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Web-Based Information Prototype System for Occupational Safety and Health Risk Assessment in Universities

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ABSTRACT

Occupational Safety and Health (OSH) is a fundamental component in ensuring safe and healthy working environments within higher education institutions. Despite regulatory frameworks such as Ministry of Health Regulation No. 48 of 2016 and the 2024 Higher Education OSH Guidelines, universities continue to face challenges in hazard reporting, compliance monitoring, and data management. This study aims to design and develop the University Occupational Safety and Health Information System (SIK3TI), a web-based prototype intended to enhance the effectiveness of OSH implementation and evaluation in academic settings.

This research employed a qualitative approach using a Research and Development (R&D) design with the prototyping model. Data were obtained through hazard identification checklists aligned with OSH regulations and Focus Group Discussions (FGD) involving university stakeholders, including infrastructure managers, academic staff, and safety experts. Data analysis followed the interactive model of Miles and Huberman to ensure validity and credibility.

The findings demonstrate that SIK3TI provides digitized features for hazard reporting, monitoring, and evaluation, transforming manual processes into integrated web-based management. The prototype includes modules for hazard identification, risk assessment, policy documentation, and audit instruments, allowing real-time data access across multiple user levels. This system significantly improves data accuracy, facilitates decision-making, and supports compliance with national OSH standards.

The development of SIK3TI illustrates that digitalization of OSH management in universities can optimize risk control, strengthen safety culture, and promote institutional accountability. However, large-scale testing and long-term implementation are required to evaluate its sustainability and integration with broader academic information systems.

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1. INTRODUCTION

Aspects of Occupational Safety and Health (K3) are one of the main discussions in Permendikbudristek Number 53 of 2023 concerning Quality Assurance of Higher Education. Article 5 paragraph 4 letter c states that educational input standards include facilities and infrastructure standards, which in Article 48 paragraph 1 regulates minimum criteria according to learning needs to achieve graduate competency standards. Furthermore, the Ministry of Education, Culture, Research, and Technology through the Guidelines for Occupational Safety, Health, and Environment Management System (SMK3L) in Higher Education issued in 2024, emphasizes that OSH is not only a legal obligation but also a critical indicator in campus accreditation and quality assurance assessments (Dirjen Pendidikan Tinggi dan Teknologi. Kementerian Pendidikan Kebudayaan Riset dan Teknologi, 2024; Fitri & Syahrani, 2021; Jannah & Santosa, 2025)

In the 5.0 Social Society Era, the application of digital technology through the Management Information System (SIM) is one of the innovative solutions in improving the quality of management, including in the field of K3 (Nugrahayani & Bunahri, 2025; Supriyadi & Sofiana, 2022) , by accelerating the monitoring process, simplifying reporting, and facilitating real-time data-based evaluation. In addition, driver's licenses are able to overcome resource limitations by increasing work efficiency, effectiveness, and productivity (Maharani & Aisah, 2024; NURAZIZAH, n.d.; Obasi & Benson, 2025; Pertiwi & Zagladi, 2025).

Based on previous research conducted at PKU Muhammadiyah Gamping Hospital, a prototype of an Android-based "e-Incident" application has been successfully overcome the problem of manual incident reporting at PKU Muhammadiyah Gamping Hospital (Herawati & Askar, 2022). In addition to the e-incident application developed at PKU Muhammadiyah Gamping Hospital, a Management Information System for risk management was also developed at Diponegoro National Hospital with the results of the development of a risk management information system with features that facilitate data input (Herawati & Askar, 2022; Syabrullah et al., 2023; Tunnisa & Erviana, 2020) , speed up the reporting process starting from the flow of the officer in charge of occupational health safety to the making of reports and being verified by doctors and occupational safety and health committees. producing the output of risk management reports, work accident reports, hazardous and toxic materials inventory reports and occupational disease reports (Papilaya et al., n.d., 2024). Therefore, the use of information technology plays an important role in recording and reporting Occupational Safety and Health (K3) (Askar et al., 2021; Nasution et al., 2024). One way to optimize the role of technology is to develop an information system that supports reporting, recording, and decision-making (Utari & Harahap, 2024; Wahono, 2024). The information system developed can facilitate information search, maintain data security, and support the decision-making process (Armanto, 2024; Papilaya et al., 2024; Wali & Akbar, 2023).

However, research and application of web-based OSH systems in higher education remain limited. This gap highlights the need for developing a university-level OSH information system that integrates monitoring, evaluation, and reporting functions in real time (Obasi & Benson, 2025; Yassaee & Mettler, 2019). Therefore, this study aims to design and develop a web-based Occupational Safety and Health Information System (SIK3TI) using a prototyping model. The system is expected to provide an innovative solution that supports digital transformation in universities, improves compliance with national regulations, and strengthens institutional safety culture.

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2. METHODS

This research uses a qualitative approach, with Research and Development (R&D) methodology. The R&D approach was selected because it enables the systematic design, testing, and refinement of a product. In this research, a prototype of a web-based Occupational Safety and Health Information System (SIK3TI) to ensure its applicability and effectiveness in higher education institutions (Okpatrioka, 2023; Zakariah et al., 2020). The research followed the prototyping model of R&D, which consists of four main stages: (1) Preliminary Study to identify problems and needs; (2) Design and Development of the system prototype based on findings; (3) Validation and Testing of the prototype by relevant stakeholders; and (4) Revision and Improvement based on feedback. This iterative process allows continuous refinement until the prototype aligns with user requirements and regulatory standards (Rahma, 2018; Slamet, n.d.).

Informants were selected by purposive sampling (Nugrahaeni & Mauliku, 2011). The inclusion criteria in this study are that informants held authority related to Occupational Safety and Health or information system development in their institution. A total of 12 informants participated, comprising infrastructure managers, K3 experts, lecturers, administrative staff, and university management representatives. The selection emphasized the richness and credibility of information rather than numerical representation (Asrulla et al., 2023; Maritasari et al., 2025; Sugiyono, 2016).

The data collection process was carried out using the Checklist for the Identification of Potential Fire and Earthquake Hazards in accordance with Permenaker Number 48 of 2016 concerning Occupational Safety and Health in Offices (Permenkes Nomor 48 Tahun 2016 Tentang Standar Keselamatan Dan Kesehatan Kerja Perkantoran, 2016). This instrument is used to systematically and in-depth identify various potential hazards, as well as to evaluate the level of compliance with applicable K3 standards. The formulation of the need for a K3 management information system that is in accordance with the characteristics of higher education is carried out by Focus Group Discussion (FGD) activities. This activity involved various stakeholders, including infrastructure managers, educators, education staff, and university management representatives. The discussion aimed to explore qualitative information about the needs, obstacles, and expectations of users for the K3 information system to be developed.

Based on the results of observations, quantitative data analysis from the checklist, as well as qualitative findings from the FGD, the researcher then designed and developed a prototype of the K3 management information system to be applied in the university environment. System validation was carried out through functional testing and black-box testing of the prototype (Purnomo, 2017). The validation process involved 10 respondents, consisting of OSH experts, system developers, and university management representatives. Respondents tested the system using structured evaluation sheets covering usability, functionality, and relevance of features. Feedback obtained from these evaluations guided the refinement of the prototype.

Data analysis followed the interactive model of Miles and Huberman, which included data reduction, data display, and conclusion drawing. The process was conducted iteratively until saturation was achieved, ensuring that no new findings emerged beyond the established themes (Pahleviannur et al., 2022).

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3. RESULTS AND DISCUSSION

The Need for an Information Technology-Based Occupational Safety and Health Information System (SIK3TI) includes a series of features and functions that must be owned by the system in order to support the effective management process of Occupational Safety and Health (K3). Based on the results of the FGD, the K3 information system is expected to be developed in the Integrated Information System of the institution that is being developed. Here are the quotes:

"....Monev, yes, we should, we should indeed have our own driver's license, but indeed it must be integrated, so those who can enter the driver's license start from the SPMI policy until later the increase in SPMI. The policy starts from the one like earlier, yes, the guidelines Then the standard is a policy, later it will enter the Implementation Implementation means who does it Now the results of the implementation reports must also enter the SIM..." **(informan 1)**

".....so the memo don't have to deliver to Mr. Haris it can be access anywhere ..." **(informan 1)**

"....The hope is that the system is already tied up, there are reports of any incidents there, so the intention is to do it later in the system, so it's not just the policy monitoring documents and others, so there is an implementationn..." **(informan 3)**

"..... indeed, for the feature it must arrive later to the upgrade, it continues to be connected to PPEPP..." **(informan 1)**

Based on this explanation, this information system is expected to facilitate the monitoring and evaluation process of K3 at UNISA Bandung and can be accessed anywhere and anytime.

Application Model Design

The design of information systems uses a model prototyping approach to enable a more structured and timely process, both for small and large scales. This method actively involves users in prototyping, so that all relevant parties including leaders, users, and developers can benefit from the feedback provided during the development process (Prabowo, 2020).

In the development process of this information system is web-based, so that it can be further developed if it will be integrated with the main information system.

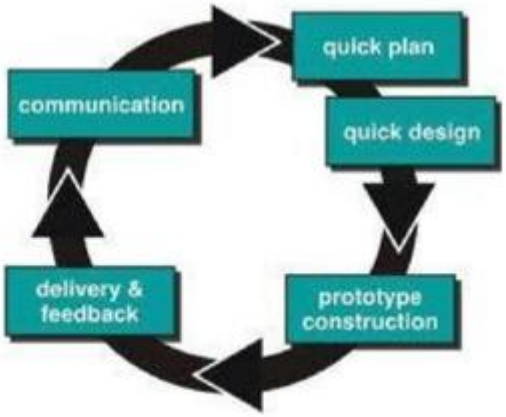

Figure 1. Prototype Model Development
Source : Pressman; Maxim, 2014, in (Prabowo, 2020)

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Based on the SMK3L Guidelines for Higher Education, the implementation of K3 SMK3L in higher education includes the cycle of K3 Policy Setting, K3 Planning, Implementation of K3 Plan, K3 Performance Monitoring and Evaluation, and K3 Performance Review and Improvement (Director General of Higher Education, Research, and Technology. Ministry of Education, Culture, Research, 2024). In the hazard assessment process in higher education, refer to the SMK3L Guidelines of the Director General of Research, Technology and Higher Education using hazard identification and risk assessment instruments, and the evaluation monitoring process using the SMK3L Audit instrument of higher education. In addition, for the identification of building hazards, refer to the Office K3 Standard (Permenkes Nomor 48 Tahun 2016 Tentang Standar Keselamatan Dan Kesehatan Kerja Perkantoran, 2016), instrument for potential fire and earthquake hazards (Permenkes Nomor 48 Tahun 2016 Tentang Standar Keselamatan Dan Kesehatan Kerja Perkantoran, 2016).

Modeling Creation

Based on the results of data analysis, it can be understood that there are 4 (four) entities that will be users in the design of the university occupational safety and health information system, namely: Work Units, K3 Experts, Management, and SMK3 Auditors. The following is a draft of the information system flowchart proposed by the researcher in the process of developing the Higher Education Occupational Safety and Health Information System (SIK3TI) :

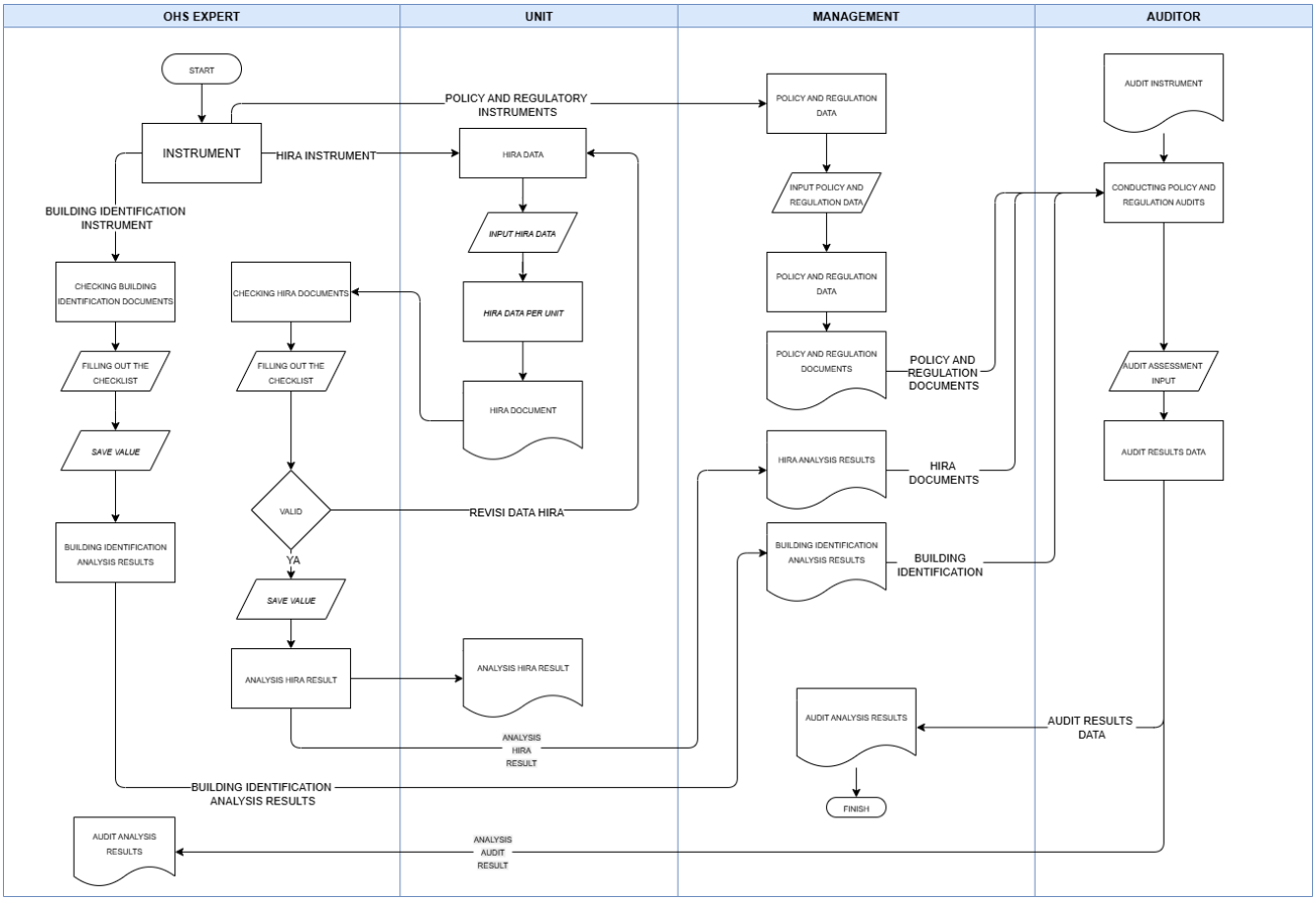

Figure 2 Flow Chart of Designing Occupational Safety and Health Management System in Universities

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In the process of creating a model, a context diagram is needed that describes the inputs, processes, and outputs in an outline. This diagram illustrates an Integrated Occupational Safety and Health (SIK3TI) information system that serves as a data processing and exchange center between various entities involved in occupational safety management. The symbols used refer to the Flowchart using Demarco and Yourdan Symbols (Kristanto, 2018).

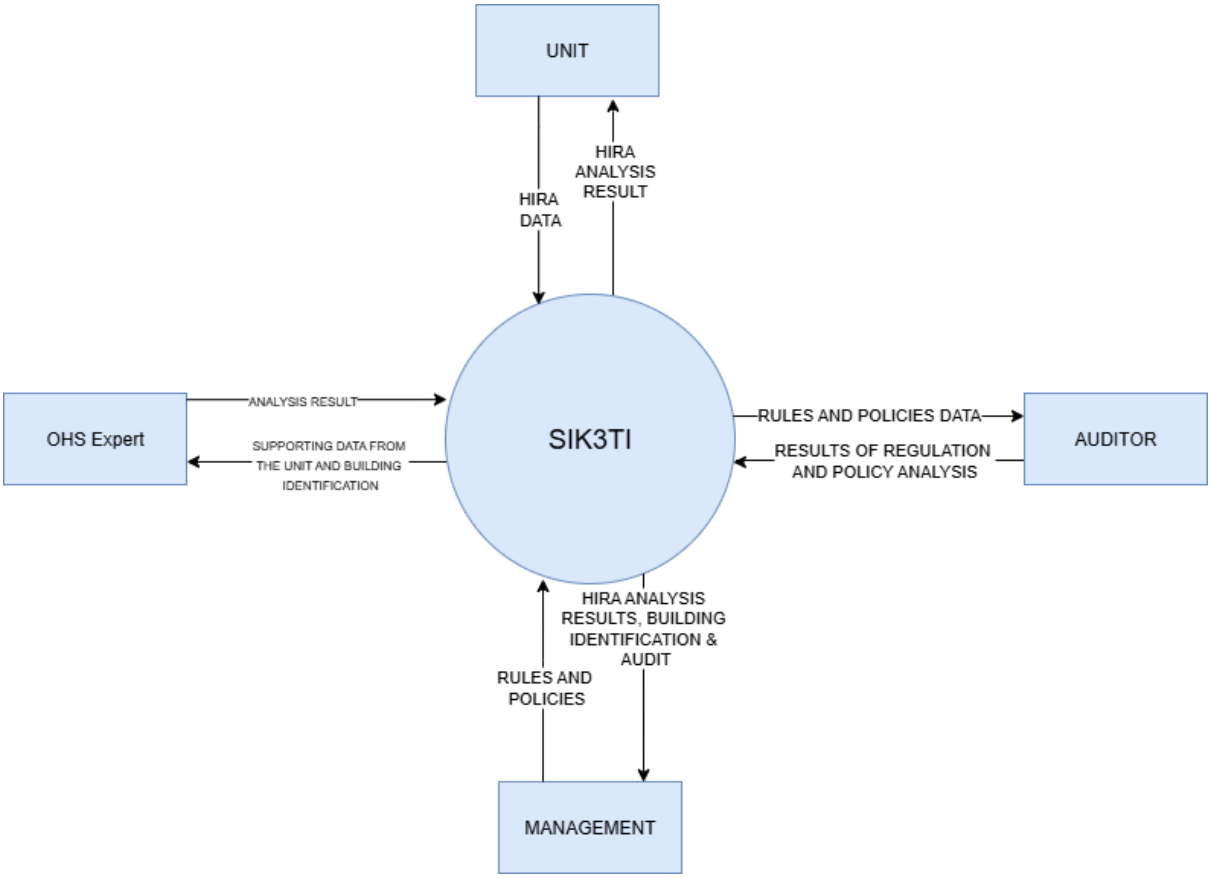

Figure 3 Context Diagram of Occupational Safety and Health Information System College

Database Design

Entity Relationship Diagram (ERD) is a diagram that provides an overview of the process of creating, storing, and using data in a business system. This diagram connects the various entities in the system, the information in the entity and shows the relationships between tables based on a data-based dictionary (Dan, Intech, Afi, Azzahra, & Anggoro, 2022). In addition, ERD also represents business rules applied in information systems, including in the development of K3 information system.

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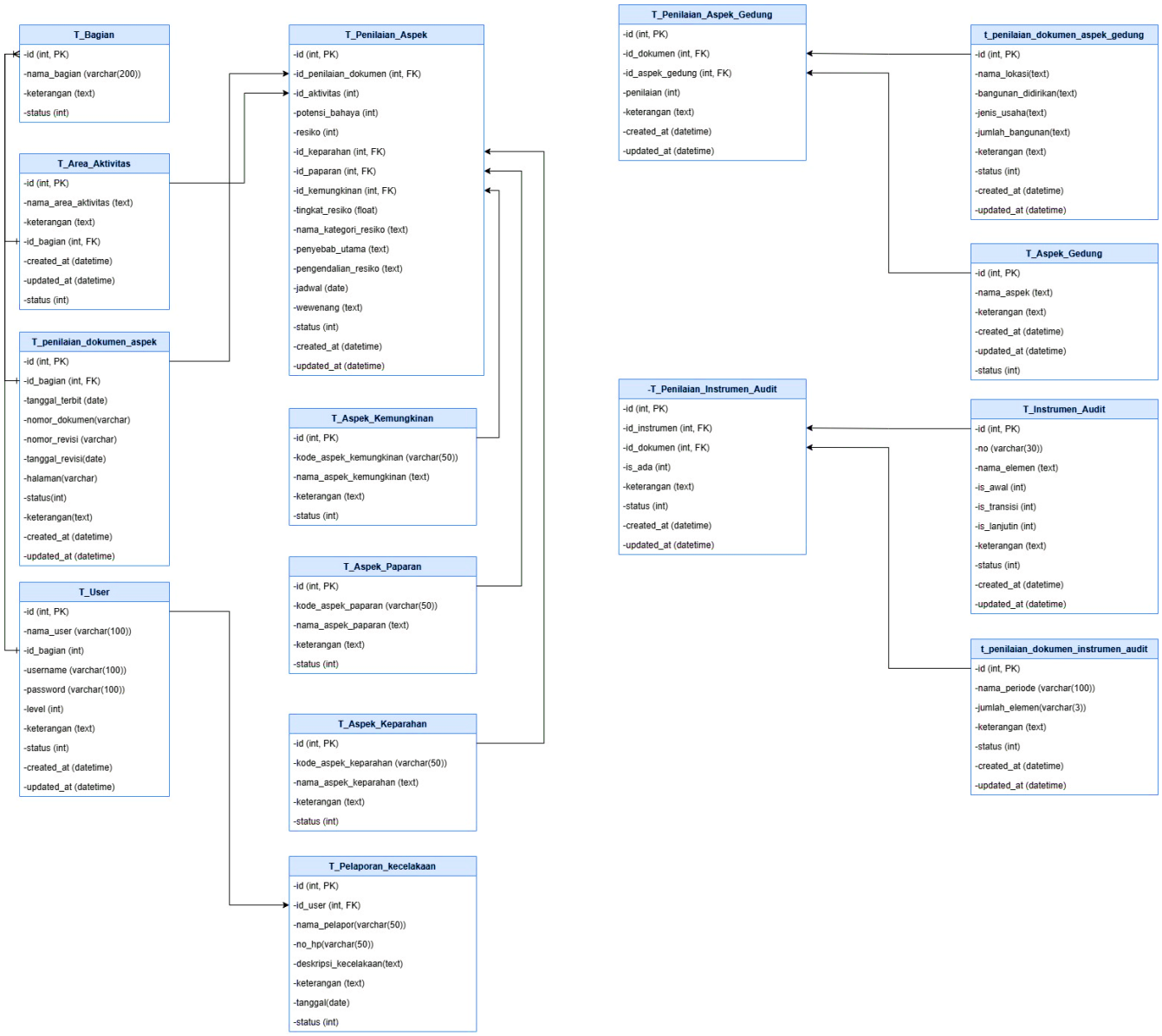

Figure 4 Draft Inter-Table Relationships for The Higher Education Occupational Safety and Health Information System Database

SIK3TI Prototype Development

The design of the information system was developed using a prototype model. In the development of the SIK3TI prototype model runs the software development steps, including communicating with system users and analyzing existing issues, this process also includes the exposure of the software and hardware requirements required to support the creation of the system. The construction stage of the prototype model is by making coding, either manual or automatic, which is done through the PHP programming language. This allows for quick design to outline the system to suit the user's needs.

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The following are the results of the system implementation that has been carried out on SIK3TI :

Figure 5 Login Page View

On this page, users are required to enter the registered username and password in order to enter the system.

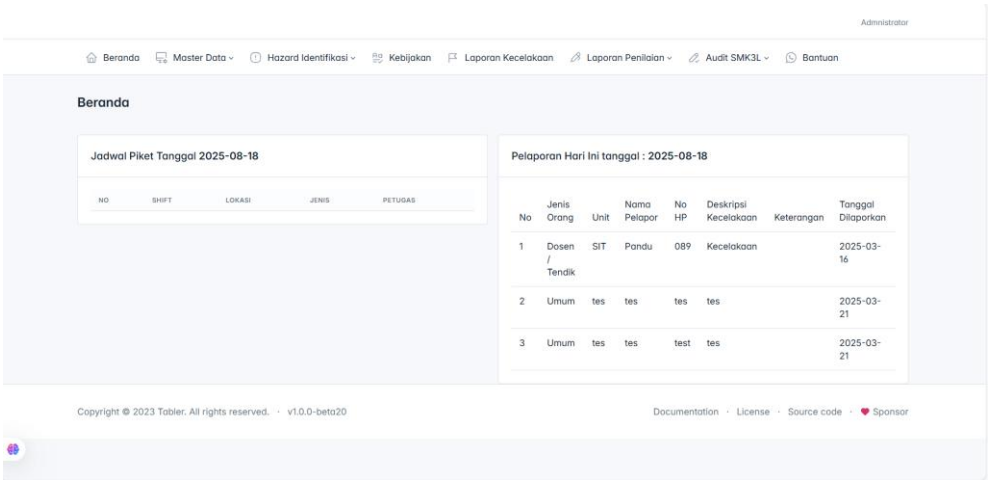

Figure 6 Dashboard View

The home page displays the emergency team picket schedule at each campus, and reports of work accident incidents that occurred in the work unit. On the home page, users are allowed to use the menu feature according to the user's level.

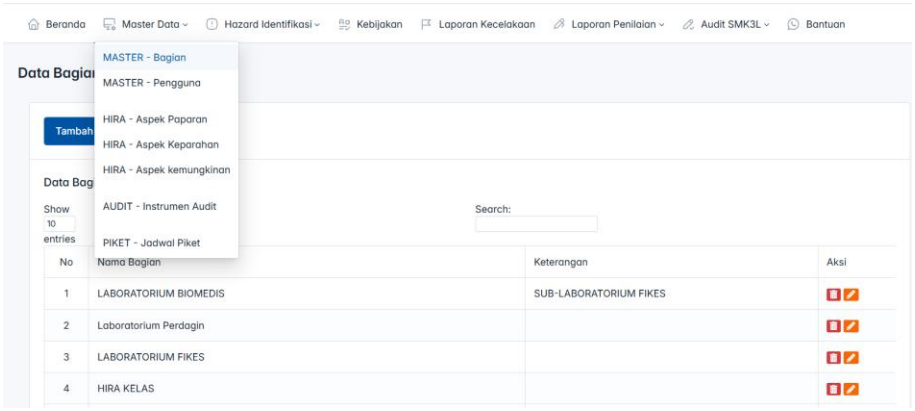

Figure 7 User Data Master View

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Master Data page - Users display user tier, username and user status activation. On this page, administrators can add, correct, and remove users who have access to SIK3TI based on directions from management.

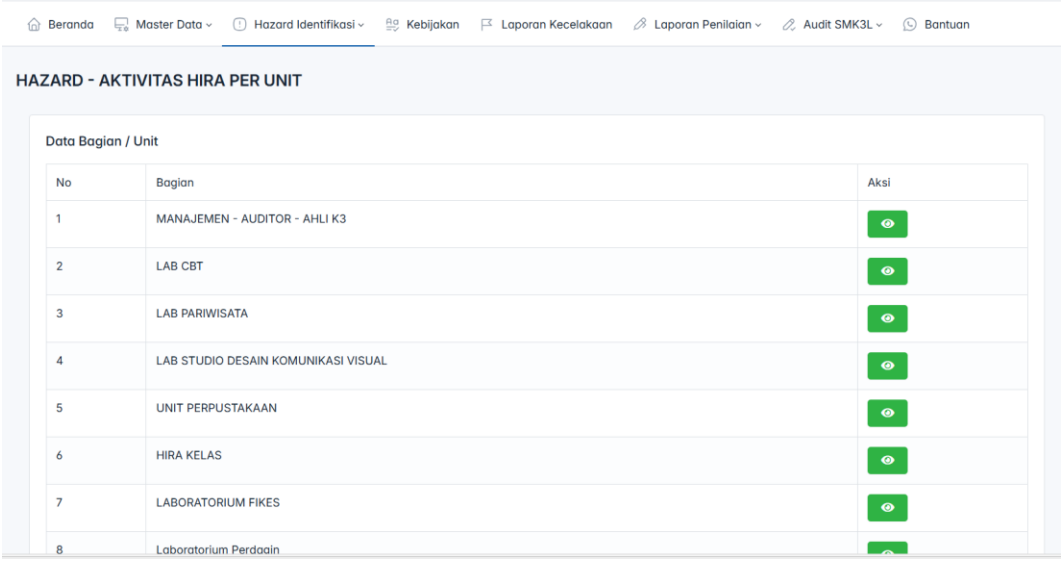

Figure 8 Hazard Identification Page – HIRA Activity Per Unit

Hazard Identification Page – HIRA Activity Per Unit displays work units that have the potential to have *hazards* and need to be controlled. Each work unit reports *hazards* in its work unit on this page. Work units appointed based on the direction of K3 Experts and Management.

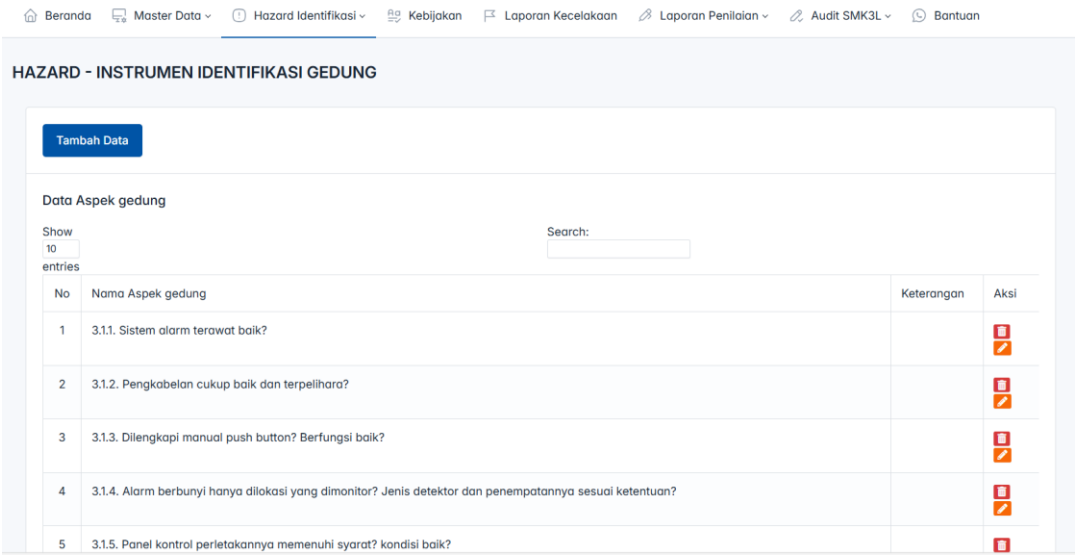

Figure 9 Hazard Identification Page – Building Identification

The *Hazard* Identification – Building Identification page displays a digitized identification form for potential fire and earthquake hazards in accordance with the Minister of Health Regulation Number 48 of 2016. The user from this page is a K3 Member.

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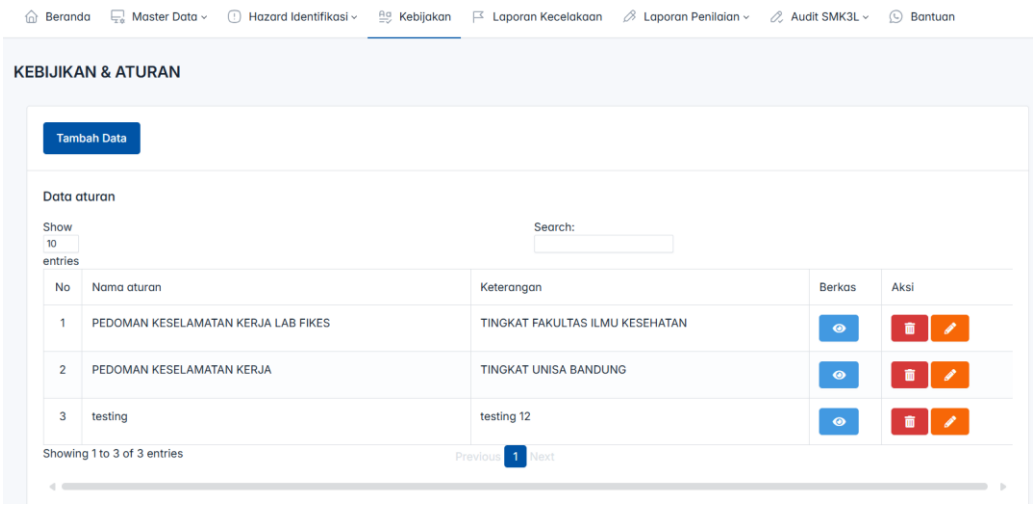

Figure 10 K3 Policy Page

The K3 Policy page displays the K3 policy documents applicable at UNISA Bandung in a digitized manner approved by the management. All users can access this page.

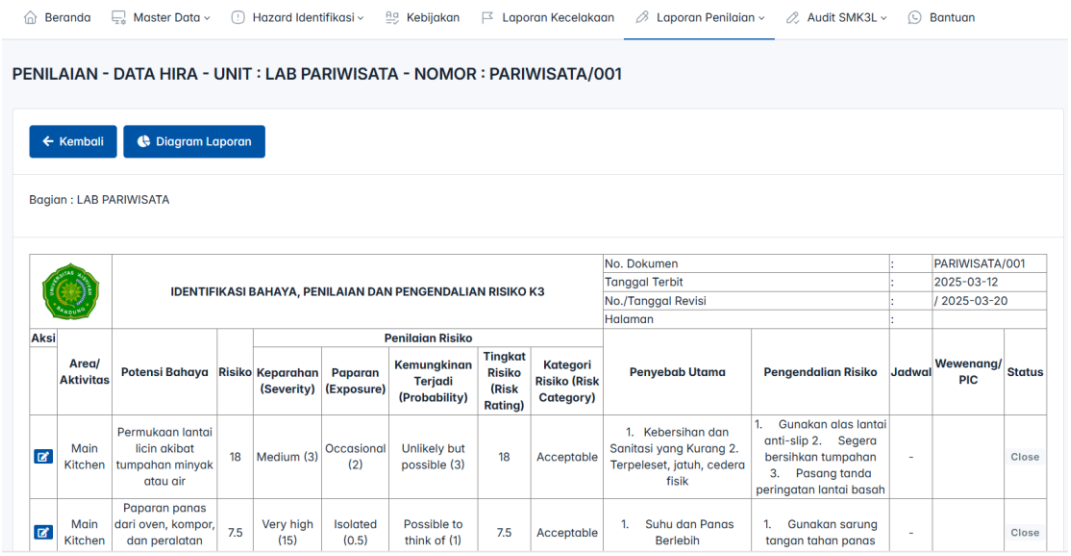

Figure 11 Page of Assessment Report – HIRA Assessment – Area Aspect – Area Aspect Assessment Data

The Assessment Report Page – HIRA Assessment – Area Aspect – Area Aspect Assessment Data displays assessment report data that will be assessed in severity and likelihood of occurrence by K3 Experts in a certain period. On this page, K3 experts can recommend risk control, control schedules, and PIC *(Person In Charge*) in risk control. The user of this page is a K3 Member

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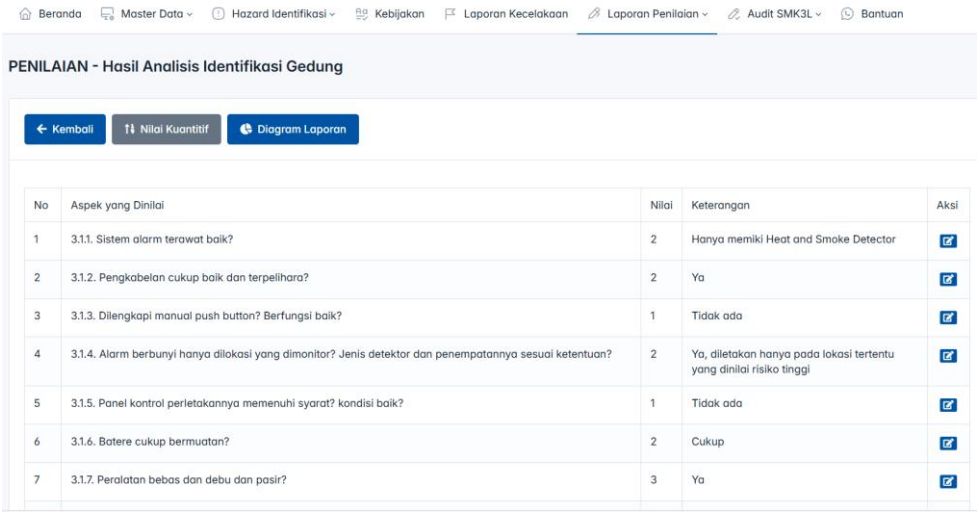
Figure 12 Pages of Assessment Report – HIRA Assessment – Area Aspects – Report Diagram

The Assessment Report Page – HIRA Assessment – Area Aspects – Report Diagram presents the assessment report in the form of a diagram so that it is easy to read, and the HIRA table is complete with risk control and *hazard* status. This page is accessible to all *users*.



No	Aspek yang Dinilai	Nilai	Keterangan	Aksi
1	3.1.1. Sistem alarm terawat baik?	2	Hanya memiki Heat and Smoke Detector	
2	3.1.2. Pengkabelan cukup baik dan terpelihara?	2	Ya	
3	3.1.3. Dilengkapi manual push button? Berfungsi baik?	1	Tidak ada	
4	3.1.4. Alarm berbunyi hanya dilokasi yang dimonitor? Jenis detektor dan penempatannya sesuai ketentuan?	2	Ya, diletakan hanya pada lokasi tertentu yang dinilai risiko tinggi	
5	3.1.5. Panel kontrol perletakannya memenuhi syarat? kondisi baik?	1	Tidak ada	
6	3.1.6. Batere cukup bermuatan?	2	Cukup	
7	3.1.7. Peralatan bebas dan debu dan pasir?	3	Ya	

Figure 13 Page of Assessment Report – Building Identification Assessment – Building Identification Assessment Data

The Assessment Report Page – Building Identification Assessment - Documents / Period displays document data on the identification form of potential fire and earthquake hazards in accordance with the digitized Permenkes number 48 of 2016. So that K3 Experts can directly fill out assessments in each building and the value of the observation results can be known in *real time*.

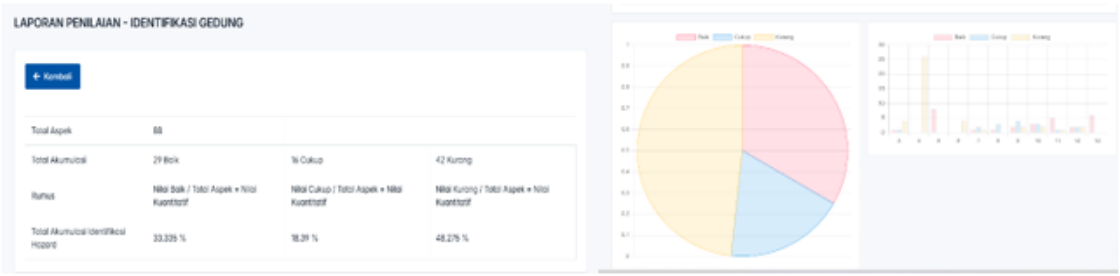


Figure 14 Page Assessment Report –Building Identification Assessment – Report Diagram

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The Assessment Report Page – Building Identification Assessment – Report Diagram displays the assessment of the accumulated calculation results based on the identification form of potential fire and earthquake hazards in accordance with the Minister of Health Regulation number 48 of 2016. The digitized calculated data displays the accumulation of hazard identification in each building. In addition to being presented in the form of numbers, reports are also presented in the form of diagrams that facilitate the analysis process.

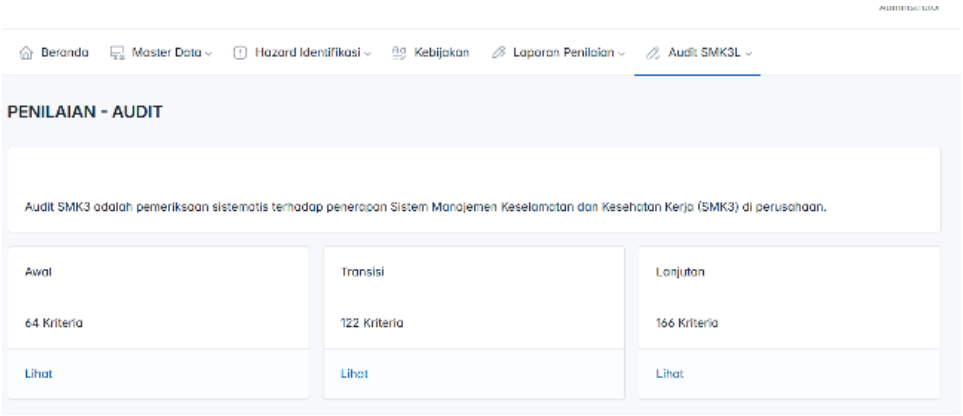

Figure 15 SMK3L AUDIT Page – Select Criteria

SMK3L AUDIT Page – Select This criterion presents 3 (three) choices of SMK3L college audit levels that can be done. For the initial level with 64 criteria, the transition level with 122 criteria, the advanced level with 166 criteria. Choice of Audit level based on agreement between management and auditors. This page can be accessed by SMK3L Audities and Auditors both internally and externally.

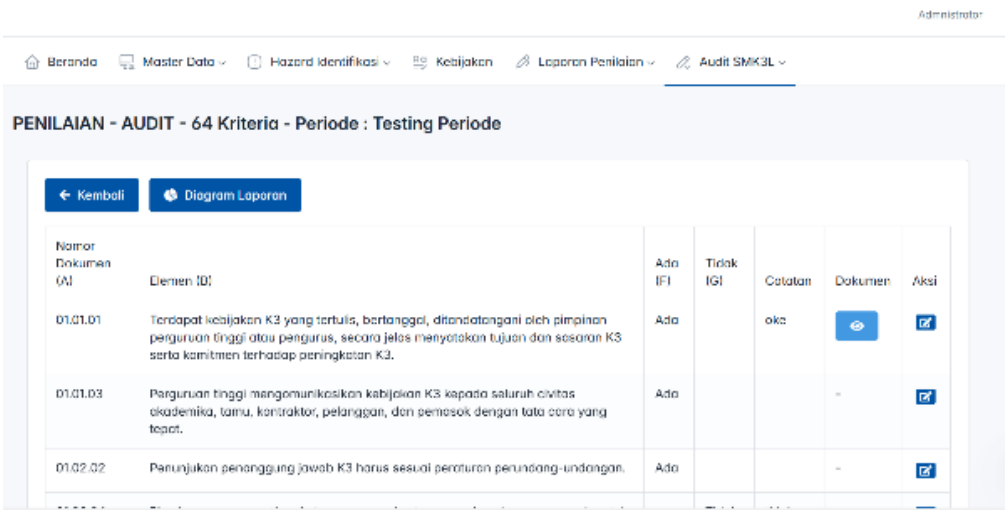

Figure 16 SMK3L AUDIT Page – Audit Assessment

SMK3L AUDIT Page – The Audit Assessment displays the SMK3L Audit instrument in a digitized manner and refers to the SMK3L Guidelines for Higher Education. On this page, the audition can upload documents, and the auditor provides an assessment of the conditions in the field and the availability of the uploaded documents. The auditor cannot download the document that has been uploaded by the auditie.

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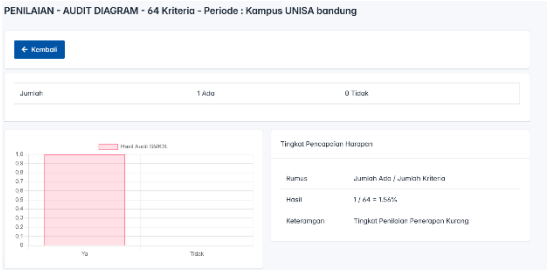

Figure 17 SMK3L AUDIT Page – Audit Assessment – Report Diagram

SMK3L AUDIT Page – Audit Assessment – Report Diagram presents the data on the results of the SMK3L Audit that has been assessed by the Auditor. This page can be accessed by all users.

Discussion

Protyping model is a method of rapid and gradual system development, so that with this approach the program can be immediately evaluated by the user (Noor Santy, 2018 in (Prabowo, 2020)). The prototyping approach ensures that system development runs smoothly, structured, and on time by actively engaging users, benefiting leaders, users, and developers.

The SIK3TI development process using *a prototype model* consists of several stages:C

1. Communication
   Initial data collection was carried out through FGD and K3 policy analysis in universities. This system involves four types of users (Management, K3 Expert, Work Unit, and SMK3 Auditor) with different access views. The main features proposed include hazard data input, identification, reporting, and SMK3 audits.
2. Rapid Planning and Modeling
   This stage includes an analysis of information needs and initial modeling of the system in the form of an interface sketch. This model helps developers understand user needs and ensure the design aligns with the system's goals.
3. Prototype Construction
   Coding is done using PHP 7.4 and the CodeIgniter Framework, followed by a function test to detect and fix errors before further development.
4. Submission
   The test is carried out using *the blackbox* method and *functional testing* to ensure the system's functionality runs optimally. The testing team includes information systems experts and related management representatives. The test results stated that the entire interface could be used without *debugging* (Purnomo, 2017).

Furthermore, the development of the SIK3TI prototype highlights significant contributions to the digitalization of Occupational Safety and Health (OSH) management in higher education institutions. The system successfully transforms manual processes into digitized workflows, integrating real-time hazard reporting, auditing, and risk monitoring. This finding aligns with international practices, where institutions such as the Occupational Safety and Health Administration (OSHA) in the United States and the Health and Safety Executive (HSE) in the United Kingdom have adopted digital systems to strengthen safety culture and regulatory compliance. Thus, SIK3TI can be considered a strategic step in harmonizing Indonesian higher education OSH standards with global trends.

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In practical terms, the system provides multiple benefits. University management can use it to facilitate accreditation and ensure compliance with national OSH regulations through integrated policy documentation and audit modules. For the academic community, the system promotes a safer working environment and faster response to potential hazards. Additionally, government authorities benefit from standardized data that can serve as evidence of compliance and a basis for policy evaluation.

However, this study also presents some limitations. The prototype was tested in a limited scope with relatively few informants, which restricts the generalizability of its effectiveness. Moreover, the evaluation focused primarily on functionality, while user experience requires more comprehensive assessment to ensure accessibility across diverse stakeholders.

Future research should involve large-scale testing in different types of higher education institutions, including public, private, and vocational universities. Integration with existing academic information systems (SIAKAD) and the development of a mobile application are also necessary to increase flexibility and usability. Finally, a cost–benefit analysis of SIK3TI implementation would provide valuable insights into its efficiency and long-term sustainability.

4. CONCLUSION

This study aimed to design and develop a web-based Occupational Safety and Health Information System (SIK3TI) for higher education institutions using the prototyping model. The research objectives have been achieved by producing a functional prototype that supports hazard identification, compliance monitoring, digital reporting, and risk analysis in accordance with national OSH regulations. The system was designed with multi-level access to ensure data security and role-based information management. Validation results indicate that the main features such as hazard reporting, policy documentation, and audit modules functioned effectively and could be accessed properly by all user levels.

Therefore, the development of SIK3TI demonstrates that digital transformation in OSH management can enhance efficiency, data accuracy, and decision-making in universities. However, further large-scale implementation and long-term testing are required to evaluate its overall effectiveness, integration with academic information systems, and contribution to strengthening campus safety culture.

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