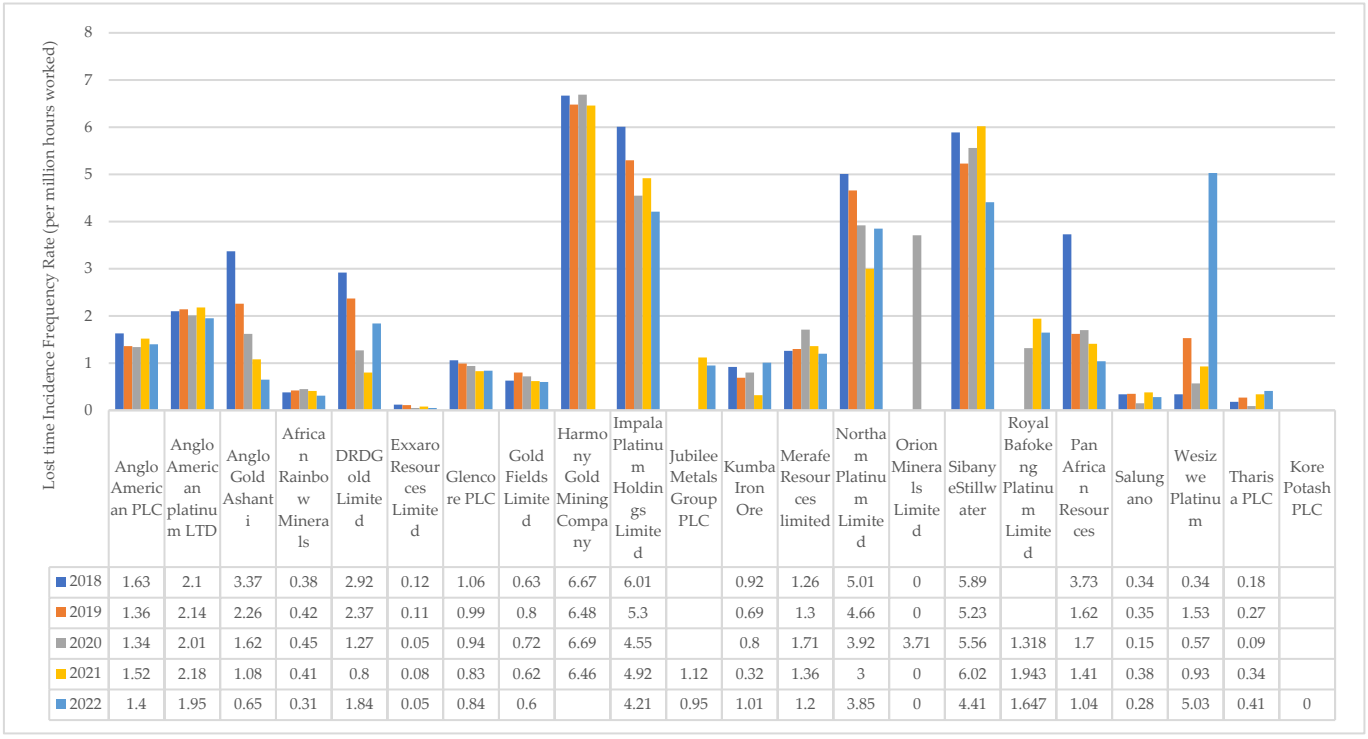
3.2.6. Medical Treatment Cases (MTCs)

Different to first aid treatment, injuries or diseases classified as MTCs require treatment administered by an occupational medical practitioner or occupational health nurse. In total, 2558 MTCs were reported by 13 companies (Figure 7), with 955 reported by SibanyeStillWater and 955 by Anglo American PLC, for the reviewed periods. As indicated in Figure 7, the MTCs averaged 135, 114, 89, 121 and 93 for the reporting periods of 2018, 2019, 2020, 2021 and 2022, respectively.

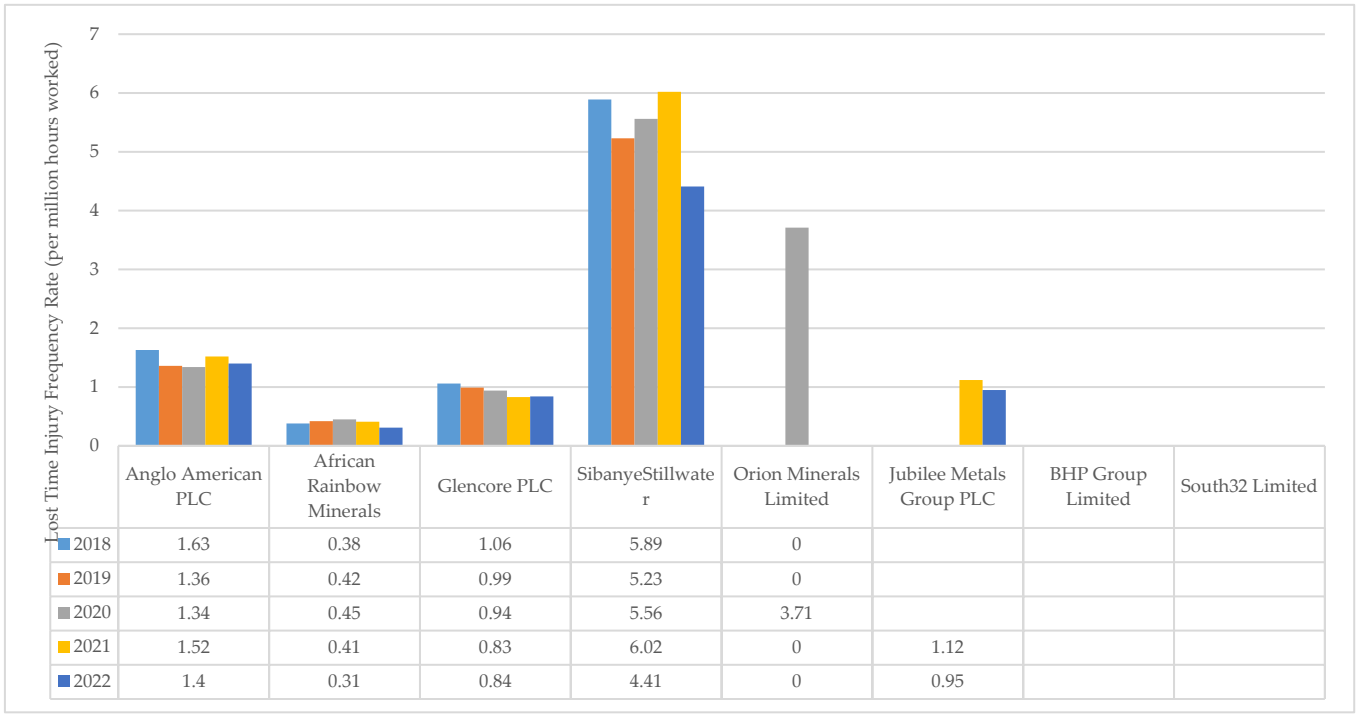


	Anglo American PLC	Anglo American platinum LTD	AngloGold Ashanti	African Rainbow Minerals	DRD Gold Limited	Exxaro Resources Limited	Gold Fields Limited	Harmony Gold Mining Company	Impala Platinum Holdings Limited	Jubilee Metals Group PLC	Kumba Iron Ore	MC Mining Limited	Merafe Resources Limited	Northam Platinum Limited	Orion Minerals Limited	SibanyeStillwater	Thungela Resources Limited	Royal Bafokeng Platinum Limited	Pan African Resources	Wesizwe Platinum	Tharisa PLC	Kore Potash PLC	Bauba Resources Limited
2018	360	156	291	91	17		34	769	650		21	1	97	128	0	881			52	9	6	0	1
2019	375	166	193	90		26	38	696	561		17	4	73	128	0	876	18		19	29	9	0	2
2020	277	128	135	86		9	32	623	456		18		82	104	1	840	17	27			4	0	3
2021	325	163	80	85		12	30	720	564		8		62	93	0	951	15	46		18	21	0	11
2022	343	156	50			7	31		522	162	28	5	60	134	0	668	15	40		23	34	0	14

Figure 5. Five-year overview of Lost Time Injuries (LTIs).



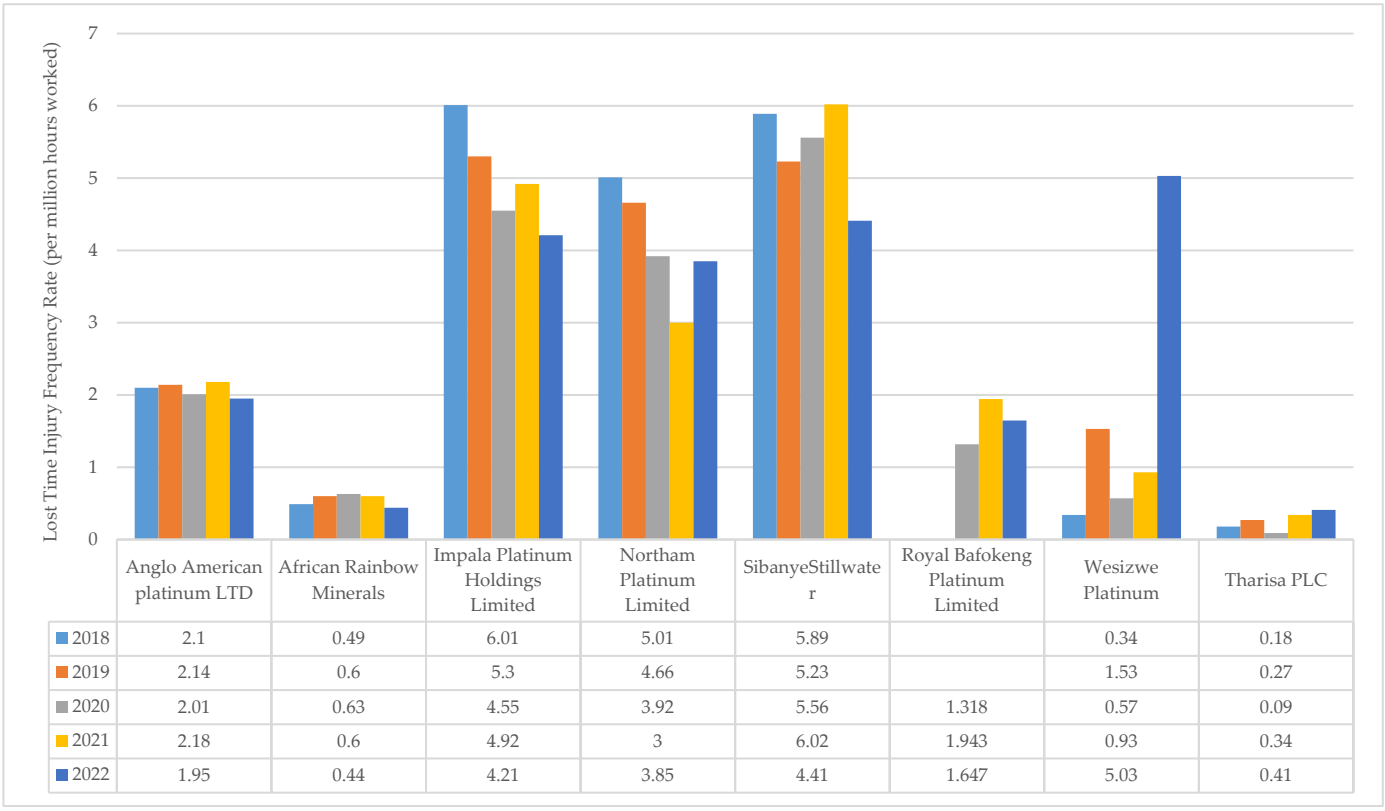
	Anglo American PLC	Anglo American platinum LTD	Anglo Gold Ashanti	African Rainbow Minerals	DRDGold Limited	Exxaro Resources Limited	Glencore PLC	Gold Fields Limited	Harmony Gold Mining Company	Impala Platinum Holdings Limited	Jubilee Metals Group PLC	Kumba Iron Ore	Merafe Resources limited	Northam Platinum Limited	Orion Minerals Limited	Sibanye Stillwater	Royal Bafokeng Platinum Limited	Pan African Resources	Salungano	Wesizwe Platinum	Tharisa PLC	Kore Potash PLC
2018	1.63	2.1	3.37	0.38	2.92	0.12	1.06	0.63	6.67	6.01		0.92	1.26	5.01	0	5.89		3.73	0.34	0.34	0.18	
2019	1.36	2.14	2.26	0.42	2.37	0.11	0.99	0.8	6.48	5.3		0.69	1.3	4.66	0	5.23		1.62	0.35	1.53	0.27	
2020	1.34	2.01	1.62	0.45	1.27	0.05	0.94	0.72	6.69	4.55		0.8	1.71	3.92	3.71	5.56	1.318	1.7	0.15	0.57	0.09	
2021	1.52	2.18	1.08	0.41	0.8	0.08	0.83	0.62	6.46	4.92	1.12	0.32	1.36	3	0	6.02	1.943	1.41	0.38	0.93	0.34	
2022	1.4	1.95	0.65	0.31	1.84	0.05	0.84	0.6		4.21	0.95	1.01	1.2	3.85	0	4.41	1.647	1.04	0.28	5.03	0.41	0



	Anglo American PLC	African Rainbow Minerals	Glencore PLC	SibanyeStillwater	Orion Minerals Limited	Jubilee Metals Group PLC	BHP Group Limited	South32 Limited
2018	1.63	0.38	1.06	5.89	0			
2019	1.36	0.42	0.99	5.23	0			
2020	1.34	0.45	0.94	5.56	3.71			
2021	1.52	0.41	0.83	6.02	0	1.12		
2022	1.4	0.31	0.84	4.41	0	0.95		

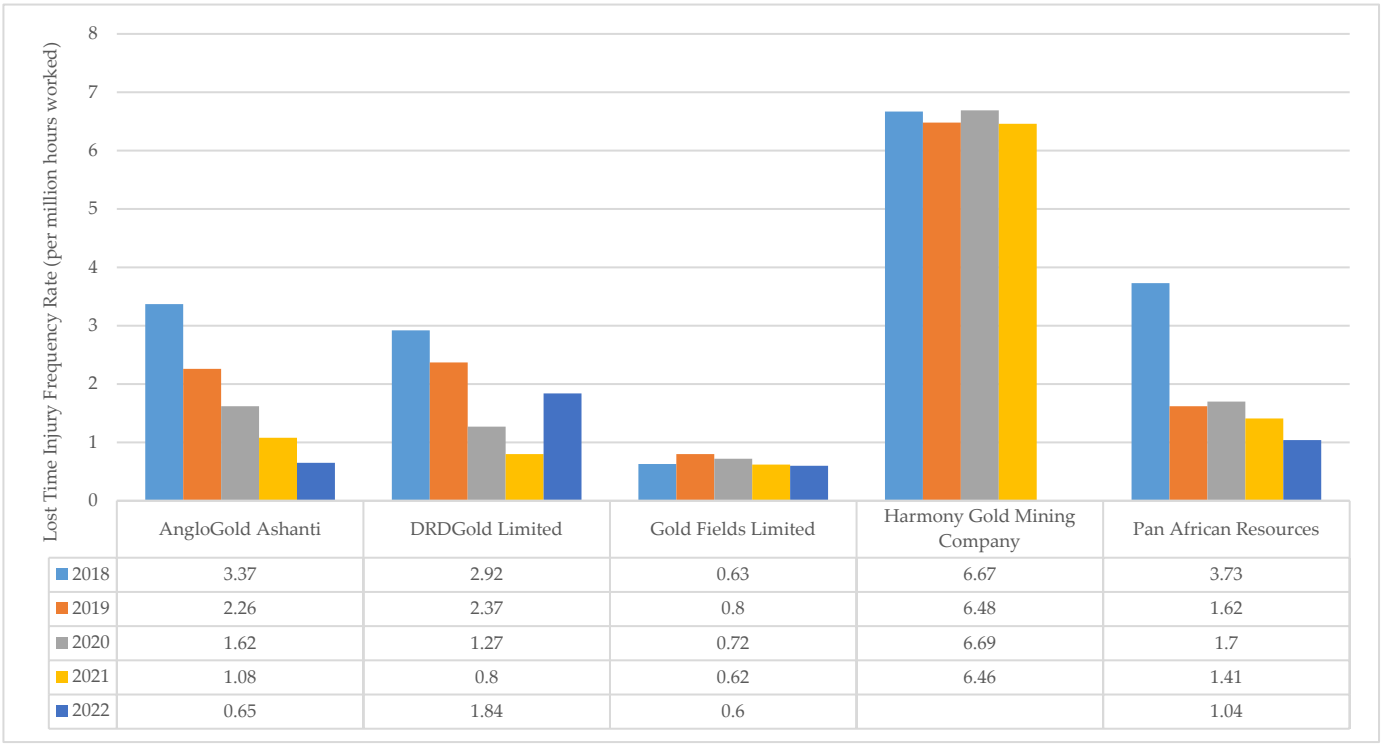
(a)

Figure 6. *Cont.*



	Anglo American platinum LTD	African Rainbow Minerals	Impala Platinum Holdings Limited	Northam Platinum Limited	SibanyeStillwater	Royal Bafokeng Platinum Limited	Wesizwe Platinum	Tharisa PLC
2018	2.1	0.49	6.01	5.01	5.89		0.34	0.18
2019	2.14	0.6	5.3	4.66	5.23		1.53	0.27
2020	2.01	0.63	4.55	3.92	5.56	1.318	0.57	0.09
2021	2.18	0.6	4.92	3	6.02	1.943	0.93	0.34
2022	1.95	0.44	4.21	3.85	4.41	1.647	5.03	0.41

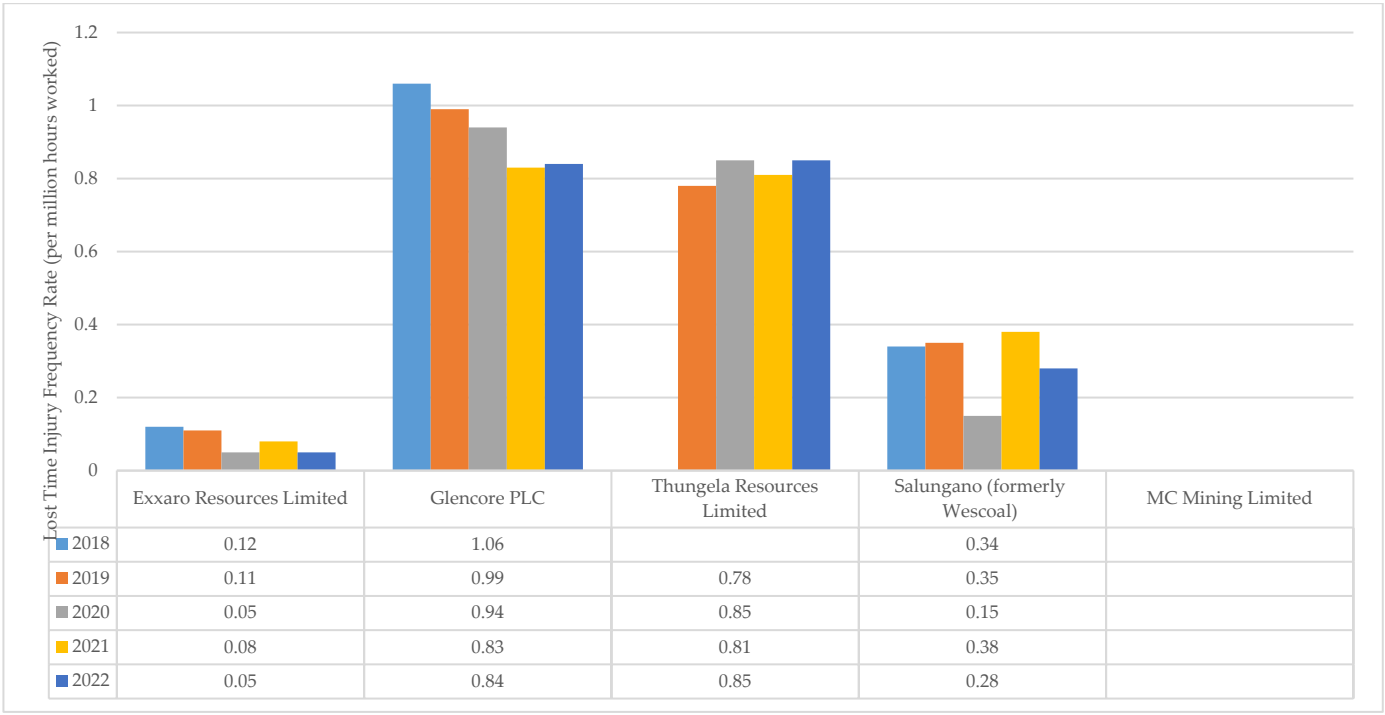
(**b**)



	AngloGold Ashanti	DRDGold Limited	Gold Fields Limited	Harmony Gold Mining Company	Pan African Resources
2018	3.37	2.92	0.63	6.67	3.73
2019	2.26	2.37	0.8	6.48	1.62
2020	1.62	1.27	0.72	6.69	1.7
2021	1.08	0.8	0.62	6.46	1.41
2022	0.65	1.84	0.6		1.04

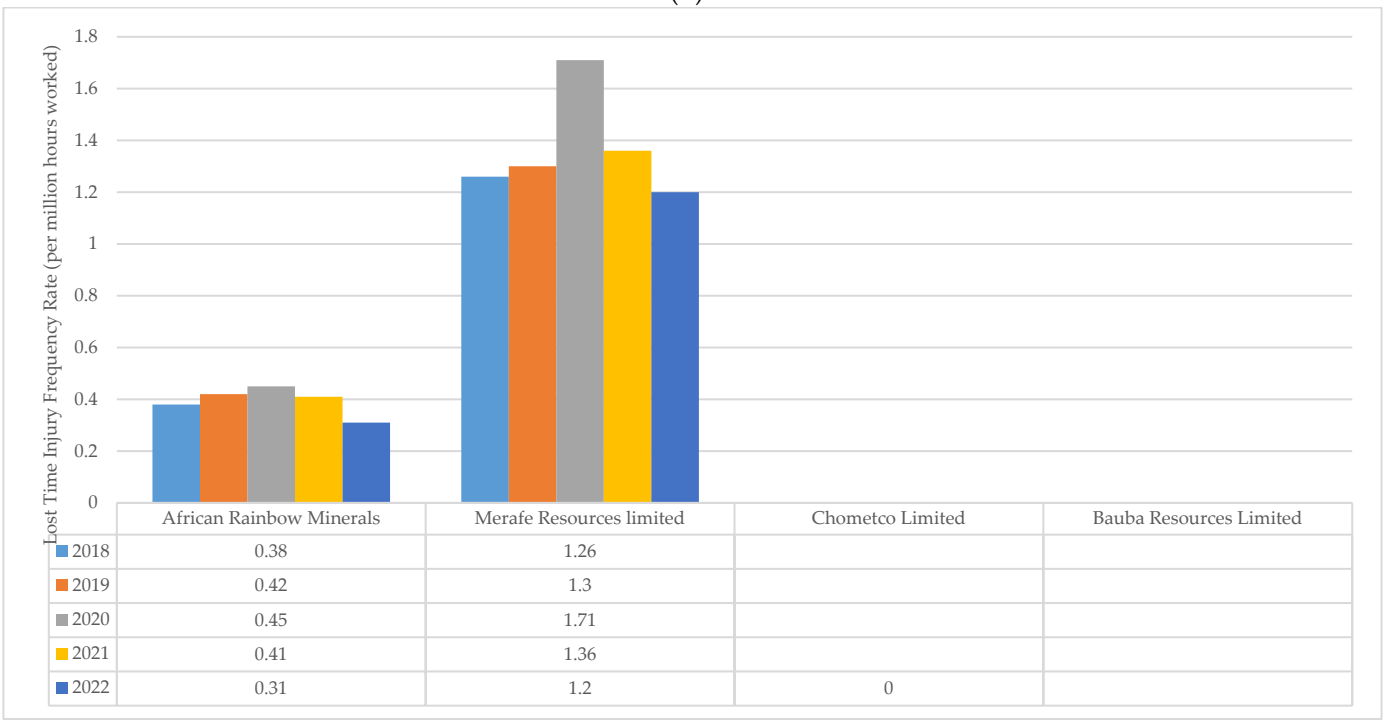
(**c**)

Figure 6. *Cont.*



	Exxaro Resources Limited	Glencore PLC	Thungela Resources Limited	Salungano (formerly Wescoal)	MC Mining Limited
2018	0.12	1.06		0.34	
2019	0.11	0.99	0.78	0.35	
2020	0.05	0.94	0.85	0.15	
2021	0.08	0.83	0.81	0.38	
2022	0.05	0.84	0.85	0.28	

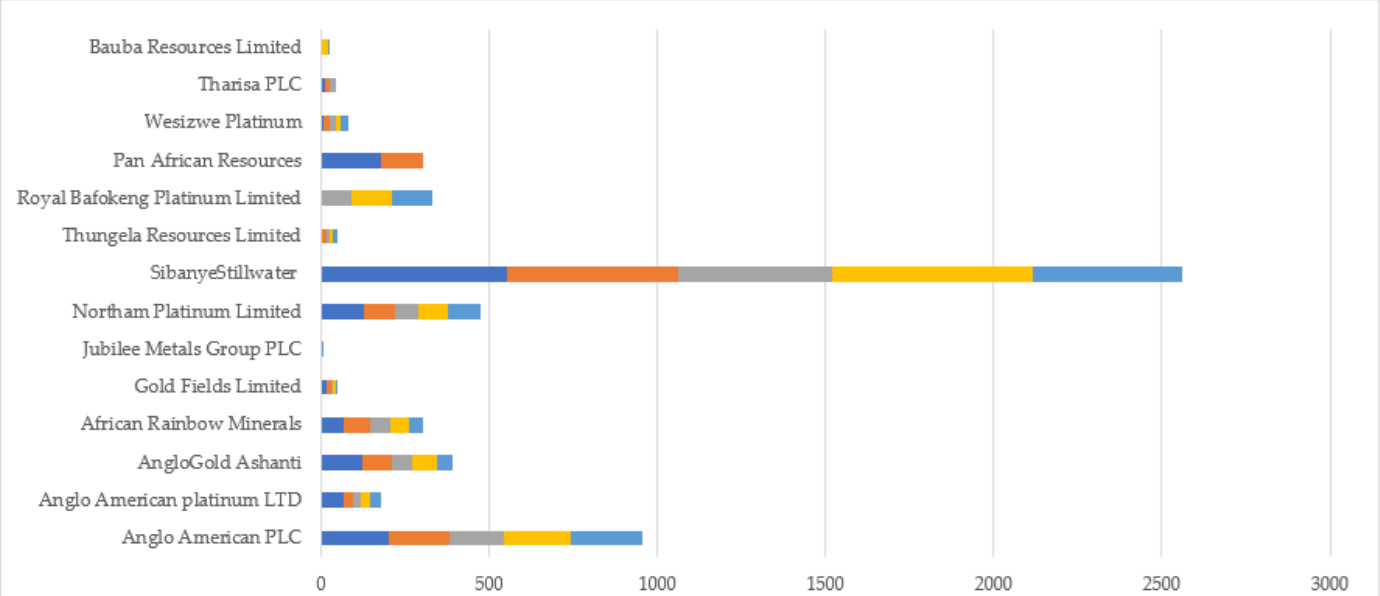
(**d**)



	African Rainbow Minerals	Merafe Resources limited	Chometco Limited	Bauba Resources Limited
2018	0.38	1.26		
2019	0.42	1.3		
2020	0.45	1.71		
2021	0.41	1.36		
2022	0.31	1.2	0	

(**e**)

Figure 6. Lost Time Incidence Frequency Rate (LTIFR) (per million hours worked) trend for included companies. (**a**) Five-year overview of Lost Time Injury Frequency Rate (per million hours worked)—conglomerate miners. (**b**) Five-year overview of Lost Time Injury Frequency Rate (per million hours worked)—platinum group metal miners. (**c**) Five-year overview of Lost Time Injury Frequency Rate (per million hours worked)—gold miners. (**d**) Five-year overview of Lost Time Injury Frequency Rate (per million hours worked)—coal miners. (**e**) Five-year overview of Lost Time Injury Frequency Rate (per million hours worked)—chrome miners.

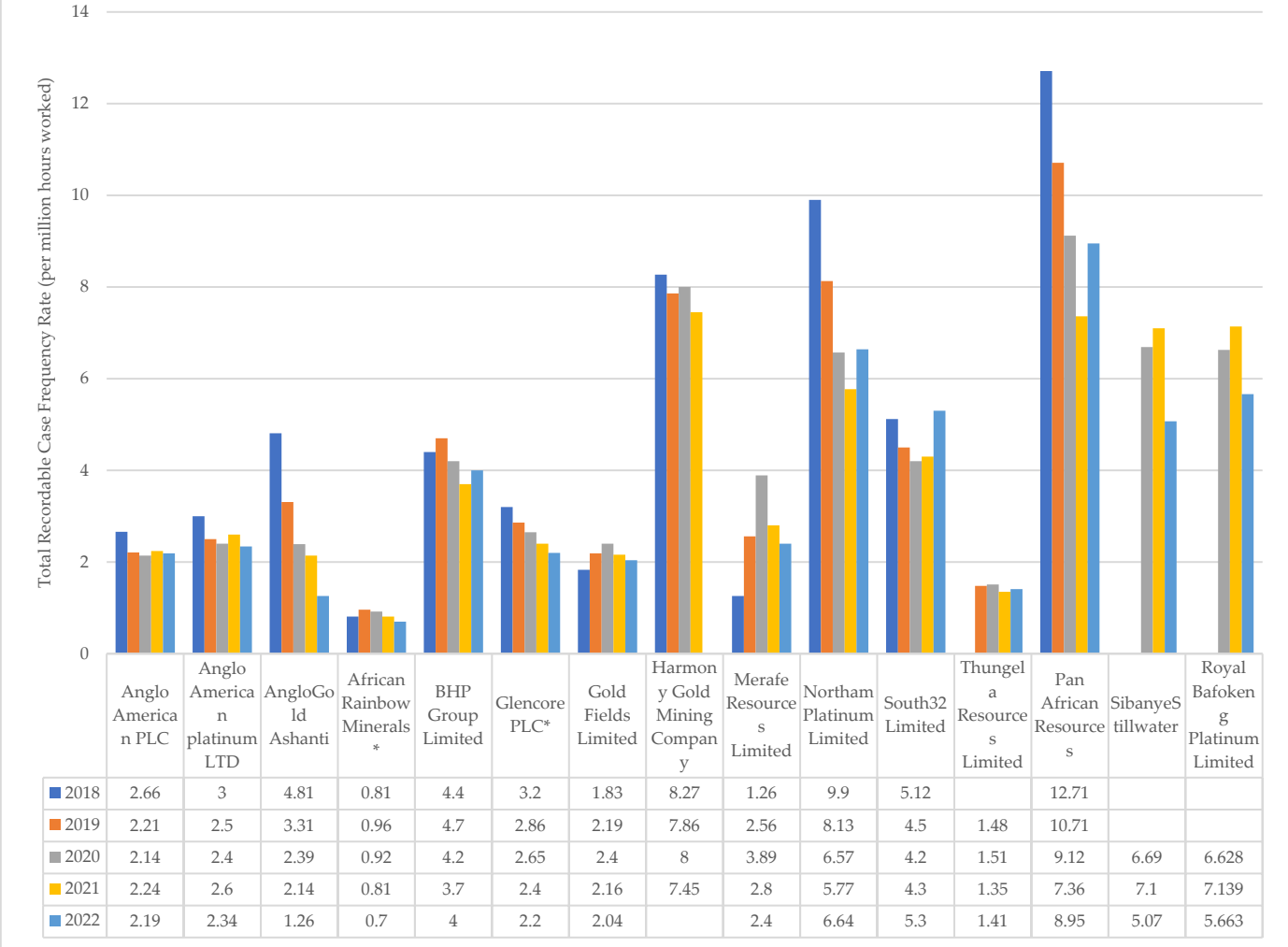


	Anglo American PLC	Anglo American platinum LTD	AngloGold Ashanti	African Rainbow Minerals	Gold Fields Limited	Jubilee Metals Group PLC	Northam Platinum Limited	SibanyeStillwater	Thungela Resources Limited	Royal Bafokeng Platinum Limited	Pan African Resources	Wesizwe Platinum	Tharisa PLC	Bauba Resources Limited
2018	202	65	121	68	17		125	553			177	7	12	
2019	177	28	90	76	12		95	508	15		126	16	11	
2020	165	24	58	63	6		70	458	12	88		20	22	1
2021	199	30	76	55	9		86	598	9	122		15		18
2022	212	31	47	42	5	3	97	441	10	120		24		2

Figure 7. Medical Treatment Case (MTC) counts.

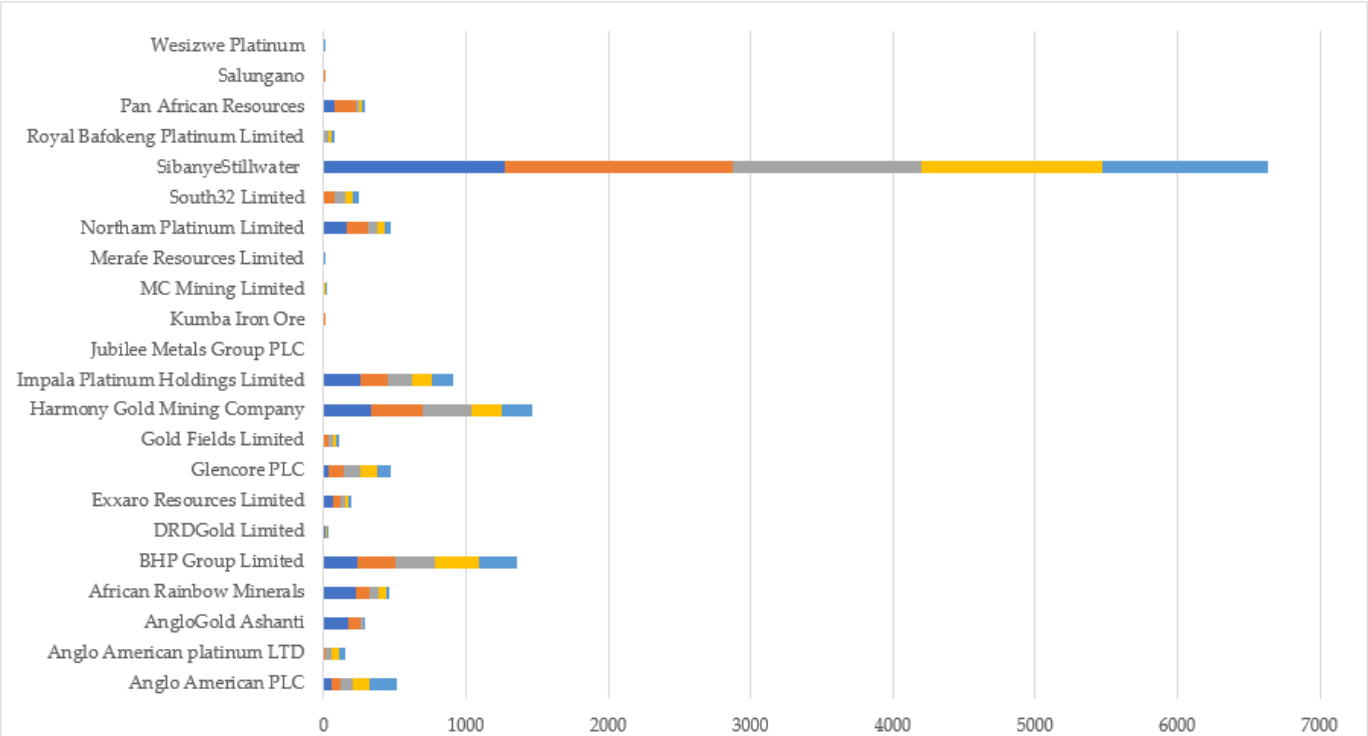
3.2.7. Total Recordable Case Frequency Rate (TRCFR) or Total Recordable Injury Frequency Rate (TRIFR)

The TRCFR is the sum of the LTIs, MTCs and injuries and is standardised per one million hours worked or 200,000 h worked. The highest TRCFRs were recorded by companies mining gold and platinum commodities (Harmony gold, SibanyeStillWater Pan African Resources, Royal Bafokeng Platinum Limited and Northam Platinum) (Figure 8). Figure 8 shows that the 15 companies that reported TRCFR as a performance indicator achieved zero harm for the reviewed period, on an annualised basis.



	Anglo American PLC	Anglo American platinum LTD	AngloGold Ashanti	African Rainbow Minerals *	BHP Group Limited	Glencore PLC*	Gold Fields Limited	Harmony Gold Mining Company	Merafe Resources Limited	Northam Platinum Limited	South32 Limited	Thungela Resources Limited	Pan African Resources	SibanyeStillwater	Royal Bafokeng Platinum Limited
2018	2.66	3	4.81	0.81	4.4	3.2	1.83	8.27	1.26	9.9	5.12		12.71		
2019	2.21	2.5	3.31	0.96	4.7	2.86	2.19	7.86	2.56	8.13	4.5	1.48	10.71		
2020	2.14	2.4	2.39	0.92	4.2	2.65	2.4	8	3.89	6.57	4.2	1.51	9.12	6.69	6.628
2021	2.24	2.6	2.14	0.81	3.7	2.4	2.16	7.45	2.8	5.77	4.3	1.35	7.36	7.1	7.139
2022	2.19	2.34	1.26	0.7	4	2.2	2.04		2.4	6.64	5.3	1.41	8.95	5.07	5.663

Figure 8. Five-year overview of Total Recordable Case Frequency Rate (TRCFR) or Total Recordable Injury Frequency Rate (TRIFR) (per million hours worked). * calculated per 200,000 h worked (SASB basis).



	Anglo American PLC	Anglo American platinum LTD	Anglo Gold Ashanti	African Rainbow Minerals	BHP Group Limited	DRD Gold Limited	Exxaro Resources Limited	Glencore PLC	Gold Fields Limited	Harmony Gold Mining Company	Impala Platinum Holdings Limited	Jubilee Metals Group PLC	Kumba Iron Ore	MC Mining Limited	Merafe Resources Limited	Northam Platinum Limited	South32 Limited	SibanyeStillwater	Royal Bafokeng Platinum Limited	Pan African Resources	Salungano	Wesizwe Platinum
2018	56	4	174	223	239	10	65	32		327	261		5		0	162		1277		81	3	1
2019	64	3	82	101	263		51	106	35	368	194		8	4	1	154	73	1598		143	12	1
2020	80	46	23	65	281	4	32	124	29	345	170		0	2	1	56	79	1330	37	27	0	1
2021	123	50	5	52	308	6	25	109	26	212	137		0	2	3	56	53	1269	22	17	0	1
2022	194	45	2	18	265	16	23	97	17	214	151	0	0	2	3	43	47	1164	20	22	0	1

Figure 9. Five-year overview of occupational disease count.

4. Discussion

4.1. Reporting Context and Format

In this study, company reports were analysed to determine the context and reporting frameworks with a specific focus on OHS performance indicators. The case companies published annual reports by compulsion of the Companies Act (71 of 2008) [40] and the JSE's listing requirements. The central focus of this historical study was the analysis of the reported OHS metrices, an indicator of OHS management system performance. In South Africa, mining companies are required to report OHS accidents and incidents in terms of chapter 23 of the Mine Health and Safety Act [34].

The publication of sustainability or ESG reports, variable in content, provided the case companies a platform for reporting progress on the attainment of voluntary pledges and commitments such as UNGC, decent work, human rights and OHS performance. In this regard, it is a natural course that the reports varied per adopted reporting guideline or framework [49].

Apart from motivating employers to institute abatement measures, OHS performance metrices can be a useful communication tool for current exposure reduction strategies and corresponding successes or failures [50]. Most of the OHS metrices used in the reviewed

reports were lagging indicators, retrospective in nature [50,51], indicating failures in aspired outcomes as well as unachieved set OHS objectives [50]. Once computed, companies can find meaning in the data as they allow for comparisons across similar companies and sectors [51].

4.2. Company OHS Performance

The analysis of incidence rates data is useful when planning targeted abatement measures and policies [11]. The case companies use injury and illness rates as an evaluation measure of performance, and their use is an integral measure of implemented OHS management system effectiveness [51]. However, OHS metrices should be cautiously evaluated as they are neither the exact measurement of workplace health and safety nor reliable indicators of workplace health and safety, cautions Safework Australia [52]. According to the Health and Safety Executive [43], policies, organisation, planning and implementation, measuring performance and auditing and reviewing performance are important functional elements that should be in place for successful OHS management. The implementation of an OHS management system is legally prescribed by the Mine Health and Safety Act in South Africa [34]. Companies can, however, also adopt voluntary OHS management systems such as the ISO/SANS 45001 for guidance elements to be implemented [53]. Performance measurement in a South African operating environment without nationally set targets is a challenge, however. In view of this challenge, the DMRE through the Mine Health and Safety Council (MHSC) sets milestones that regulated industry should attain within a specified timeframe [15]. The OHS performance indicators, especially fatalities, LTIs and pulmonary tuberculosis (PTB), as reported in this current study should be interpreted in view of the agreed milestone focus areas adopted by the MHSC in the 2014 summit. For clarity on the specific milestones, a 20% reduction in LTIs for all industries has been set, whilst the PTB incidence rate has been agreed to be at or below the national rate. Furthermore, a 20% reduction in serious injuries has also been set [15]. Company reporting or disclosures, from a regulatory perspective, should thus include these agreed performance milestones. Only a handful (two companies) of the case companies reported serious injuries, whereas LTIs and PTB incidence were extensively reported in the reviewed reports.

The current study indicates that a total of 74; 49; 44; 53 and 41 fatalities were reported by the case companies during 2018; 2019; 2020; 2021 and 2022, respectively. Total fatalities for ICCM company members were 50; 286; 44; 45 and 33 during 2018; 2019; 2020; 2021 and 2022, respectively [54]. Compared to the 1988 and 1989 study conducted by Leger [10], total fatalities for all mines operating at the time were at 674 and 735, respectively. Similar to the Leger [10] study, the mining companies with the highest fatalities were from gold miners, with a total of 123 loss of life cases for the reviewed period. Regarding total injuries, 11,357 and 10,097 injuries were reported during 1988 and 1989, respectively. The self-reports by the case companies shows that 3564 (2018); 3320 (2019); 2842 (2020); 3204 (2021) and 2292 (2022) injuries have been recorded for the 5-year review period. However, the Mine Health and Safety Inspectorate annual reports reported 2426 (2018), 2436 (2019), 1813 (2020), 2143 (2021) and 2065 (2022) injuries for the comparable period [12]. Compared to the ICCM safety performance data, 7751; 7780; 6997; 7355 and 7126 recordable injuries were reported during 2018; 2019; 2020; 2021 and 2022, respectively [54]. Though the South African statistics show a remarkable decrease over the period, one injury or disease is still too many. The gold, platinum and coal sectors were the largest contributors to both fatalities and injuries. This is unsurprising in that the three sectors are the largest employers with the sums of 87,478 (gold), 157,782 (platinum) and 86,070 (coal) employed during 2022, from total employment of 443,367 in the entire mining sector. The sources of fatalities and injuries were fall of ground (FOG), machinery, T&M, conveyance accidents and heat sickness, amongst others [12]. Disasters are a major contributor to fatalities. Disasters are defined as "accidents in which six or more lives are lost" and include events such as methane explosions, rockbursts, rockfalls, cage- or skip-related events, fires and inundation [34].

Employees in the mining industry have also been impacted by exposure to occupational health hazards, with a total of 13,733 OD cases reported in the 5-year review period. On a comparative basis, the DMRE [12] reported a total of 12,758 OD cases for the corresponding timeframe. The balance of the ODs was from foreign operations of some of the case companies, as appropriate. The majority of the recorded ODs were from the gold, platinum and coal mining sectors. In both cases where the injury rates and OD rates show a decreasing trend over time, this should not be construed to mean that health and safety have been measured, as the rates only measure occurrences. Thus, company statements such as "Our LTIFR shows we significantly improved health and safety at work" show a misunderstanding of the meaning of the OHS metrices, cautions Safework Australia [52]. With regard to OD incidences, some of the case companies were implicated and have settled with the complainants in the silicosis and PTB class action [55].

The reported incidence rates and absolute counts point to weaknesses in the case companies' OHS management systems [56]. This also points to a glaring company failure in achieving the expressed aspired end goal of zero harm. It, however, remains unclear from reviewed records whether the fatalities, injuries and ODs were from inherent or residual risks. Apart from having a demotivating effect on workers when targets are not met, the zero-harm approach has a weakness in that companies with inadequate risk assessments may be misled to expend finite financial resources on risks ranked low on the risk assessment matrix. Within the zero-harm philosophy, hazards and risks should be completely eliminated [57]. With the reported infirmities, the decent work principle, SDG 8 and zero harm are yet to be realised for some mining operations in South Africa. It is also unclear whether the reported declining trends in metrices have resulted in actual improvement in the overall OHS status [10].

4.3. Limitations and Future Research

The current study omitted the analysis of the data within the context of the economic business cycle when the recorded accidents or injuries occurred [58], as this has an impact of injury incidence. The current study focused on the general overview of fatality, injury and OD incidences as reported by the case companies. Future studies should focus on injury rates by occupation, an important variable in employee risk of injury [58]. This is associated with the limitations of the reporting format used by the case companies which excludes reporting the incidences by occupation. Further studies can also be conducted to analyse the incidences per type of mining method used, such as underground or open cast mining.

Furthermore, the current results have limitations in that the status of OHS performance from private small-scale mining companies remains unknown to the general public. This is an outcome of such companies having no regulatory reporting mandates. Some of the included case companies had disposed their South African operations but still maintained listing on the JSE.

4.4. Recommendations

The reported incidences should be used by affected companies as an opportunity to evaluate current implemented OHS programmes [59] and address the underlying causes of poor working conditions. This can be accomplished by addressing gaps in governance, legislation, knowledge, resources and promoting the culture of prevention [22]. There is also a need for the standardisation of reported incidence rates to aid comparisons across sectors.

University research niche areas (RNAs) focusing on the subject matter also have potential to contribute towards finding long-lasting solutions of the hazards of work in the mining industry [2]. RNAs provide researchers in the academic sector a collaborative opportunity "to be part of the solution rather than the problem" with other affected stakeholders [1,3].

5. Conclusions

Although varying in content and structure, the reporting of OHS performance by South African mining companies within the context of sustainability or ESG is well entrenched and promising. The reporting variances, however, obfuscate attempts for intra-company performance comparisons. The industry-stated goal of zero harm remains elusive for the mining companies included in this study, in view of the protracted reported incidences of injuries, fatalities and occupational diseases, which pose a direct threat to the decent work principle. The gold, platinum and coal sectors remain the main contributors to fatality, injury and occupational disease incidence in particular. The status quo challenges stakeholders, including regulators, employers, employees and labour unions alike, to continuously investigate measures for arresting the situation.

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Conflicts of Interest: The authors declare no conflicts of interest.

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