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Dashboard Design for Monitoring Health, Safety, and Security as Part of Social Sustainability in the Mining Industry Holding Group

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Abstract. Social sustainability is a critical aspect of sustainable development, particularly in the mining industry, which poses high risks to occupational health and safety. However, its implementation in holding group structures is often held up by data fragmentation and the absence of integrated reporting across subsidiaries, which limits data-driven decision-making on Health, Safety, and Security (HSS) performance. To address this gap, this study conducts three main activities: identifying relevant HSS indicators, designing an HSS monitoring dashboard using a User-Centered Design (UCD) approach, and evaluating its usability using the Dashboard Assessment Usability Model (DATUS The dashboard was developed iteratively by applying the principles of the Visual Information Seeking Mantra (VISM), Gestalt, and Data Storytelling. It includes 32 HSS indicators organized into four modules: KPI, Health, Safety, and Security. The usability evaluation, covering effectiveness, efficiency, and satisfaction as defined by DATUS, showed strong results. Users achieved a 98.9% task completion rate with only a 1.1% error rate, and task completion time improved by 18.04% in the second session, indicating high learnability. User satisfaction scored 88.3 out of 100. These results demonstrate that the dashboard meets high usability standards across all three dimensions, supporting more effective monitoring and strategic decision-making for social sustainability in the mining sector.

Keywords: dashboard, social sustainability, HSS, mining industry, DATUS

1 Introduction

Sustainability has become a central focus in global agendas, built on three interconnected pillars: environmental, economic, and social [1]. Social sustainability is key to ensuring worker well-being. Eizenberg and Jabareen [2] define it as encompassing not only physical safety, but also equitable resource distribution, active participation, and inclusive work environments. However, many companies prioritize environmental compliance and economic performance, overlooking issues such as mental health, accident data transparency, and community involvement. Studies have found that 65% of extractive companies allocate less than 10% of their sustainability budgets to social programs, despite work accidents potentially reducing productivity by up to 30% [3].

The mining industry faces particularly acute challenges in implementing social sustainability principles. Operations involve hazardous materials, heavy equipment, and remote worksites, where risks such as toxic chemical exposure, mine collapses, and waste leaks threaten both worker lives and organizational reputation [3]. Incomplete or fragmented accident data makes it difficult to identify patterns and root causes of incidents [4]. The lack of real-time monitoring and low situational awareness in hazardous underground environments increases the risk of human error, which data-driven solutions can help mitigate [5]. Poor data integration and visualization further hinder decision-makers from quickly understanding safety trends and high-risk areas [6].

These challenges are compounded within holding group structures that manage multiple subsidiaries. In Indonesia, the Regulation of the Minister of Energy and Mineral Resources on Power No. 38 of 2021 requires companies to implement an integrated Health, Safety, and Security (HSS) reporting system, and the International Council on Mining and Metals (ICMM) likewise mandates integrated risk management and data transparency across member organizations. However, in practice, HSS data across subsidiaries remains siloed, and reporting relies on manual monthly processes rather than real-time consolidated monitoring. This structural gap means that decision-makers at the holding level lack timely, integrated visibility into HSS performance across the group, making centralized, visual monitoring both necessary and urgent.

Dashboards offer an effective solution to this problem, integrating data from various sources into a visual format that is easy for stakeholders to interpret [7]. Dashboards also support real-time monitoring, streamline reporting, and enhance decision-making through timely, data-driven insights [8]. In the HSS context specifically, dashboard implementation has been shown to improve transparency and accountability in occupational safety monitoring [9]. This study, therefore, aims to identify key HSS indicators for visualization, design an informative HSS dashboard for a mining industry holding group, and evaluate its usability in supporting analysis and decision-making related to social sustainability. The research involves identifying user needs, selecting relevant KPIs, developing the dashboard in Tableau, and evaluating usability using the Dashboard Assessment Usability Model (DATUS).

2 Literature Review

2.1 Sustainability

The concept of sustainable development was first introduced in the Brundtland Report as “development that meets the needs of the present without compromising the ability of future generations”. It is based on three pillars: environmental, social, and economic [1]. Social sustainability focuses on human well-being and includes equity, safety, ecological awareness, and sustainable urban forms [2].

2.2 Health, Safety, and Security (HSS)

HSS consists of three interrelated elements essential for maintaining a safe and productive workplace. Health refers to physical, mental, and emotional well-being; Safety focuses on preventing workplace accidents; and Security involves protecting people and assets from internal and external threats. Together, these elements form an integrated framework that organizations in high-risk industries, such as mining, must manage holistically to ensure worker welfare and regulatory compliance [10].

2.3 Dashboard

A dashboard is a unified visual interface that presents key information on a single screen to support performance monitoring, trend detection, and decision-making. It simplifies complex data into intuitive visuals, thereby reducing the cognitive load on users [11]. Dashboards are typically categorized as strategic, analytical, or operational, with each type serving a different level of organizational decision-making [12].

2.4 User Centered Design

UCD is a design approach based on ISO 9241-210:2010 that focuses on improving user interaction with computer systems through usable hardware and software design [13]. It is intended for professionals developing interactive systems, with its process illustrated in Figure 1. The UCD process is iterative, requiring designers to continuously evaluate and refine solutions based on user feedback until usability goals are met.

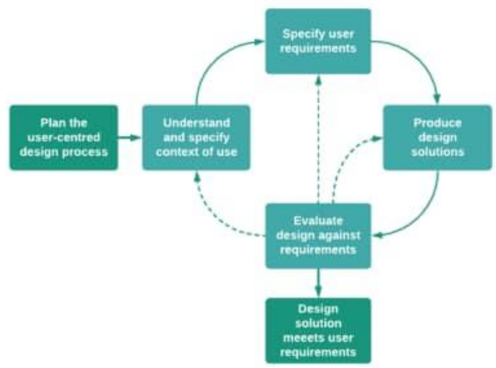

Figure. 1. UCD Process (Nakić et al., 2019)

2.5 Dashboard Design Principles

Dashboard design follows several key principles:

- Visual Information Seeking Mantra (VISM)

  Developed by Shneiderman in 1996, VISM emphasizes "overview first, zoom and filter, then details-on-demand" as a guiding sequence for interactive information visualization. VISM 2.0, shown in Figure 2, enhances this by adding UCD, collaboration, dynamic transitions, and flexible interfaces for various user levels. This updated framework ensures dashboards support both high-level overviews and detailed exploration across different user roles [14].

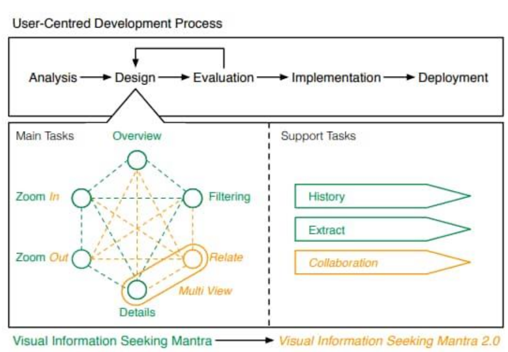

Figure. 2. VISM 2.0 (Stauffer et al.,2016)

- Data Storytelling

Knaflic [15] highlights the importance of presenting data through narrative to make information more meaningful and actionable for audiences. Key steps in this process include understanding context, choosing effective visuals, focusing attention, designing purposefully, and telling a coherent story. By following these steps, dashboard designers can guide users toward insights rather than leaving them to interpret raw data on their own.

- Gestalt Principles

  Gestalt principles are psychological principles that explain how users naturally perceive and group visual elements. These principles include proximity, similarity, enclosure, closure, continuity, and connection, each of which influences how information is interpreted on screen [16]. Applying Gestalt principles in dashboard design helps create layouts that feel intuitive, reducing the effort required for users to extract meaning from visual displays.

2.6 Usability

According to ISO 9241-11, usability is the extent to which a product can be used by specific users to achieve defined goals effectively, efficiently, and with satisfaction in a given context. Key aspects include effectiveness, efficiency, and satisfaction, which together determine the overall quality of a user's interaction with a system. This study uses the Dashboard Assessment Usability Model, which extends this definition by evaluating eight dimensions: effectiveness, efficiency, satisfaction, learnability, accessibility, appropriate recognizability, UI aesthetics, and operability [17].

3 Method

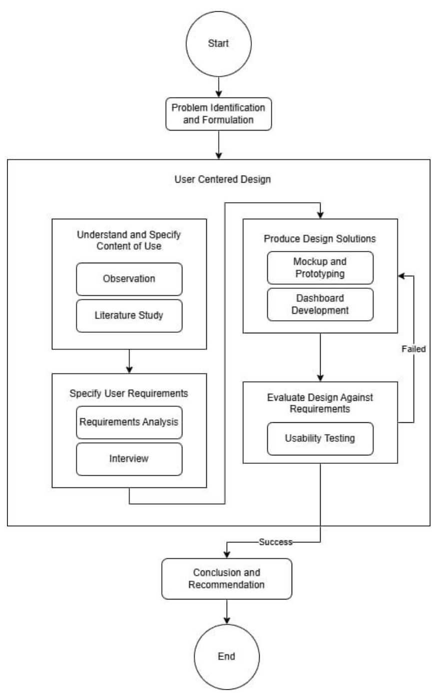

Figure. 3. Conceptual Framework

This study consists of five main stages, as shown in Figure 3. The first stage involves identifying and formulating the problem through observation, literature review, and relevant prior studies. The second stage, understand and specify context of use, is carried out via interviews to identify business processes and key performance indicators. The third stage, specifying user requirements, includes developing user personas and defining user needs. The fourth stage, produce design solutions, involves creating mockups, building a prototype, and developing the dashboard using Tableau. The fifth stage, evaluate design against requirements, is conducted through usability testing using DATUS to assess effectiveness, efficiency, and user satisfaction. The research concludes with findings, deliverables, testing results, and recommendations for future development.

3 Designing

3.1 Understand and Specify Content of Use

The Mining Industry Holding Group, based in Jakarta, serves as the case study for this research. As a company in the extractive sector managing multiple subsidiaries, it holds a major responsibility in implementing sustainability principles, particularly in social aspects such as occupational health and safety. However, the distributed nature of its operations means that HSS data is often fragmented across subsidiaries, making consolidated monitoring difficult. To strengthen its safety culture and support timely decision-making, consolidating HSS data through an integrated dashboard is therefore necessary. This section describes the key steps undertaken in the design and development process.

1. Specify Business Process

   Understanding the business process flow is crucial for effective social sustainability monitoring, as illustrated in Figure 4.

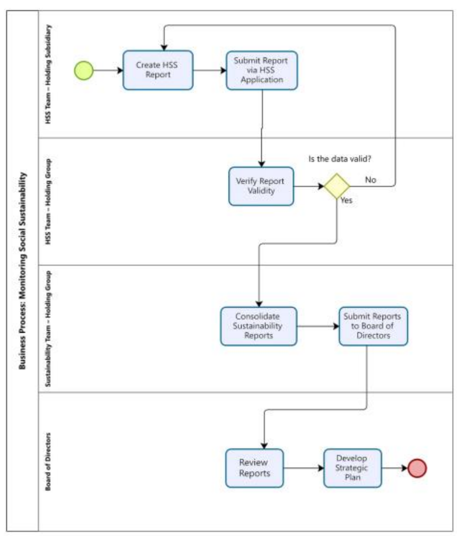

Figure. 4. Business Process

2. Specify Key Performance Indicators (KPI)

   The HSS team has developed KPIs to ensure structured and measurable performance monitoring across all subsidiaries. These KPIs are grouped into leading and lagging indicators, covering the four main modules of the dashboard: KPI, Health, Safety, and Security. A summary is presented in Table I, while the complete list is provided in Appendix A.

Table 1. HSS KPI Weights Summary

Indicator	Sub-function	Amount	Weight
Leading Indicators	*Operational Safety*	11	22
	Occupational Health & Industrial Hygiene	7	15
	Strategic Security	5	13
Subtotal		23	50
Lagging Indicators	*Operational Safety*	4	35
	Occupational Health & Industrial Hygiene	4	10
	Strategic Security	1	5
Subtotal		9	50
Total		32	100

3.2 Specify User Requirements

1. User Persona

   Based on interviews with three users, a fictional user persona in Figure 5 was created to represent user needs.

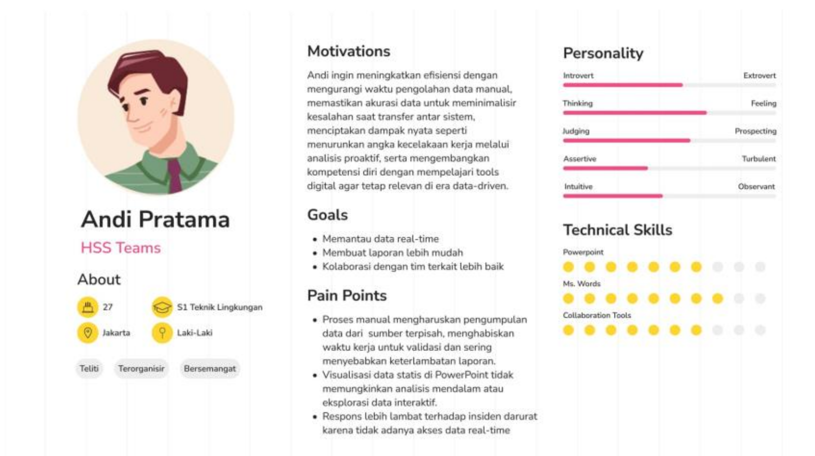

Figure. 5. User Persona

2. User Requirements

   Based on interviews and user persona analysis, two key user roles were identified with distinct requirements. Users need to access and explore real-time data, compare trends, export reports in various formats, share dashboards via links, and review data history to support collaboration and decision-making. Administrators, on the other hand, require control over access permissions, the ability to edit content, automate data updates, monitor dashboard performance, and ensure data accuracy across the system.

3.3 Produce Design Solutions

Based on the identified user requirements and defined KPIs, the design solution was developed through an iterative process following UCD principles. The following are key steps in this section:

1. Dashboard GUI Design
   The GUI design process defines the appropriate visualization for each KPI. Table II shows examples of visual types used, while the complete list is provided in Appendix A

Table 2. GUI Visualization Design

Indicator	Data	GUI	Information
Security Risk Assessment	Table detail top risk security profile	Table	Using a table because detailed data related to the top risk security profile is needed.
	Risk level comparison	Pie Chart	Comparing total assets based on risk levels, which falls under the “part-to-whole” category, is used to illustrate how a single entity can be divided into several elements.
	Risk security matrix	Matrix	Using a matrix because it already has standardized formulas and assessment criteria presented in matrix form.

2. Sitemap
   Figure 6 illustrates the dashboard structure and layout.

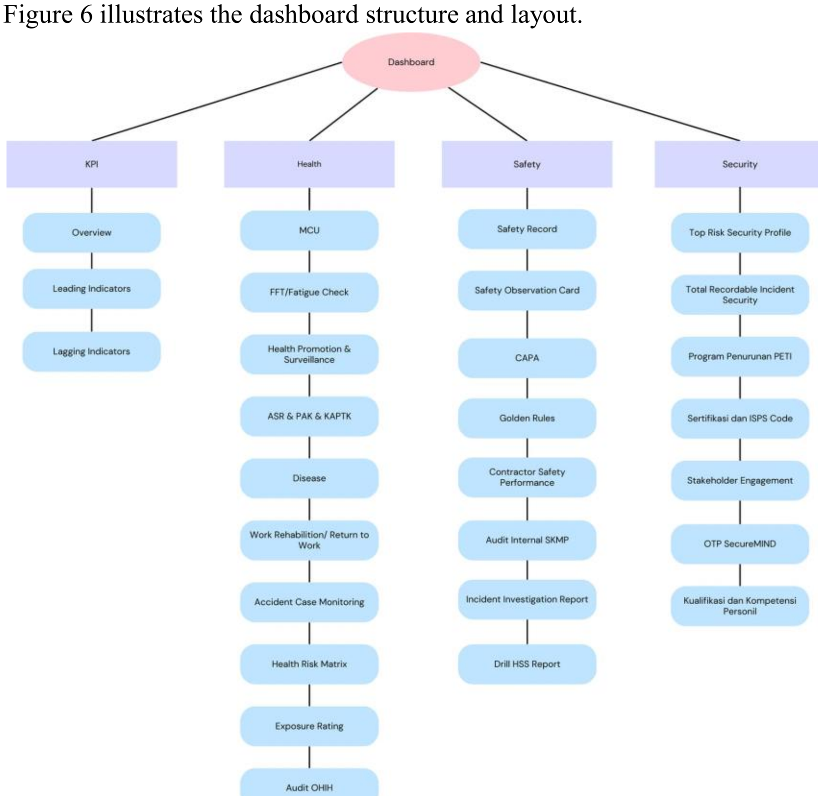

Figure. 6. Sitemap

3. UI Style Guideline
   Figure 7 presents the UI design standards to ensure consistency.

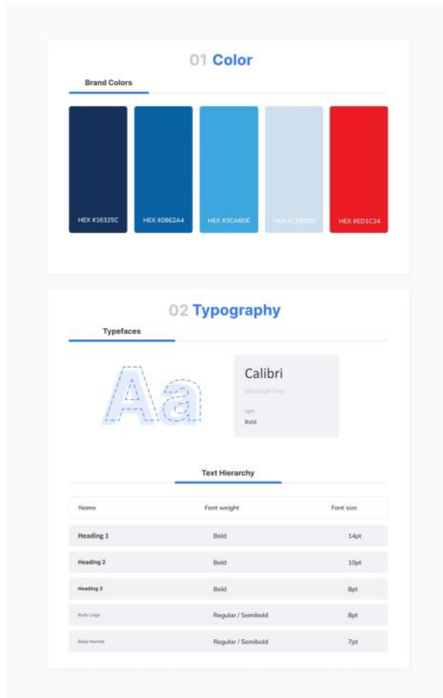

Figure. 7. UI Guideline

4. Mockup and Prototyping

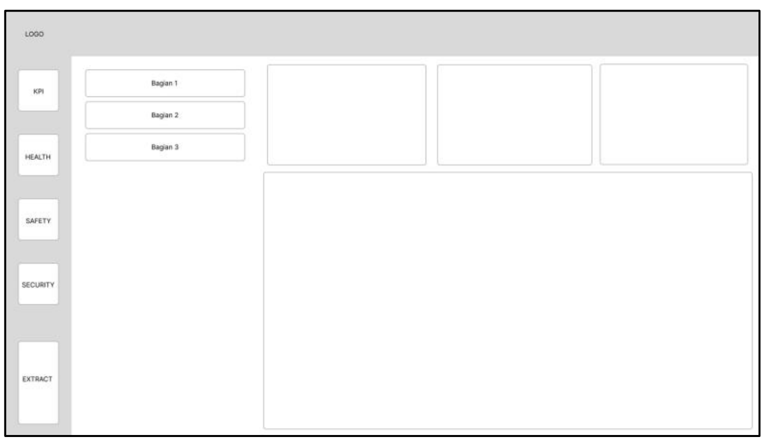

Figure. 8 Low-Fidelity Mockup

The dashboard was developed across two iterative design cycles, built upon the GUI that was structured according to the defined KPIs and sitemap. It is organized into four main modules: KPI, Health, Safety, and Security. In the first iteration, shown in Figure 8, a low-fidelity mockup was created to establish the basic layout, with each module containing its own dedicated overview section. However, user feedback indicated that this arrangement was less efficient due to the additional navigation required to access overview information. In the second iteration, shown in Figure 9, several improvements were made: all overview sections were consolidated into the KPI module, data presentation was aligned with quarterly reporting periods, and the "Last Update" label was repositioned for better visibility. These refinements aimed to streamline navigation and improve overall user understanding of the dashboard. The complete prototype is provided in Appendix A.

Figure. 9. First Iteration of Prototype Overview in Security Module

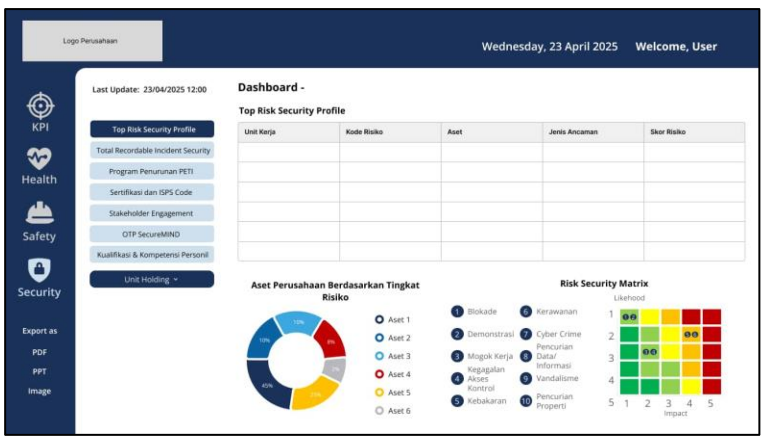

Figure. 10 Second Iteration of Prototype in Security Module without Overview

4 Results and Discussion

4.1 Dashboard Development

The dashboard was developed based on the final iteration of the prototype, with visualizations designed according to the principles of VISM, Gestalt, and Data Storytelling. It is organized into four main modules as described in the following subsections. The detailed application of design principles for each dashboard page is provided in Appendix A.

1. KPI Module

   The KPI module presents the overall performance of holding members, divided into several sections: Overview in Figure 11, Leading Indicators in Figure 12, and Lagging Indicators in Figure 13

Figure.11 Overview Dashboard

Figure.12 Leading Indicators Dashboard

Figure.13 Lagging Indicators Dashboard

2. Health Module

The Health module displays comprehensive employee health data, divided into several sections: Medical Check up in Figure 14, Fitness for Task/Fatigue Check in Figure 15, Health Promotion & Surveillance in Figure 16, ASR & PAK-KAPTK in Figure 17, Diseases in Figure 18, Work Rehabilitation & Accident Case Monitoring in Figure 19, Health Risk & Exposure Rating in Figure 20, and OHIH Audit in Figure 21.

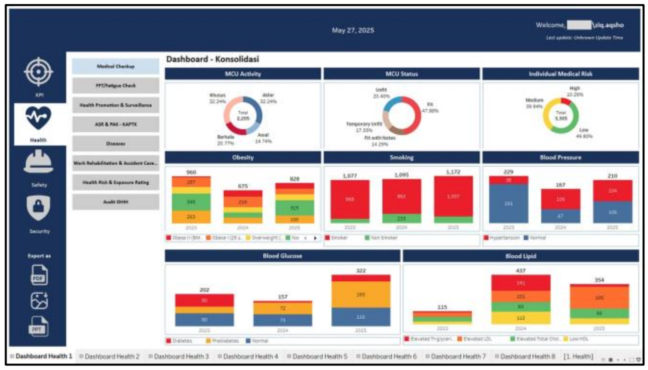

Figure.14 Medical Checkup Dashboard

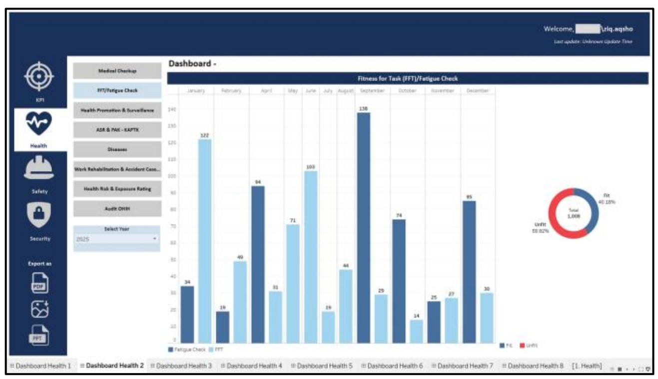

Figure.15 Fitness for Task/Fatigue Check Dashboard

Figure.16 Health Promotion & Surveillance Dashboard

Figure.17 ASR & *PAK-KAPTK* Dashboard

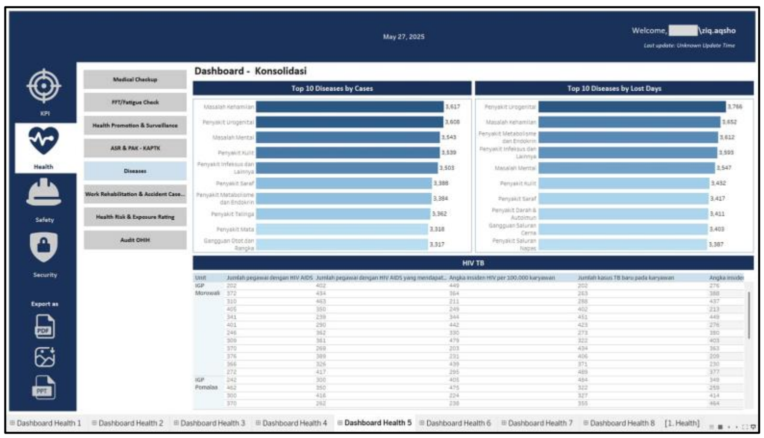

Figure.18 Diseases Dashboard

Figure.19 Work Rehabilitation & Accident Case Monitoring Dashboard

Figure.20 Health Risk & Exposure Rating Dashboard

Figure.21 OHIH Audit Dashboard

3. Safety Module

   The Safety module monitors compliance aspects of occupational safety, divided into: Safety Record in Figure 22, Safety Observation Card in Figure 23, Golden Rules in Figure 24, Contractor Safety Performance in Figure 25, SKMP Internal Audit in Figure 26, and Incident Classification & Drill in Figure 27.

Figure.22 Safety Record Dashboard

Figure.23 Safety Observation Card Dashboard

Figure. 24 Golden Rules Dashboard

Figure.25 Contractor Safety Performance Dashboard

Figure.26 *Internal SKMP Audit* Dashboard

Figure. 27 Incident Classification & Drill Dashboard

4. Security Module

Figure. 28 Top Risk Security Profile Dashboard

The Security module provides information on security governance, divided into: Top Risk Security Profile in Figure 28, Total Recordable Incident Security in Figure 29, PETI Reduction Program in Figure 30, Certification and ISPS Code in Figure 31, Stakeholder Engagement in Figure 32, OTP SecureMIND in Figure 33, and Personnel Qualification & Competency in Figure 34.

Figure.29 Total Recordable Incident Security Dashboard

Figure.30 Illegal Mining (PETI) Reduction Program Dashboard

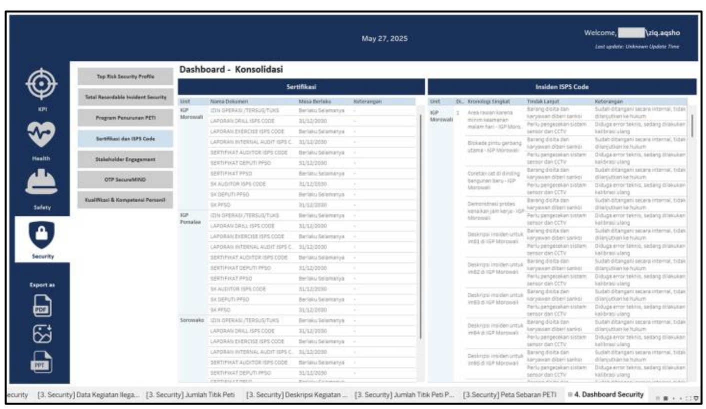

Figure.31 ISPS Code and Certification Dashboard

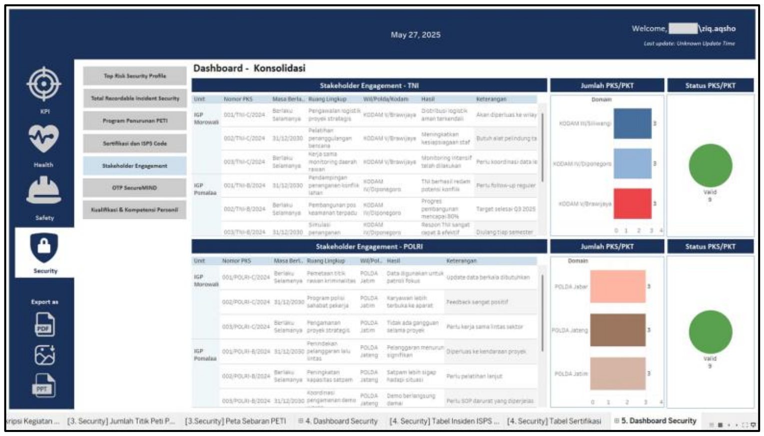

Figure.32 Stakeholder Engagement Dashboard

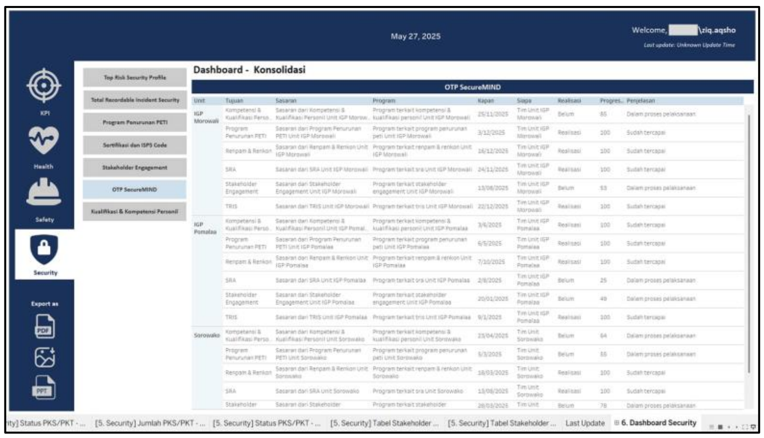

Figure.33 OTP SecureMIND Dashboard

Figure.34 Personnel Qualification & Competency Dashboard

4.2 Evaluate Design Against Requirements

Testing was conducted using the DATUS model with five participants from the HSS team of the Mining Industry Holding Group, consisting of HSS managers and operational staff who represent the primary users of the dashboard. The evaluation comprised three main stages: task completion by participants, performance measurement using DATUS metrics, and questionnaire completion. Results showed the dashboard achieved a high level of effectiveness, with a task success rate of 98.9% and an error rate of only 1.1%. The average task completion time decreased by 18.04% in the second session, indicating improved efficiency and learnability. User satisfaction scored an average of 88.3 out of 100, reflecting a positive reception from participants. These findings confirm that the dashboard effectively supports monitoring and strategic decision-making for social sustainability in the mining industry holding group. The in-depth review of the usability testing questionnaire is provided in Appendix A.

5. Conclusion

Based on the results, the study concludes:

- The dashboard visualizes 32 HSS indicators, consisting of 23 leading and 9 lagging indicators.
- It is designed into four main modules (KPI, Health, Safety, and Security)using visualization principles from VISM, Gestalt, and data storytelling to enhance comprehension and decision-making.
- Usability testing shows high task success (100% in session two), low error rate (1.1%), and an average satisfaction score of 88.3, proving the dashboard is effective, efficient, and user-friendly.

For future development, integrating a data-driven decision support system could further extend the dashboard's value by enabling trend analysis, pattern recognition, and automated recommendations for both operational and strategic decision-making.

Appendix A

The following link provides access to supplementary materials developed in this study, including the KPI list, GUI design, prototype, justification per dashboard page, and in-depth DATUS review: https://drive.google.com/drive/folders/1dXBIdH1bX3E-96QCWKVOyA3Lm6KEaG1y?usp=drive_link

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