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Assessment of the Current State of Adoption of Digital Transformation Within Tanzania's Major Mining Sector

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Abstract

The study assessed the current state of adoption of digital transformation within Tanzania's major mining sector. This study employed a mixed-methods approach with a cross-sectional survey design, in which case data were collected from randomly selected major mines across different sources. Primary data were collected through online surveys from 198 top management personnel and 586 employees, who were proportionately randomly selected, as well as semi-structured interviews with 20 key informants. Secondary data were collected from official documents and previous studies. Quantitative data were analysed using descriptive statistics in terms of frequencies, percentages, and composite mean scores generated by R version 4.3.2. Qualitative data were analysed using the thematic analysis methods following the Braun and Clarke (2006) six-stage method.

The degree to which digital tools are implemented varies between and across major mines, sections and departments regarding digital incident reporting systems, real-time safety monitoring systems, automated hazard detection systems, digital safety training platforms, and safety compliance tracking software. Some of the major mines (33.3%) exhibited low implementation maturity, indicated by partially implemented digital tools [Median Score = 2.6 – 3.2]. Such major mines were associated with delayed and infrequent systems updates, extended time before installations of new digital solutions, the lack of financial readiness indicated by a comparatively smaller proportion of OSH spending for safety digital tools, and low perceived cost savings resulting from implementing digital tools. However, the contrary was true for the 33.3% of the major mines approximating to fully implemented and optimised digital tools [Median Score = 3.81 – 4.4].

Keywords: *Digital Transformation, Implementation of Digital Tools, Occupational Safety, Digital Tools in the Mining Sector*

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1.0 INTRODUCTION

The mining sector is crucial for Tanzania's economy, significantly contributing to employment, exports, and national income(Lyatuu et al., 2021). According to the 2020 Tanzania National Bureau of Statistics report, the mining sector contributed around 5.1% to the country's GDP and employed over 100,000 workers. According to Floris (2014) mining sector is said to be an inherently hazardous industry, with workers facing dangerous conditions that lead to accidents, injuries, and even death. Protecting workers' health and safety, maintaining productivity, and promoting socially and ethically acceptable behaviors all depend on this industry's dedication to Occupational Safety and Health (OSH) standards.

Despite efforts to enforce safety regulations, the challenges persist especially in large-scale operations where maintaining consistent oversight is seem to be difficult (Pagell et al., 2013). According to Boniface (2013), the mining industry in Tanzania has experienced an average of 120 work-related accidents per year, including 15 fatalities, over the past 5 years across major mining operations. Moreover, the informal artisanal mining industry presents

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much greater health and safety hazards, characterized by inadequate monitoring and compliance (Smith et al. 2016)

Digital transformation has been realised as the strategy to tackle these difficulties. Technologies include digital sensors, real-time data analytics, automated monitoring systems, and mobile apps have shown the capacity to improve occupational safety and health compliance by facilitating superior tracking, reporting, and administration of safety standards. These solutions has been a key to enhance danger identification, optimize operations performance, minimize manual labour, and cultivate a safety-oriented culture inside mining facilities. Despite the considerable advantages of digital technologies, their implementation in Tanzania's mining industry is restricted, and there is a lack of comprehension of their effects on occupational safety and health compliance due to resource-limitation.

The application of digital technologies has emerged as a promising approach to address the challenges in occupational safety and health compliance within the mining sector. According to Kinyondo innovations such as digital sensors, real-time data analytics, automated monitoring systems, and mobile applications have demonstrated potential to enhance OSH compliance by facilitating improved tracking, reporting, and management of safety protocols. These digital tools not only enhance hazard detection but also streamline processes, reduce manual work, and foster a culture of safety within organizations. However, while these digital solutions offer substantial benefits, their adoption in Tanzania's mining sector remains limited, and there needs to be a more comprehensive understanding regarding their impact on OSH compliance, particularly in resource-constrained environments (Kinyondo & Huggins, 2021).

The primary mining sector in Tanzania is the focus of this paper, which aimed to assess the current state of digital adoption. The paper aimed to provide data-driven insights that may guide policy choices and make it easier to integrate solutions that are based on technology. This research aimed to improve mining safety standards in Tanzania by highlighting how digital transformation may lead to better industrial safety measures.

1.1 Research Porblem

The mining sector is a cornerstone of Tanzania's economy, contributing significantly to the country's GDP and providing employment opportunities. The high-risk nature of the labor in this industry, however, makes Occupational Safety and Health regulations very difficult to enforce. Protecting the health and safety of miners is just as important as ensuring that the industry continues to be socially and environmentally responsible (Pelders & Nelson, 2018).

The mining industry is only one of several that has been effectively impacted by digital transformation in the last few years. In mining settings, technologies like the Internet of digital sensors, data analytics, mobile apps, and automated systems might improve danger monitoring, simplify compliance, and increase safety standards. Despite this potential, the state of digital transformation on OSH compliance in Tanzania's major mining sector remains unclear.

This study fills a knowledge gap by collecting and analyzing data on the digital technology on occupational safety and health compliance in Tanzanian mines. By exploring these dynamics, the study aimed to provide insights that could inform policy decisions and encourage the effective adoption of digital solutions to promote a safer working environment in Tanzania's mining industry.

Research Questions

The main questions of research as related to the current status of digital transformation in the major mining sector was: -

1. What is the the overall state of digital transformation within Tanzania's major mining sector.
2. What is the the current level of implementation of safety digital tools within Tanzania's major mining sector.

2.0 LITERATURE REVIEW

The study was guided by the Socio-Technical Systems (STS) Theory, and the Technological Acceptance Model (TAM). The STS theory that can be traced far back in the early 19th C. In the 1940s, Eric Trist, Ken Bamforth, and Fred Emery conducted research at the Tavistock

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Institute on coal mining operations in England, which led to the development of Socio Technical Systems Theory (STS) (Trist & Bamforth, as referenced in Long, 2013; Stranks, 2007). Later, STS was expanded to emphasize the joint optimization of technological and social systems through wider applications in organizational development. In sophisticated settings, such as the case of OSH digitalization in the mining sector, the contemporary STS combines the human-machine interfaces and cybernetic processes altogether (Long, 2013; Cardenas & Kozine, 2025). One of the fundamental tenets of STS is the joint optimization principle, which maintains that for the system to function effectively as a whole, neither the technological nor the social subsystem should predominate (Cardenas & Kozine, 2025). The theory makes the assumption that people, technology, tasks, and environment interact to produce work results, and that when these factors are taken into account together, organizational performance is maximized (Long, 2013).

On the other hand, the TAM was first propounded by Fred D. Davis in 1986 and later it was jointly formalized by Fred D. Davis, Richard P. Bagozzi, and Paul R. Warshaw, in the year 1989. TAM was initially broadly founded in the Theory of Reasoned Action before being condensed to concentrate on two main ideas namely perceived usefulness and perceived ease of use (Davis et al., 1989). According to TAM perceived usefulness and perceived ease of use determines the use of technology. The model posits that the actual usage of technology is a function of behavioral intentions that mapped through perceived usefulness and ease of use for a given technology. As a result of this strong axiom, TAM suggests that the degree of digital tool usage needs to be regarded as a mediating variable between implementation of digital tools and OSH compliance.

These two theories work in tandem to describe the behavioral mechanisms influencing the use of digital tools and the systemic integration of these tools into mining operations, both of which have an impact on OSH compliance. The broad macro perspective provided by STS examines the interactions between mining companies, their technologies, employees, and overall environment signifying legal frameworks, policies and mandates (Coiera, 2007). On the other hand, according to perceived qualities, training, social context, and experience, TAM offers the micro foundation for how people embrace and use digital products (Venkatesh et al., 2003; Hendricks et al., 2023).

In actuality, STS presents the use of digital tools as a component of a broader sociotechnical framework that influences OSH compliance. Then, TAM explains why people in that system may or may not use those tools. For instance, according to STS, a well-integrated digital monitoring system only improves compliance if the social subsystem—which includes users, training, and norms—aligns. With moderators like experience and mine type, TAM assists in defining whether users desire to use the system and do so based on perceived usefulness, perceived ease of use, or effort expectancy, as well as facilitating conditions (Hendricks et al., 2023; Venkatesh et al., 2003).

By combining these theories, the study was designed on a cohesive conceptual and empirical model, with TAM directing usage behavior measurement and hypothesis testing and STS directing the research design and contextual variables. Systemic insight and behavioral specificity are made possible by the combination, which also allows for the discussion of technical-social alignment (Dodoo et al., 2024; Hendricks et al., 2023).

3.0 METHODOLOGY

This study deployed a mixed-methods approach to comprehensively assess the current state of adoption of digital transformation within Tanzania's major mining sector. The crossectional survey desing was adopted in which case data were collected across the selected major mines from different sources. the study was conducted in Tanzania and involved six major mines out of the existing operational 8 major mines [Figure 2.1]. The population of the study included the top managemnt and employees from six major mines tha were randomly seleted. The study relied on multistage sampling methods wuth simple random sampling at each stage starting with selecting major mines, followed by sampling top management anf then ampling the ocerall staff. At the first stage six major mines including Geita Gold Mine, Bulyanhulu Gold Mine, Williamson Diamond Mine, Buckreef Gold Mine, New Luika Gold Mine, and Ngaka Coal Mine were selected. The second stage involved sampling the 232 top management using stratified random sampling. The top management was treated as separate sample to assess the current state of adoption of digital transformation within Tanzania's

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major mining sectors. Thus, top management was selected from each major mine in this case regarded as sampling cluster using stratified random sampling respective of the sample proportion. This method ensured that sample was adequate and representative to answer the research question regarding the current state of adoption of digital transformation. The same procedure was followed for selecting 594 staff from major mines across departmets and sections.

At the end of the study 198 top management staff which is equivalent to 85.3%, and 586 overall staff which is equivalent to 98.6% responded. Qualitative data were collected through the semi-structured interviews with 2 safety officers including the head of safety officers who is also the head of the Safety Committee, 1 ICT manager for each of the six major mines, and from 2 OSH Authority representatives including 1 Principal ICT Officer with 17 years of working experience, and 1 Safety Engineer with relevant field and administrative experience in OSH and the ongoing digital transformations.

On the other hand quantitaive data were collected from 198 top management and 586 employees who were randmly seletced from the six major mines using questionnaires. Nontheless, secondary data were collected from official documents including the implantation plans specifically for safety digital tools, procurement reports, and safety reports. Also, the literature review of previous studies and digital transformation resources (Innotech, 2021; Mipac, 2022; Johnston, 2017). Qualitative data were analysed using the thematic analysis methods following the The Braun and Clarke (2006) six stages. Quantitative data were analysed using descriptive statistics in term of frequencies, percentages, and composite means score. In this case the statistical analysis software namely R version 4.3.2 was used.

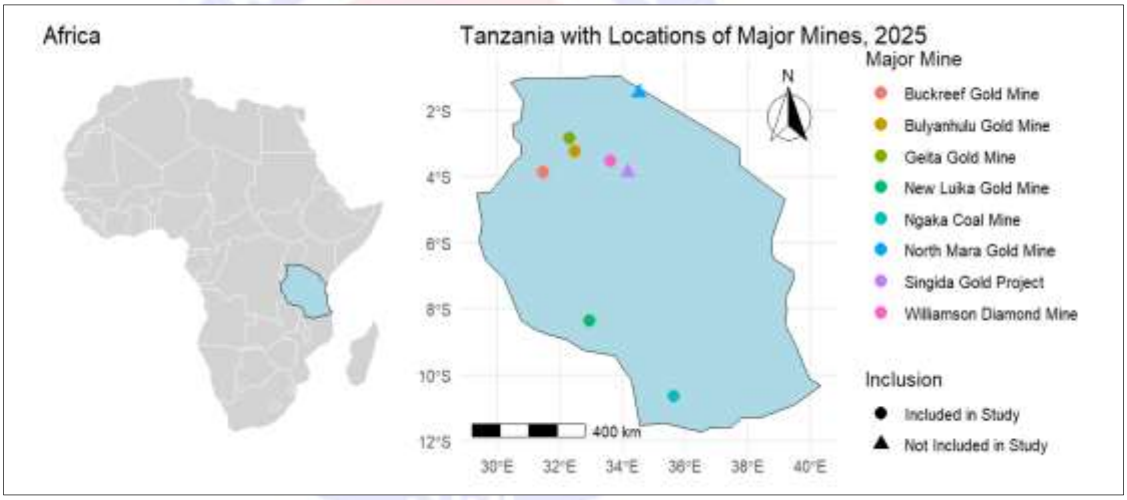

Figure 2.1 Locations of Tanzania Major Mines, 2025

4.0 RESULTS AND DISCUSSIONS

The study findings are presented in subsections with respect to different areas of focus including profile of major mines included in the study, overall state of digital transformation in major mines, implementation of digital tools between major mines, financial readiness for digital transformation, system update frequency, time to implement new digital safety solutions, reported cost savings, training effectiveness, and usage level of safety digital tools.

4.1 Profile of Major Mines Included in the Study

The profile of major mines includes the overall characteristics in terms of mine type, origin or ownership, mineral type, capital expenditure, operating expenditure and size by number of employees.

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Table 3.1: Summary Statistics of the Studied Major Mines

Major Mine	**Mine Type**	**Origin / Ownership**	**Mineral**	**Capital Expenditure (Year)**	**Operating Expenditure / oz (Year)**	**Number of Employees**
Geita Gold Mine	Mixed	Foreign	Gold	-	$944 (2024)	3150
Williamson Diamond Mine	Open-pit	Mixed	Diamonds	$35 M (Q1 2025)	$1,714 (Q1 2025)	1470
Bulyanhulu Gold Mine	Underground	Foreign	Gold (& Ag, Cu)	-	-	1460
Ngaka Coal Mine	Open-pit	Mixed	Coal	-	-	1304
New Luika Gold Mine	Mixed	Foreign	Gold	$25 M (2023)		1203
Buckreef Gold Mine	Open-pit	Foreign	Gold	$196 M (2024)	$984 (2024)	1007

Source: Administrative Data, 2025

The study included six major mines, 3 of them are open-pit, 2 are mixed and 1 is undergoing. Four of them were foreign owned, 2 were co-owned by foreign and Tanzania government. Gold is the major focus of major mines in Tanzania where 4 are dealing with gold, the remaining 2 are dealing with either diamonds or coal. The rankings of these mines by size are not clear with financial data such as capital expenditure and operating expenditure, owing to lack of adequate data. However, based on the number of employees, Gita Gold Mine is regarded the largest with 3150 employees and the smallest is Buckreef Gold Mine with 1007 employees. In a broad view, the study included a diversity of major mines with respect to mine type, mineral type, ownership, and size as indicated by number of employees. This improves the external validity of the study findings (Creswell & Creswell, 2018), it also reflects that bias from homogeneous sampling was controlled (Bryman, 2016), and therefore the study findings are grounded in practical realities (Patton, 2015).

4.2 Overall state of Digital Transformation in Major Mines

The overall state of digital transformation was assessed using qualitative data from key players in OSH and related ICT personnel across the major mines and the Tanzania OSH Authority. The themes that were defined from thematic analysis show that the digital transformation of the six major mines ranges from digital incident reporting systems, real-time safety monitoring systems, automated hazard detection systems, digital safety training platforms, and safety compliance tracking software. The details are presented in Figure 3.1.

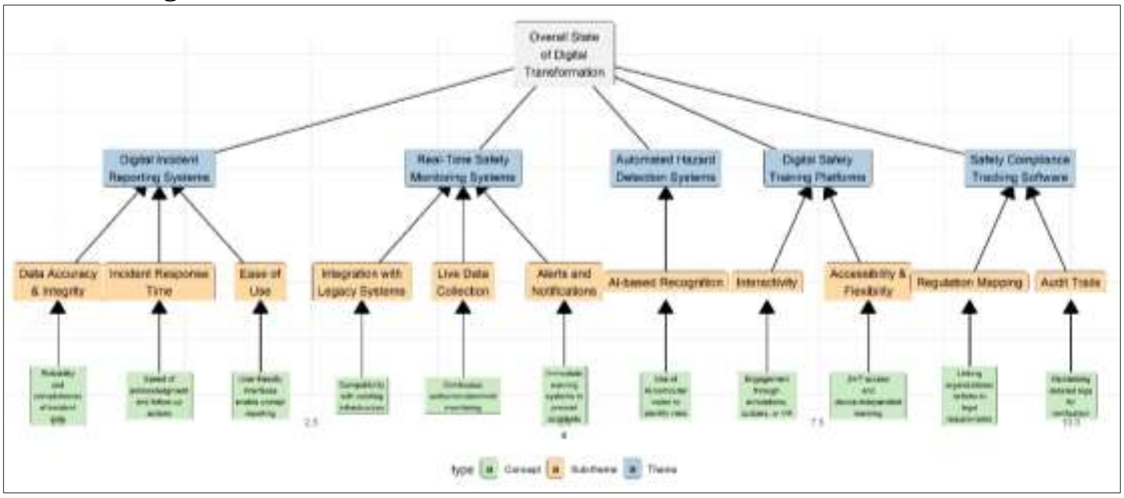

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Figure 3.1: Thematic Maps

The results in Figure 3.1 indicate a significant step toward ongoing proactive, and data-driven safety management using the digital OSH systems. However, the details on the level to which the safety digital tools are implemented deduced from survey results show varying levels across these indicators. This finding is supported from further analysis comparing implimentation levles for different safety digital tools. The respective survey results are presnted in form of frequences and percentages in Table 3.2.

Table 3.2: Comparing Implimentation Levles Between Indicators

Indicator	1	2	3	4	5	Total
Automated hazard detection	11 (5.6%)	24 (12.1%)	32 (16.2%)	50 (25.3%)	81 (40.9%)	198 (100%)
Digital safety training	19 (9.6%)	29 (14.6%)	34 (17.2%)	51 (25.8%)	65 (32.8%)	198 (100%)
Incident reporting system	13 (6.6%)	31 (15.7%)	38 (19.2%)	52 (26.3%)	64 (32.3%)	198 (100%)
Real time safety monitoring	12 (6.1%)	22 (11.1%)	41 (20.7%)	46 (23.2%)	77 (38.9%)	198 (100%)
Safety compliance tracking	9 (4.5%)	34 (17.2%)	28 (14.1%)	55 (27.8%)	72 (36.4%)	198 (100%)
Key: 1=Not implemented, 2=Planning stage, 3=Partially implemented, 4=Fully implemented, 5=Fully implemented and optimized						

The results in Table 3.2 show a diverse rating on the level of implementation of digital tools for all categories of digital tools. However, the distribution indicates high implementation levels signified by an increasing trend from lower percentage [4.5% - 9.6%] in 'Not implemented' level to high percentage [32.3% - 40.9%] in 'fully implemented and optimized' level across all five indicators. A similar trend is evident in all mining companies. The diverse of responses indicates different levels of implementation across departments and sections within the mines rather than between mining companies. However, the level of implementation is not necessarily uniformly distributed across the indicators.

4.3 Implementation of Digital Tools Between Major Mines

The study used primary data from top management, and secondary data to evaluate the level of implementation of digital tools in big mines. The level of implementation was evaluated using five indicators including digital incident reporting systems, real-time safety monitoring systems, automated hazard detection systems, digital safety training platforms, and safety compliance tracking software. Analysis focused on the implementation evaluation question with five-point scale for each of the five indicators. The results are presented in subsections as primary data analysis of the level of implementation of safety digital tools, and secondary data analysis of the level of implementation of safety digital tools.

4.4 Primary data analysis of the level of implementation of safety digital tools.

Using these indicators the top management staff rated a five-point Likert scale was used with 1=Not implemented, 2=Planning stage, 3=Partially implemented, 4=Fully implemented, 5=Fully implemented and optimized. Descriptive analysis methods are used to analyse the level of implementation. The means scores and boxplot are used to compare implementation levels between major mines.

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Table 3.3: Mean score of implementation level by mining company

Major Mine	N	Min	Max	Mean	SD	Median	IQR
Bulyanhulu Gold Mine	30	4.4	4.8	4.49	0.14	4.4	0.2
Geita Gold Mine	41	4.4	4.6	4.47	0.1	4.4	0.2
Buckreef Gold Mine	31	3.6	4.2	3.8	0.24	3.6	0.4
Williamson Diamond Mine	27	3.6	4.2	3.76	0.18	3.8	0.2
Ngaka Coal Mine	37	3	3.4	3.18	0.15	3.2	0.2
New Luika Gold Mine	32	3	3.4	3.15	0.14	3.2	0.2

Source: Survey Data, 2025

The results in Table 3.3 show that the minimum of the minimum is 3 which indicates even the least implementation level is already pointing to a partially implemented level on a five-point Likert scale. Thus, classification of the mining by implementation need to align with the thresholds of lower percentile, medium and upper percentile rather than the traditional cut off points of five-point Likert scale. Using this approach the companies were successfully categorized into fully implemented and optimized for upper percentile, fully implemented for medium percentile, and partially implemented for lower percentile.

Consequently, two mining companies namely Bulyanhulu Gold Mine and Geita Gold Mine were categorized as mines with fully implemented and optimized digital tools, other two mines namely Buckreef Gold Mine, and Williamson Diamond Mine were categorized as mines with fully implemented digital tools, and the remaining two mines namely Ngaka Coal Mine, and New Luika Gold Mine were categorized as mines with partially implemented digital tools. The visualization of classification results is shown in Figure 3.2 as boxplot.

Figure 3.2: Boxplot of Overall Implementation Level of Digital Tools
Source: Survey Data, 2025

The results in Figure z show that there is a clear demarcation between the mines in terms of implementation level. These findings are useful in fitting the model in stage two where implementation level is treated as an important independent variable. These results are further aligning with the assessment from secondary data as shown in Table 3.5.

4.5 Secondary data analysis of the level of implementation of safety digital tools

The purpose of using secondary data was to ensure validity of the study findings through cross validation methods. This helped to crosscheck for optimism bias that

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would emerge from the top management who are involved in answering the implementing evaluation questions. Cross-validation using secondary data strengthens robustness of the findings of primary data (Johnston, 2017; Smith, 2008). In this study the secondary data were extracted from official documents including the implantation plans specifically for safety digital tools, procurement reports, and safety reports. Also, the literature review of previous studies and digital transformation resources. Based on a combination of sources the indicators for each level of implementation were defined with the following matrix (Figure 3.3).

Indicator	Level 1 Not Implemented	Level 2 Planning	Level 3 Partially Implemented	Level 4 Fully Implemented	Level 5 Optimized
Digital Incident Reporting Systems	No digital system; paper/manual reporting only	Plans to implement digital reporting tools	Digital reporting exists but limited coverage or adoption	Digital system in place, widely used by employees	Integrated with real-time alerts, analytics, and continuous improvement mechanisms
Real-Time Safety Monitoring Systems	No real-time monitoring; manual checks only	Planning or piloting real-time sensor systems	Sensors installed but limited scope or not always active	Full real-time monitoring of key safety parameters	Advanced sensor network with predictive analytics and automated responses
Automated Hazard Detection Systems	No automated hazard detection	Planning deployment of automated detection	Automated hazard detection installed in some areas	Automated hazard detection operational across operations	Fully integrated AI-based hazard detection with automatic alerts and mitigation
Digital Safety Training Platforms	No digital training; only in-person sessions	Plans to introduce e-learning or digital training	Partial digital training modules available	Comprehensive digital training platform in use	Adaptive, personalized digital training with real-time assessments and feedback
Safety Compliance Tracking Software	No compliance tracking software; manual logs	Considering software solutions	Software used but limited functionality or compliance areas	Comprehensive software for tracking all compliance activities	Fully integrated compliance system with dashboards, reporting, and audit trails

Figure 3.4: Matrix of Implementation Level indicators Used
Source: (Administrative Data, 2025; Innotech, 2021; Mipac, 2022; Johnston, 2017)
Based on the defined indicators for each level of implementation of digital safety tools, each of the six major mine was evaluated and the results are presented in Table 3.4.

Table 3.4: Five-point Scores on Documented Digital Tools Implementation

Major Mine	Indicators on Digital Tools Implementation Status					
	Digital Incident Reporting Systems	Real-Time Safety Monitoring Systems	Automated Hazard Detection Systems	Digital Safety Training Platforms	Safety Compliance Tracking Software	Average
Geita Gold Mine	5	4	4	5	5	4.6
Bulyanhulu Gold Mine	5	3	4	5	5	4.4
Williamson Diamond Mine	3	3	2	3	5	3.2
Buckreef Gold Mine	3	3	3	2	5	3.2
New Luika Gold Mine	2	2	3	3	3	2.6
Ngaka Coal Mine	3	3	2	2	3	2.6
Average	**3.5**	**3.0**	**3.0**	**3.3**	**4.3**	**3.4**

Values 1-5: are based on Indicators from Document Review [Figure 3.3]
Source: Administrative Data, 2025

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The scores in Table 3.4 show that the mines can be categorized in those with relatively high score of 4.4 and 4.6, medium score of 3.2 and low score of 2.6. The results suggest that the data from primary source and secondary sources yield common general conclusion in terms of categorization despite slight differences in magnitude. THus, it can be deduced that categorizing the mines into three categories of fully implemented and optimized, fully implemented, and partially implemented holds credibility and robustness findings based on triangulation this approach (Patton, 2015).

Financial Readiness for Digital Transformation

The ability of an organization to set aside and oversee the funds required to implement and maintain ongoing digital transformations related to OSH (Chen et al., 2021; Deloitte, 2020). In this study the financial readiness was conceived as proportion of OSH expenses for system integration, training, new technology, and continuing maintenance expenses related to using digital tools (Ghosh & Scott, 2022). The top management was asked to reveal the budget allocation for the financial year preceding the study ranging from less than 10%, 10-25%, 26-50%, or more than 50%. The results are presented in Table 3.5.

Table 3.5: Budget Allocation for Digital Transformation

	OSH Budget Allocated to Digital Transformation				
Major Mine	**<10%**	**10-25%**	**26-50%**	**>50%**	**Total**
Bulyanhulu Gold Mine	3 (10%)	12 (40%)	10 (33.3%)	5 (16.7%)	30 (100%)
Geita Gold Mine	4 (9.8%)	15 (36.6%)	18 (43.9%)	4 (9.8%)	41 (100%)
Buckreef Gold Mine	10 (32.3%)	12 (38.7%)	6 (19.4%)	3 (9.7%)	31 (100%)
Williamson Diamond Mine	8 (29.6%)	10 (37.0%)	6 (22.2%)	3 (11.1%)	27 (100%)
Ngaka Coal Mine	20 (54.1%)	10 (27%)	5 (13.5%)	2 (5.4%)	37 (100%)
New Luika Gold Mine	18 (56.3%)	9 (28.1%)	3 (9.4%)	2 (6.3%)	32 (100%)
Total	**63 (31.8%)**	**68 (34.3%)**	**48 (24.2%)**	**19 (9.6%)**	**198 (100%)**

Source: Survey Data, 2025

The results in Table 3.5 show that majority (34.3%) of the departments and sections across major mines allocate 10-25% of OSH budget to digital transformations, followed by 31.8% who allocate less than 10%. However, majority of the departments and sections from major mines with high level of implementation maturity such as the Bulyanhulu Gold Mine (33.3%) and Geita Gold Mine (43.9%) had allocated between 26-50% of OSH budget to digital transformations. Contrastingly, majority of departments and sections of major mines with low implementation maturity such as Ngaka Coal Mine (54.1%), and New Luika Gold Mine (56.3%) had allocated less than 10% of OSH budget to digital transformations. The findings indicate that financial readiness which is a key determinant for safety digital transformation as it affects the level of implementation in terms of acquitting new technologies, and regular maintenance of existing ones.

System update Frequency

Timely updates of systems is a key element of implementation status of the safety digital tools. Timely updates of safety digital systems guarantee that they stay up to date and adaptable to changing circumstances; however, infrequent updates can create weaknesses and negatively affect their anticipated usefulness (Zheng et al., 2020; Tiefenau et al., 2020). Top management were asked to indicate how often they realize systems updates in their respective departments and sections in respective major mines. they had to choose between monthly, quarterly, annually, as needed or never. The results are presented in Table 3.6.

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Table 3.6: System Update Frequency

Major Mine	Digital Safety Systems Update Frequency					
	Monthly	**Quarterly**	**Annually**	**As needed**	**Never**	**Total**
Bulyanhulu Gold Mine	5 (16.7%)	12 (40.0%)	10 (33.3%)	3 (10.0%)	-	30 (100%)
Geita Gold Mine	6 (14.6%)	16 (39.0%)	13 (31.7%)	5 (12.2%)	1 (2.4%)	41 (100%)
Buckreef Gold Mine	2 (6.5%)	8 (25.8%)	14 (45.2%)	6 (19.4%)	1 (3.2%)	31 (100%)
Williamson Diamond Mine	3 (11.1%)	9 (33.3%)	10 (37.0%)	4 (14.8%)	1 (3.7%)	27 (100%)
Ngaka Coal Mine	2 (5.4%)	5 (13.5%)	15 (40.5%)	10 (27%)	5 (13.5%)	37 (100%)
New Luika Gold Mine	1 (3.1%)	4 (12.5%)	13 (40.6%)	12 (37.5%)	2 (6.3%)	32 (100%)
Total	**19 (9.6%)**	**54 (27.3%)**	**75 (37.9%)**	**50 (25.3%)**	**10 (5.1%)**	**198 (100%)**

Source: Survey Data, 2025

The results in Table 3.6 show that overall update frequency is less timely for majority of departments and sections. This is indicated by the low percentage of 25.3% updating the systems as needed. The finding indicates that the scheduling for systems updates is not necessarily matching the prescribed or technically recommended time frame or real time update requirements. However, the level of deviation from perfection varies across mines with respect to implementation maturity. For instance, the results show that major mines with high implantation maturity tend to update more frequently such as 40% quarterly for Bulyanhulu Gold Mine and 39% quarterly for Geita Gold Mine. On the other hand, major mines with low implantation maturity tend to update less frequently such as 40.5% annually for Ngaka Coal Mine and 40.6% annually for New Luika Gold Mine.

4.6 Time to Implement New Digital Safety Solutions

To reduce risk exposure and expedite safety advantages, digital safety solutions must be implemented in a shorter average time (Dissanayake et al., 2022). In dynamic work situations, delays can diminish system efficacy and impede adoption. In this study this was intended to measure agility and readiness for ongoing digital tranformation for OSH in major mines. Thus, the top management were asked on the average time taken to implement new digital safety solutions. They had to choose between less than 3 months, 3-6 months, 7-12 months, or more than 12 months. The results are presnted in Table 3.7.

Table 3.7: Average Time to Implement New Digital Safety Solutions

Major Mine	Average Time Period				
	< 3 Months	**3-6 Months**	**7-12 Months**	**>12 Months**	**Total**
Bulyanhulu Gold Mine	8 (26.7%)	12 (40.0%)	7 (23.3%)	3 (10%)	30 (100%)
Geita Gold Mine	10 (24.4%)	16 (39.0%)	9 (22.0%)	6 (14.6%)	41 (100%)
Buckreef Gold Mine	4 (12.9%)	9 (29.0%)	10 (32.3%)	8 (25.8%)	31 (100%)
Williamson Diamond Mine	3 (11.1%)	8 (29.6%)	9 (33.3%)	7 (25.9%)	27 (100%)
Ngaka Coal Mine	2 (5.4%)	5 (13.5%)	15 (40.5%)	15 (40.5%)	37 (100%)
New Luika Gold Mine	1 (3.1%)	4 (12.5%)	14 (43.8%)	13 (40.6%)	32 (100%)

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Total	**28 (14.1%)**	**54 (27.3%)**	**64 (32.3%)**	**52 (26.3%)**	**198 (100%)**

Source: Survey Data, 2025

The results in Table 3.7 show that overall averate time taken to implement new digial solutions is relatively long with majority (32.3%) of departments and sections take between 7-12 months, whereas 26.3% of departments and sections across major mines take more than 12 months. The finding indicate that overall pace of digital safety tools implementations is at least not highly accelerating across some of the departments and sections of the major mines. However, the results in Table tgh show that the averate time taken to implement new digial solutions varies across major mines with regard to implemtation maturity levels. For example majority (32.3%) of departments and sections across mines with high implementation maturity levels such as Bulynhulu Gold Mine (40%) and Geita Gold Mine (39%) take between 3-6 months, whereas between 24.4 – 26.7% take less than 3 months. In the oposite direction lies the major mines with low implementaion maturity levels such as Ngaka Coal Mine and New Luika Gold Mine with 40.5 – 43.8% taking 7-12 months and at least 40.5% taking more than 12 months.

4.7 Reported Cost Savings

Reported cost savings are essential in this study as they offer useful indicator of whether and to what extent does implementing digital safety tools relate with returns on investments and operational efficiency, which encourages stakeholder support and hence accelerated adoption of digital tools (Li et al., 2023). In this study cost savings are considered as useful signs of value generation in intricate socio-technical mining settings. Thus, the top management was asked to identify areas of cost savings associated with digital tools adoption. The results are presented in Table 3.8.

Table 3.8: Reported Areas of Cost Savings

		Areas of Cost Savings			
Major Mine	**N**	**Accident Costs**	**Insurance Premiums**	**Productivity**	**Compliance Penalties**
Bulyanhulu Gold Mine	30	20 (66.7%)	15 (50%)	18 (60.0%)	12 (40%)
Geita Gold Mine	41	28 (68.3%)	25 (61%)	29 (70.7%)	21 (51.2%)
Buckreef Gold Mine	31	12 (38.7%)	8 (25.8%)	14 (45.2%)	10 (32.3%)
Williamson Diamond Mine	27	11 (40.7%)	9 (33.3%)	10 (37.0%)	8 (29.6%)
Ngaka Coal Mine	37	8 (21.6%)	6 (16.2%)	10 (27%)	7 (18.9%)
New Luika Gold Mine	32	7 (21.9%)	5 (15.6%)	8 (25%)	5 (15.6%)
Total	**198**	**86 (43.4%)**	**68 (34.3%)**	**89 (44.9%)**	**63 (31.8%)**

Source: Survey Data, 2025

The results in Table 3.8 show that in overall the top management identify area with high-cost savings as productivity (44.9%), followed by accident costs (43.3%), insurance premiums (34.3%), and compliance penalties (31.8%). How ever the results differ across major mines with different levels of implementation maturity levels. Major mines with high implementation maturity levels such as Bulynhulu Gold Mine and Geita Gold Mine exhibit relatively huge cost savings since majority of top management between 40% to 70.7% identify considerable cost savings in areas of productivity, accident costs, insurance premiums, and compliance penalties. On the other hand, only 15.6% to 21.9% of the top management report similar findings in the major mines from a lower end of implementation maturity levels such as Ngaka Coal Mine and New Luika Gold Mine.

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4.8 Training Effectiveness

The success of digital transformation initiatives is directly impacted by whether or not employees are sufficiently equipped to accept and use digital tools, which is why evaluating the effectiveness of training is crucial to this study. Effective training improves user competence and acceptance of the safety digital tools in turn sustaining proper usage, which is a requisite for intended OSH outcomes (Shaibu et al., 2022; Asuman et al., 2018). In this study training effectiveness was conceived as the measured of employee digital literacy by using the training effectiveness evaluation questions. This approach is supported for its direct link to learning outcomes, being tailored to specific contexts, and how adequately the approach fits with the existing human resource and training systems (Lee et al., 2022). Thus, the staff were asked to respond to whether the training was very less effective, less effective, neutral, highly effective, or very highly effective. The results are presented in Table 3.9.

Table 3.9: Training effectiveness

	Training Effectiveness Level					
Major Mine	**1**	**2**	**3**	**4**	**5**	**Total**
Bulyanhulu Gold Mine	23 (23.5%)	22 (22.4%)	15 (15.3%)	14 (14.3%)	24 (24.5%)	98 (100%)
Geita Gold Mine	29 (29.9%)	12 (12.4%)	25 (25.8%)	13 (13.4%)	18 (18.6%)	97 (100%)
Buckreef Gold Mine	22 (22.2%)	24 (24.2%)	16 (16.2%)	14 (14.1%)	23 (23.2%)	99 (100%)
Williamson Diamond Mine	28 (28.6%)	17 (17.3%)	15 (15.3%)	18 (18.4%)	20 (20.4%)	98 (100%)
Ngaka Coal Mine	25 (26%)	27 (28.1%)	19 (19.8%)	8 (8.3%)	17 (17.7%)	96 (100%)
New Luika Gold Mine	30 (30.6%)	23 (23.5%)	12 (12.2%)	9 (9.2%)	24 (24.5%)	98 (100%)
Total	**157 (26.8%)**	**125 (21.3%)**	**102 (17.4%)**	**76 (13%)**	**126 (21.5%)**	**586 (100%)**

Key: 1= Very Less Effective, 2 =Less Effective, 3 = Neutral, 4 = Highly Effective, 5 = Very Highly Effective

Source: Survey Data, 2025

The results in Table 3.9 show that the in overall very less training effectiveness was reported by 26.8% with small variations across major mines [22.2 – 30.6%], followed by very high training effective that was reported by 21.5% with small variations across major mines [18.6 – 24.5%]. The findings indicate that although there was evidence of variations of training effectiveness across departments and sections of major mines and between the major mines, the marginal effect on OSH outcomes would be small. This was further reported in regression analysis where training exhibited about 1.8% marginal effect on OSH compliance [Marginal Effects = 0.0175, p-value<0.001; 95% CI = 0.0114 - 0.0235].

4.9 Usage Level of Safety Digital Tools

Analyzing the digital tools usage would make it easier to spot discrepancies between the availability of technology and its actual adoption, which might reveal obstacles like low user acceptance, insufficient training, or a lack of alignment with operational requirements (Bai et al., 2022). In this study it was useful to evaluate the connection between tool use and OSH compliance as it is a key mediating factor between digital implementation and the associated outcomes. The staffs were asked to rate the level at which they think they are using different digital tools within the last month prior to this study. The five-point scale of 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always was used. The results are presented in Table 3.10.

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Table 3.10: Level of Digital Tools Usage among Staff

variable	Never	Rarely	Sometimes	Often	Always	Total
Digital incident reporting system	9 (1.5%)	136 (23.2%)	314 (53.6%)	124 (21.2%)	3 (0.5%)	586 (100%)
Safety monitoring devices	3 (0.5%)	77 (13.1%)	336 (57.3%)	162 (27.6%)	8 (1.4%)	586 (100%)
Digital training platforms	4 (0.7%)	78 (13.3%)	267 (45.6%)	219 (37.4%)	18 (3.1%)	586 (100%)
Safety communication apps	6 (1%)	95 (16.2%)	314 (53.6%)	160 (27.3%)	11 (1.9%)	586 (100%)
Automated hazard alerts	13 (2.2%)	135 (23%)	288 (49.1%)	138 (23.5%)	12 (2%)	586 (100%)

Source: Survey Data, 2025

The results in Table 3.10 show that majority use digital tools for some of the times [45.6% - 57.3%], followed by those who use them often [21.2% - 37.4%]. Since those who have always used digital tools are few [0.5% - 2%], the study findings indicate occasional disregard of using digital tools for reasons such as technical problems. However, there are some who use at least some of the digital tools rarely [13.1% - 23.2%] indicating negligence. On the other hand, those who may have never used certain digital tools who happen to be few [0.5% - 2.2%] indicate lack of some types of digital tools for some sections or department within the major mining sector.

5.0 CONCLUSIONS

5.1 Overall state of Digital Transformation in Major Mines

The overall digital transformation included digital incident reporting systems, real-time safety monitoring systems, automated hazard detection systems, digital safety training platforms, and safety compliance tracking software with ddifferent levels of implementation across departments and sections within the mines. The existing transformational achievements allow real-time visibility, automatic danger detection, and immediate response capabilities, which are important in high-risk, fast-changing underground situations (Uppaluri, 2025). Furthermore, compliance monitoring solutions offer robust documentation and responsibility to satisfy regulatory standards, whereas the digital training platforms increase the possibility that employees remain continuously informed and involved, regardless of location (Roselt, 2024).

However, the impact of these transformational changes depends on how effective and to what level the digital tools are implemented. For instance, a study by Buthelezi and Naidoo (2024) found that digital OSH initiatives struggle with implementation, which lead to their failure or poor performance in South Africa mining sector. The findings align with the Socio-Technical Systems (STS) theory as it stresses on systemic alugment between the technological transformations and the organizational coherence and coordination (Cardenas & Kozine, 2025). Inline with STS theory, the organizational coeherence and coordination is a function of usefulness and ease of use in accordance with the Technological Acceptance Model (Hendricks et al., 2023). The theoretical underpinings suggest that the details of implemtaion, systems usage and excusions should not be overlooked. Thus, in the next subsections the study focuses on the level of implemenation of dgital tools across the major mines.

5.2 Financial Readiness for Digital Transformation

The ability of an organization to set aside and oversee the funds required to implement and maintain ongoing digital transformations related to OSH (Chen et al., 2021; Deloitte, 2020). In this study the financial readiness was conceived as proportion of OSH expenses for system integration, training, new technology, and continuing maintenance expenses related to using digital tools (Ghosh & Scott, 2022). The study found high financial readiness among the mines with high implementation maturity levels compared to their

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lower maturity counterparts. The findings imply that financial readiness was a key determinant for safety digital transformation as it affects the level of implementation in terms of acquiring new technologies, and regular maintenance of existing ones. In line with these findings, the previous studies found that financially stable mining entities are more likely to successfully integrate digital solutions, improving safety results and regulatory compliance (Ghosh & Scott, 2022; Chen et al., 2021). Furthermore, in an increasingly digitalized mining environment, the mines that emphasize long-term planning for technology updates exhibit superior levels of safety performance and resilience (Deloitte, 2020; ILO, 2019). Nonetheless, the study findings are supported by the socio-technical systems theory as financial resources are essential for amalgamating organizational, human, and technological subsystems to influence the overall effectiveness of implementation of digital tools as evidence shows across the six major mines (Subačienė & Tamulevičienė, 2024).

5.3 System Update Frequency

Timely updates of systems is a key element of implementation status of the safety digital tools. Timely updates of safety digital systems guarantee that they stay up to date and adaptable to changing circumstances; however, infrequent updates can create weaknesses and negatively affect their anticipated usefulness (Zheng et al., 2020; Tiefenau et al., 2020). The study found that the scheduling for systems updates was not necessarily matching the prescribed or technically recommended time frame or real time update requirements. This problem was much serious with the mines featuring lower implementation maturity. The findings imply that the complete integration of safety technologies is impeded by operational vulnerabilities and performance degradation caused by extended delays in patching and upgrading systems, aligning with previous study (Dissanayake et al., 2022). Furthermore, when updates are not in line with changing system requirements and user needs, the respective implementations exhibit failures resulting to lack of trust in digital solutions and underutilizes safety innovations as it was also found by (DeBrusk, 2024).

Also, the findings imply that delays in system updates upset this equilibrium by lowering user trust and impeding productive human–technology interaction. This is consistent with Socio-Technical Systems (STS) theory, which highlights the interdependence of social and technical elements in organizational transformation (Ngowi, 2018). Update delays can also have a negative impact on "perceived usefulness and ease of use," which are important factors in determining user adoption, according to the Technology Acceptance Model (TAM) (Venkatesh & Davis, 2000).

5.4 Time to Implement New Digital Safety Solutions

To reduce risk exposure and expedite safety advantages, digital safety solutions must be implemented in a shorter average time (Dissanayake et al., 2022). In dynamic work situations, delays can diminish system efficacy and impede adoption. In this study this was intended to measure agility and readiness for ongoing digital tranformation for OSH in major mines. The findings indicate that overall pace of digital safety tools implementations is at least not highly accelerating across some of the departments and sections of the major mines. The fiding concures with Degan (2023) reporting that the digital transformation in mining is still in its infancy. Other studies show that only around 10% of mining corporations have finished even one digital implementation, and many are still in the pre-implementation or exploration stages (Abdellah et al., 2022; Degan 2023). This implies that implementation in mining usually lasts much longer than six months and usually comes close to or beyond a year.

However, the findings show that the averate time taken to implement new digial solutions varies across major mines with regard to implemtation maturity levels. As proposed by Socio-Technical Systems Theory (STS) and the Technology Acceptance Model (TAM), the variance in implementation time for new solutions in mines reflects varying degrees of socio-technical alignment and user acceptance. According to Baptista and Oliveira (2022) and Trist and Bamforth (2020), mines with faster implementation timelines usually have stronger integration of social (human, organizational) and

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technological subsystems (STS), as well as higher perceived usefulness and simplicity of use that drive adoption (TAM). Longer periods, on the other hand, can suggest misalignments or resistance to technology as a result of organizational or social hurdles that affect the success of OSH digitalization.

5.5 Reported Cost Savings

Reported cost savings are essential in this study as they offer useful indicator of whether and to what extent does implementing digital safety tools relate with returns on investments and operational efficiency, which encourages stakeholder support and hence accelerated adoption of digital tools (Li et al., 2023). In this study cost savings are considered as useful signs of value generation in intricate socio-technical mining settings.

The findings show that in overall the mines were featuring several areas with high-cost savings mainly in productivity, followed by accident costs, insurance premiums, and compliance penalties. Major mines with high implementation maturity levels exhibit relatively huge cost savings compared to those with relatively lower implementation maturity. The findings are in agreement with Li et al. (2023), who contends that mines that report larger savings frequently exhibit more sophisticated use of digital tools in areas including processing optimization, autonomous haulage, and predictive maintenance. Those that report lower savings, on the other hand, can be in the early stages of implementation and lack the size or integration required to achieve cross-functional benefits (Mining Review Africa, 2022).

Based on the Socio-Technical Systems (STS), mines that see significant cost reductions probably accomplish better alignment between technical systems and social subsystems allowing for the efficient deployment of safety digital solutions (Trist & Bamforth, 2020). On the other hand, these results are associated with higher digital usage resulting from a wider range of digital tools implementation which aligns with TAM (Venkatesh & Davis, 2000). To the contrary, fewer areas for cost savings could be a sign of organizational resistance, a lack of skills, or a poorly usable system that downplays the OSH digitalization in terms of adoption and integration.

5.6 Training Effectiveness

The success of digital transformation initiatives is directly impacted by whether or not employees are sufficiently equipped to accept and use digital tools, which is why evaluating the effectiveness of training is crucial to this study. Effective training improves user competence and acceptance of the safety digital tools in turn sustaining proper usage, which is a requisite for intended OSH outcomes (Shaibu et al., 2022; Asuman et al., 2018). In this study training effectiveness was conceived as the measured of employee digital literacy by using the training effectiveness evaluation questions. This approach is supported for its direct link to learning outcomes, being tailored to specific contexts, and how adequately the approach fits with the existing human resource and training systems (Lee et al., 2022). The study found that although there was evidence of variations of training effectiveness across departments and sections of major mines and between the major mines, the marginal effect on OSH outcomes was very small [Marginal Effects = 0.0175, p-value<0.001; 95% CI = 0.0114 - 0.0235]. Based on the reported infinitesimally varying levels of training effectiveness across the departments and section of major mines imply some gaps in knowledge or skill preparedness. This would result in emergence of improper digital system usage, less cross-site standardization, and may need to be considered as wakeup call to improve underperforming sections and departments (Zvarivadza, 2023). In theoretical perspective this suggests that the technical subsystem (digital tools) and the social subsystem (training, human capabilities) are partially aligned from the standpoint of Socio-Technical Systems (STS). Similar to this, variations in training levels may impact perceived usefulness and simplicity of use, which in turn may impact behavioral intention and system utilization under the Technology Acceptance Model (TAM) (Holden & Karsh, 2010). If not properly addressed, even minor training gaps might lead to a decline in digital maturity.

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5.7 Usage Level of Safety Digital Tools

Analyzing the digital tools usage would make it easier to spot discrepancies between the availability of technology and its actual adoption, which might reveal obstacles like low user acceptance, insufficient training, or a lack of alignment with operational requirements (Bai et al., 2022). In this study it was useful to evaluate the connection between tool use and OSH compliance as it is a key mediating factor between digital implementation and the associated outcomes. The study findings show that majority use digital tools for some of the times, followed by those who use them often with occasional disregard of using digital tools for reasons such as technical problems, negligence, or lack of some types of digital tools for some sections or department within the major mining sector.

The finding implies that digital adoption is uneven across sections and departments, the phenomenon that could be explained through variations in operational fit, training, or awareness. Also, the finding implies that although the majority of users incorporate tools into their daily routines, this variability suggests that areas of underuse may suffer from less extensive efficiency gains and indicate early-stage diffusion within the organization (Crabbe et al., 2025).

More importantly, this pattern shows incomplete alignment of the socio versus technical subsystems in contradiction with the Socio-Technical Systems (STS) theory. In the lens of the STS, most departments and sections in major mines have the technical subsystems in place, but social or organizational subsystems (including norms, the support, and processes) may be absent or misaligned for employees who use tools infrequently (Haas et al., 2019). However, based on the Technology Acceptance Model (TAM), while rare use by some users may result from low perceptions of these dimensions, majority adequate use indicates strong perceived usefulness and ease of use among the majority of users, thereby limiting behavioral intention to use and actual usage (Venkatesh et al., 2003).

5.8 Conclusion

The digital transformation in the Tanzania's major mining sector includes but is not limited to digital incident reporting systems, real-time safety monitoring systems, automated hazard detection systems, digital safety training platforms, and safety compliance tracking software. The study found the degree to which digital tools are implemented vary between major mines and across sections and departments within respective major mines. Some mines exhibit low implementation maturity which is classified as partially implemented [Composite Median Score: 2.6 – 3.2]. The implementation of digital tools in these mines was characterized by existence of digital reporting but with limited coverage, installed sensors but with limited scope or not always active, installations of automated hazard detection at least in some of the areas, availability of partial digital training modules, usage of software but with limited functionality or areas of compliance.

Some mines exhibit moderate implementation maturity which is classified as fully implemented [Composite Median Score: 3.21 – 3.8]. The implementation of digital tools in these mines was characterized by existence of digital system being widely used among the employees, full real-time monitoring of key safety indictors, availability of automated hazard detection that are operational, existence of a comprehensive and functional digital training platform, and availability of a comprehensive software with the capability to track all OSH compliance activities.

Some mines exhibit high implementation maturity which is classified as fully implemented and optimized [Composite Median Score: 3.81 – 4.4]. The implementation of digital tools in these mines was characterized by existence of a well-integrated real-time alerts system, data analytics, and mechanism for continuous improvements; existence of advanced sensor networks mainly for predictive data analytics and automated responses; with a fully integrated AI-based detection of hazards aligned together with automatic alerts and mitigation; existence of adaptive, customizable digital training platform that can offer real-time assessments and feedbacks; and availability of

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a fully integrated compliance system embedded with user dashboards, options for reporting, and the audit trails.

REFERENCES (APA)

- Boniface, R., Museru, L., Munthali, V., & Lett, R. (2013). Occupational injuries and fatalities in a tanzanite mine: Need to improve workers safety in Tanzania. In R. Boniface, L. Museru, V. Munthali, & R. Lett, Pan African Medical Journal (Vol. 16). African Field Epidemiology Network. https://doi.org/10.11604/pamj.2013.16.120.3420

- Eiter, B. M., Kosmoski, C., & Connor, B. P. (2016). Defining hazard from the mine worker�s perspective. In B. M. Eiter, C. Kosmoski, & B. P. Connor, Mining Engineering (Vol. 68, Issue 11, p. 50). Society for Mining, Metallurgy & Exploration. https://doi.org/10.19150/me.6832

- Geldart, S. (2014). Health and Safety in Today's Manufacturing Industry. In S. Geldart, Elsevier eBooks (p. 177). Elsevier B.V. https://doi.org/10.1016/b978-0-08-096532-1.00816-5

- Kinyondo, A., & Huggins, C. (2021). State-led efforts to reduce environmental impacts of artisanal and small-scale mining in Tanzania: Implications for fulfilment of the sustainable development goals. In A. Kinyondo & C. Huggins, Environmental Science & Policy (Vol. 120, p. 157). Elsevier B.V. https://doi.org/10.1016/j.envsci.2021.02.017

- Lyatuu, I., Winkler, M. S., Loss, G., Farnham, A., Dietler, D., & Fink, G. (2021). Estimating the mortality burden of large scale mining projects—Evidence from a prospective mortality surveillance study in Tanzania. In I. Lyatuu, M. S. Winkler, G. Loss, A. Farnham, D. Dietler, & G. Fink, PLOS Global Public Health (Vol. 1, Issue 10). Public Library of Science. https://doi.org/10.1371/journal.pgph.0000008

- Maliganya, W., & Bengesi, K. M. K. (2018). Policy Enabling Environment of Mining Sector in Tanzania: A Review of Opportunities and Challenges [Review of Policy Enabling Environment of Mining Sector in Tanzania: A Review of Opportunities and Challenges]. Journal of Sustainable Development, 11(4), 1. Canadian Center of Science and Education. https://doi.org/10.5539/jsd.v11n4p1

- Mrisha, S. H. (2021). Dynamic Business Environment in the Tanzanian Mining Sector. In S. H. Mrisha, International Journal of Business and Economics Research (Vol. 10, Issue 1, p. 1). Science Publishing Group. https://doi.org/10.11648/j.ijber.20211001.11

- Pagell, M., Johnston, D., Veltri, A., Klassen, R. D., & Biehl, M. (2013). Is Safe Production an Oxymoron? In M. Pagell, D. Johnston, A. Veltri, R. D. Klassen, & M. Biehl, Production and Operations Management (Vol. 23, Issue 7, p. 1161). Wiley. https://doi.org/10.1111/poms.12100

- Pelders, J., & Nelson, G. (2018). Contributors to Fatigue of Mine Workers in the South African Gold and Platinum Sector. In J. Pelders & G. Nelson, Safety and Health at Work (Vol. 10, Issue 2, p. 188). Elsevier B.V. https://doi.org/10.1016/j.shaw.2018.12.002

- Smith, N., Ali, S. H., Bofinger, C., & Collins, N. (2016). Human health and safety in artisanal and small-scale mining: an integrated approach to risk mitigation.

SJSI 2025, Volume 5, Issue 8, Page 48-56
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web: https://damaacademia.com/index.php/sjsi/

In N. Smith, S. H. Ali, C. Bofinger, & N. Collins, Journal of Cleaner Production (Vol. 129, p. 43). Elsevier B.V. https://doi.org/10.1016/j.jclepro.2016.04.124

- Stemn, E. (2018). Analysis of Injuries in the Ghanaian Mining Industry and Priority Areas for Research. In E. Stemn, Safety and Health at Work (Vol. 10, Issue 2, p. 151). Elsevier B.V. https://doi.org/10.1016/j.shaw.2018.09.001
- Ackah, D., & Boadu, K. O. (2025), "Integration of ESG (Environmental, Social, and Governance) Factors in Petroleum Project Planning and Execution", The Nexus Journal, 2025, 5(2): pp.01-09. DOI: https://dx.doi.org/10.64839/tnj.v5i2.1
- Ackah, D., & Boadu, K. O. (2025). "Optimising Procurement Strategies for Cost Efficiency and Risk Mitigation in Petroleum Engineering Projects: The Study of Offshore Drilling Operations" African Journal of Procurement, Logistics & Supply Chain Management, 2025, 5(8): pp.17-41. DOI: https://dx.doi.org/10.4314/ajplscm.v8i5.2
- Ackah, D. (2025). "An Analysis of the Project Management Maturity Level in the Construction Industry of Developing Countries" Journal of Interdisciplinary & Innovation, 2025, 5(8): pp.01-45. DOI: https://dx.doi.org/10.64839/jii.v5i8.1
- Ackah, D., & Boadu, K. O. (2025), "Assessment of Digital Twin Technology in Managing Lifecycle Performance of Petroleum Infrastructure Projects", The Nexus Journal, 2025, 5(2): pp.10-21. DOI: https://dx.doi.org/10.64839/tnj.v5i2.2
- Ackah, D., & Boadu, K. O. (2025). "The Impact of Strategic Procurement on Cost Overruns and Delays in Petroleum Exploration and Production Projects" African Journal of Procurement, Logistics & Supply Chain Management, 2025, 5(8): pp.56-73.DOI: https://dx.doi.org/10.4314/ajplscm.v8i5.3
- Ackah, D., & Boadu, K. O. (2025), "Integrating Agile Methodologies in Large-Scale Engineering Projects: Challenges and Opportunities", The Nexus Journal, 2025, 5(2): pp.22-33. DOI: https://dx.doi.org/10.64839/tnj.v5i2.3
- Ackah, D. (2025). "The Possible Economic Factors Leading to the Abandoned Project in the Ghanaian Economy (Influence)" Journal of Interdisciplinary & Innovation, 2020, 5(8): pp.46-55. DOI: https://dx.doi.org/10.64839/jii.v5i8.2
- Ackah, D., Dadzie, B. E. (2025), "Sustainable Public Procurement as Organisational Change", Project Management Scientific Journal, 2025, 8(3): pp.43-52. DOI: https://dx.doi.org/10.4314/pmsj.v8i3.1
- Veiga, M. M., Scoble, M. J., & McAllister, M. L. (2001). Mining with communities. In M. M. Veiga, M. J. Scoble, & M. L. McAllister, Natural Resources Forum (Vol. 25, Issue 3, p. 191). Wiley. https://doi.org/10.1111/j.1477-8947.2001.tb00761.x
- Verbrugge, B., & Geenen, S. (2020). Global Gold Production Touching Ground. In B. Verbrugge & S. Geenen, Springer eBooks. Springer Nature. https://doi.org/10.1007/978-3-030-38486-9
- Improving OSH for Young Workers: A Self-Training Package - Enetosh. https://www.enetosh.net/good-practice/database/database-detail/improving-osh-for-young-workers-a-self-training-package_1003.html