Development of Web-Based Occupational Safety and Health Management Information System (OSH-MIS) at Engineering Faculty of Diponegoro University

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Abstract

The Faculty of Engineering, Diponegoro University (FT UNDIP) is an educational institution in the city of Semarang that is planning the implementation of an Occupational Safety and Health Management System (OSHMS). FT UNDIP, which consists 12 departments and 57 laboratories, has many unsafe conditions that can endanger the safety and health of the academic community. The results of the onsite visit to each department found that 67% of occupational health and safety programs have not been fulfilled. These unsafe conditions must be managed immediately to improve the image of FT UNDIP with an appreciation for zero accidents. The implementation of OSHMS requires an information medium so that it can be managed quickly, dynamically and easily to access, especially in incident reporting, HIRARC (Hazard Identification, Risk Assessment and Risk Control), and equipment inspection. This study was intended to design a website-based occupational safety and health management information system (OSH-MIS). The website that was built also payed attention to the level of usability to see how acceptance and satisfaction of prospective users were to the OSH-MIS website. The usability assessment used the Nielsen method which was given to 20 OSH committees. The OSH-MIS website usability value was 4.24 out of a scale of 5. This score was in the good category, which meant that the OSH-MIS website was able to meet every need related to OSH management in FT UNDIP. Of the 5 factors assessed, the variable with the lowest mean was few of errors on the item which stated that participants get a clear warning when an error occurs. The proposed improvement to increase the usability of these variables is to provide a popup that provides a warning or condition that must be done when the system is in error or the user makes an error. The OSH-MIS website, which is overall good and given suggestions for improvement, is expected to be able to be applied to support the successful implementation of OSHMS in FT UNDIP.

Keywords

Information System, Website, OSHMS, Usability, and Nielsen Method.

1. Introduction

The Occupational Safety and Health Program (OSH) is an effort to create a work area that is safe, healthy, and accident-prevented, so as to increase work efficiency and productivity. In addition to protecting workers, the OSH aspect can also protect company or production assets. In the industrial world, OSH aspects really need to be considered because they involve the safety and health of workers and the surrounding community. Therefore, it is necessary to have a management system that regulates and is responsible for the safety and health of workers. This management system is known as the Occupational Safety and Health Management System (OSHMS). OSHMS is regulated in the Indonesian regulation (Permenaker RI No.Per. 05/MEN/1996) article 3 paragraphs 1 and 2, which states that "Every company that employs a workforce of 100 people or more and/or contains potential hazards caused by the characteristics of production processes or materials that can cause work accidents such as explosion, fire, environment, and occupational diseases must implement OSHMS". With the implementation of OSHMS, OSH management can be

carried out more systematically and comprehensively in a complete management system through planning, implementing, measuring, and monitoring processes (Ramli 2010) in (Kukun 2015). The importance of occupational safety and health does not only apply to large companies or factories, but everywhere such as government agencies, health, education and others. However, this aspect of OSH is often neglected and has not become a top priority in other institutions such as educational institutions.

The Faculty of Engineering, Diponegoro University (FT UNDIP) is an educational institution in Semarang that is planning to implement OSHMS as an effort to create a safe and comfortable campus environment for the academic community in it. This was stated in the Decree of the Dean of the Faculty of Engineering, Diponegoro University Number: 5/UN7.5.3/HK/2020, dated January 6, 2020, concerning the Appointment of the FT UNDIP Occupational Safety and Health Advisory Committee. The OSHMS application is also carried out in order to obtain ISO 45001 certification which is intended to enable organizations to manage OSH risks and improve their performance. FT UNDIP with 12 departments and 57 laboratories in it certainly contains a lot of unsafe conditions that can endanger the safety and health of the academic community in it, considering that most engineering student activities are carried out in laboratories full of machines, computers, chemicals, and other dangerous equipment.

From January 28 to February 10, 2020 an onsite visit was carried out to 12 departments in FT UNDIP. Based on the results of the visit, it was found that there have been several OSH applications such as hazard prevention and safety induction before conducting experiments and at the time of admission of new students. However, in reality, there are still many shortcomings in the application of the OSH, such as the absence of OSH training for the academic community, no safety drill, no information regarding emergency telephone contacts, and the absence of counseling guidance at FT UNDIP. The results of the OSH case findings during the onsite visit showed that 67% were still unfulfilled and were classified as unsafe conditions, both from the results of the equipment and activity checklist (checklist data attached).

This unsafe condition occurred due to the lack of inspection activities by OSH officers. In addition, other academics, especially students who are directly involved in the laboratory, are very limited in being involved in the implementation of the OSH program, especially in incident reporting. This is because there is no media that can be used to report dangerous conditions or incidents around campus. This unsafe condition must be immediately managed by the OSH FT UNDIP to improve the image of UNDIP with the title of zero accident, so that the OSHMS and ISO 45001 programs that are being planned can be achieved. However, to support the OSHMS program, an information system that is dynamic and easy to access is needed.

Information systems in general that are currently widely used are website-based information systems. This is because the website has the advantage of centralized files and databases and only requires installation on the server, so that it can easily maintain and update information. In making an information system, a system development method is needed. The method used is Agile Development with the Extreme Programming approach. The website-based information system to be built must also pay attention to interface design and usability. This aspect also provides an idea whether the appearance of the website to be built will be suitable and liked by users or not. To find out whether the website built can be said to have good quality, a usability test is carried out. Usability testing will be carried out using the Nielsen's Attribute of Usability (NAU) questionnaire. Thus, researchers are interested in designing an information system based on mobile apps that can manage information about incident reporting and inspection activities for fire extinguishers and first aid kits at FT UNDIP.

2. Research Method

This research is a type of Research and Development (R&D). The data in this study were obtained by collecting primary and secondary data. Primary data were obtained by means of interviews and observations regarding the required information system features, Hazard Identification, Risk Assessment, and Risk Control (HIRARC) reports, and data on usability testing questionnaires. Meanwhile, secondary data was obtained by reviewing the ISO 45001: 2018 manual document. This study was conducted following these steps:

1. Designing Information Systems Design
   Information system design refers to the extreme programming method (Rahmi et al. 2016).
2. Exploration Stage
   The exploration stage is the initial stage where the researcher collects all the basic needs associated with the system.
3. Planning Stage

At this stage, the researcher will make plans regarding functional requirements and non-functional requirements. Functional requirements include what the team will do, while non-functional requirements include software and hardware requirements.

4. System Development Iteration Stage
   This stage consisted of a number of system development iterations, which are the process of analysis, design, planning, and testing. The design process consists of data design, process design and user interface design
5. Final Production Stage
   At this stage, the system performance is checked before being released to the user. The changes required to the system can be detected at this stage. After checking, the first version of the software can be released to the user.
6. Usability Testing Stage
   The usability testing stage is carried out using the NAU (Nielsen's Attributes of Usability) questionnaire.

2.1 Participants
Respondents who will participate in the OSH-MIS FT UNDIP usability test are 20 participants who are the OSH FT UNDIP committee.

2.2 Data collection
After using the newly designed information system, respondents will be asked to fill out a questionnaire. Answers to questions are based on a Likert scale.

2.3 Data Processing
Descriptive statistical analysis is conducted to assess the usability of OSH-MIS FT UNDIP based on questionnaire data that had passed the reliability and validity tests. The usability value is obtained based on the mean value of each variable.

3. Result and Discussion

3.1 Exploration Stage
Based on the exploration results of the plan-do-check-action (PDCA) of ISO 45001: 2018 scheme and the results of the FT UNDIP internal audit, it can be concluded that there was some basic feature needed to be included on the OSH-MIS website. These basic requirements were:

a. Incident Reporting
   The purpose of incident reporting was to make it easier for OSH to manage all information regarding accidents in the FT environment, so that OSH FT could prepare preventive measures against new accidents and the risk of similar accidents in the future.
b. Potential Hazards Reporting
   The purpose of reporting of potential hazards was to enable the academic community other than the FT OSH team to be involved in reporting potential hazards in the FT environment.
c. Equipment Inspection (fire extinguisher and first aid kit)
   The purpose of an equipment inspection was to ensure that OSH equipment is in good condition and ready for use in the event of an emergency.
d. HIRARC (Hazard Identification, Risk Assesment, Risk Control)
   The purpose of HIRARC was to make it easier for OSH to manage all information regarding dangerous conditions in the FT environment, so that OSH FT can prepare management actions for these dangerous conditions and can minimize any possible risks of work accidents.

3.2 Planning Stage
Functional Requirement
The following were potential users of the FT UNDIP OSH-MIS website:

a. The Occupational Safety and Health Committee was a potential user who was able to access all the menus that would be available in the system, including the incident reporting menu, HIRARC, equipment inspection, dashboard, inventory list, and incident list.
b. Leaders were potential users who were only able to access the report incident menu, report potential hazards, and the dashboard, namely each head of the FT UNDIP department.

c. General was a potential user who only accesses the report incident menu, report potential hazards, and dashboard. The general category includes every academic community both lecturers, students and employees outside the OSH committee and leaders.

Non-Functional Requirement

The non-functional requirements required in the OSH-MIS website development process were as follows:

a. The OSH-MIS website can be accessed on any device such as a computer or mobile phone.
b. This website required an internet connection to access the menus in it.
c. This application used a log-in system with a Single Sign-On (SSO) system UNDIP account.

3.3 Iteration Stage

Designing Entity Relationship Diagram (ERD)

The relationships between entities that occur in the FT UNDIP OSH-MIS were as follows in Figure 1.

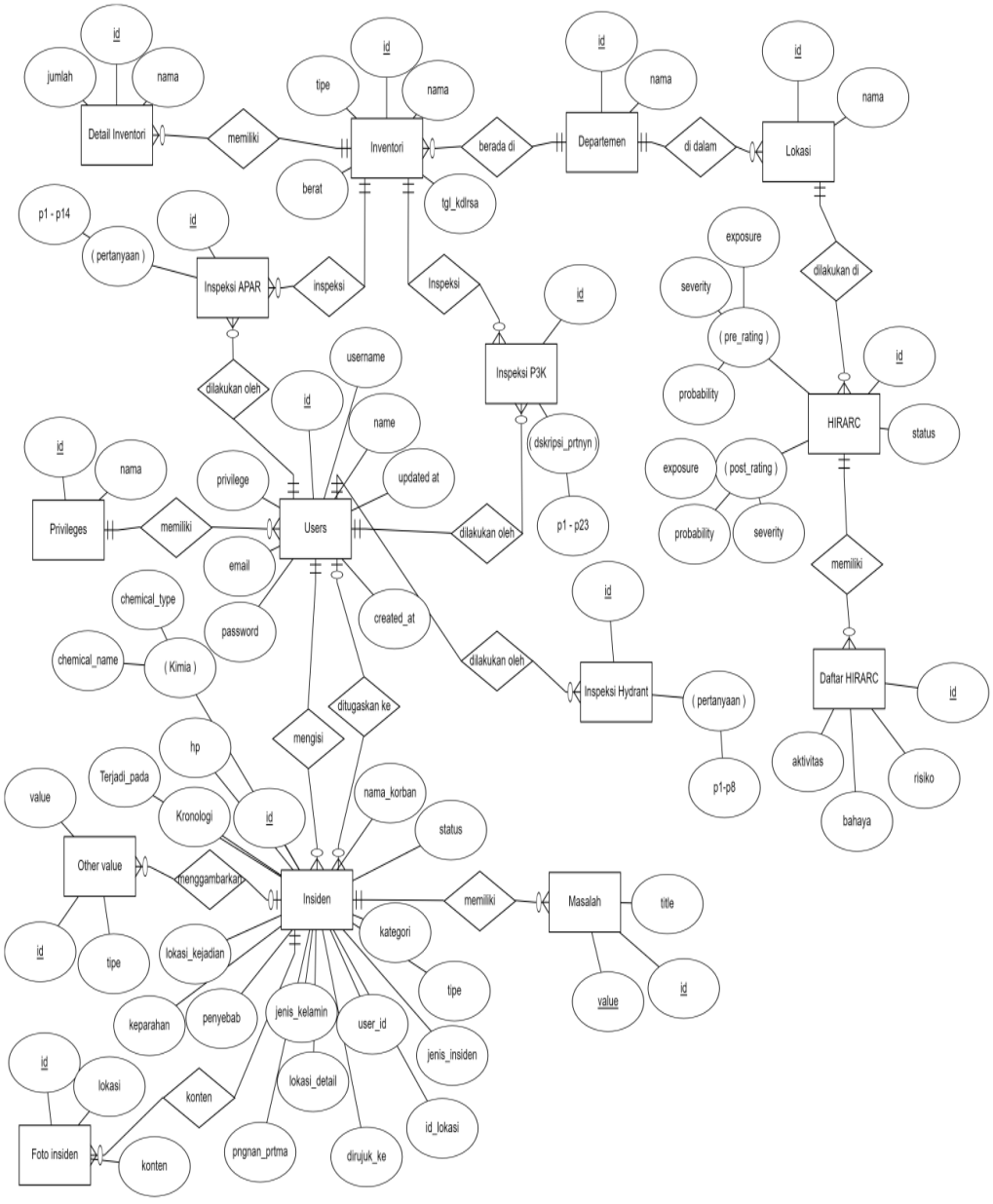


Figure 1. OSH-MIS entity relationship diagram

Designing Use Case Diagram

Figure 2 shows the use case table for the entire OSH-MIS.

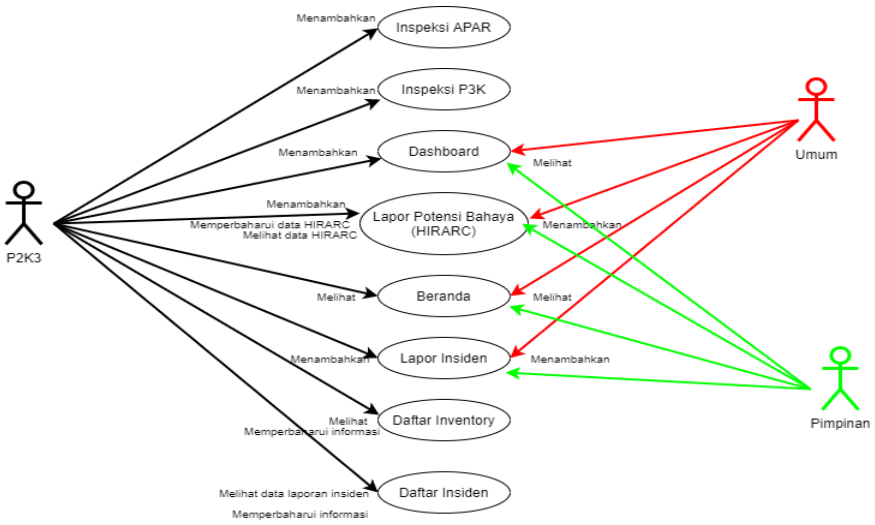


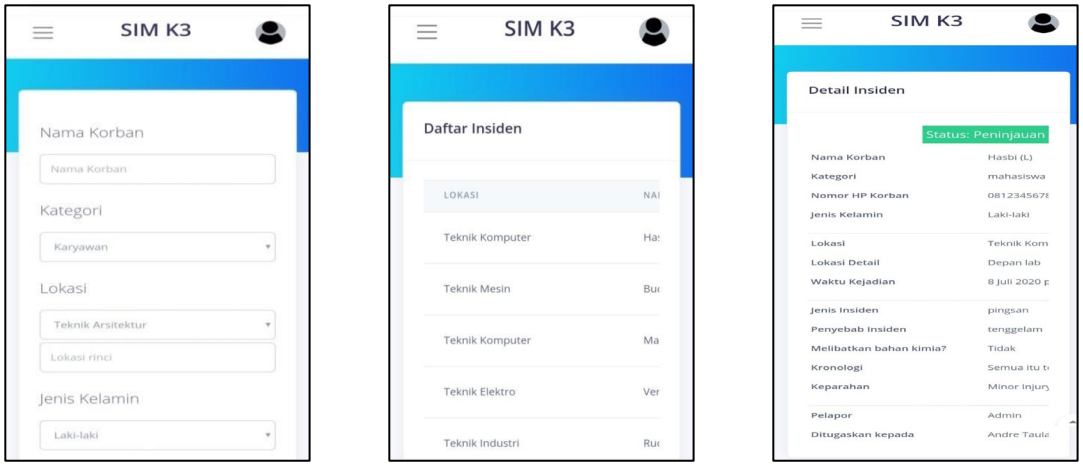
Figure 2. OSH-MIS system development use case diagram

Productionizing Stage

Figure 3 is the interface design for the OSH-MIS. The next Figure 4 shows the OSH-MIS login page. Figure 5, then shows the interface of incident report in the OSH-MIS. Figure 6, furthermore, shows the interface of OSH-MIS inventory page. OSH inventory includes fire extinguisher and first aid kit. Figure 7 is the interface of OSH-MIS HIRARC page.

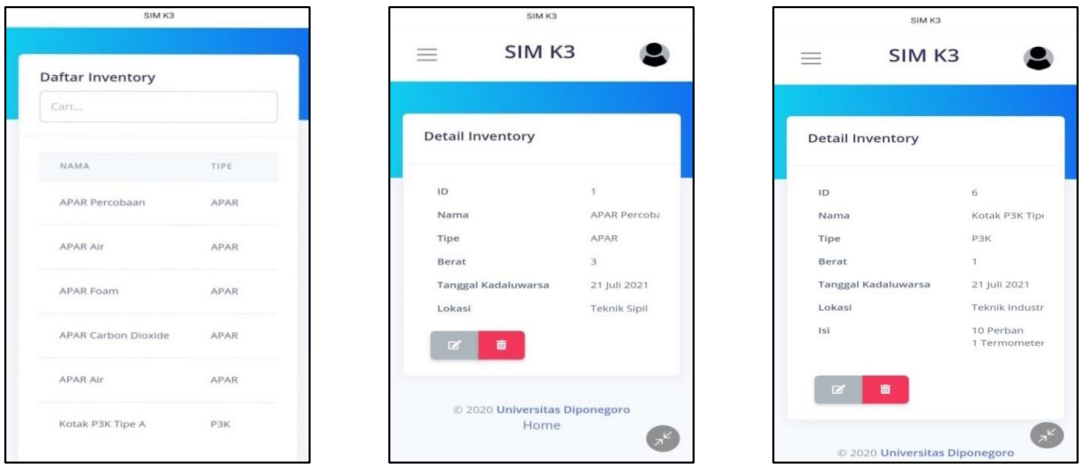
Figure 3. Interface of OSH-MIS homepage

Figure 4. Interface of OSH-MIS login page



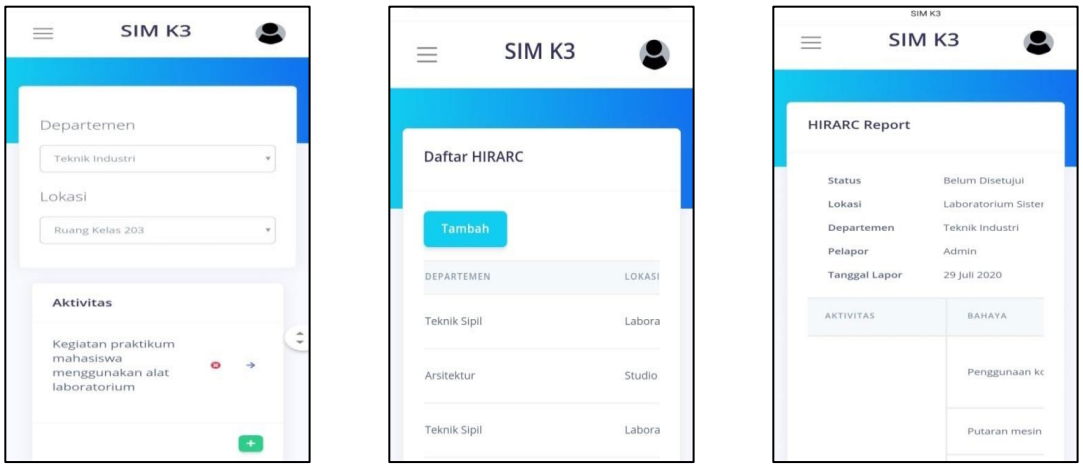
(a) Report form (b) List page (c) Detail report

Figure 5. Interface of OSH-MIS incident reporting



(a) Inventory list (b) Fire extinguisher detail (c) First aid kit detail

Figure 6. Interface of OSH-MIS inventory (fire extinguisher & first aid kit) page



(a) HIRARC front page (b) HIRARC list page (c) HIRARC detail page

Figure 7. Interface of OSH-MIS HIRARC page

Usability Testing Stage

Based on the results of descriptive statistical processing that has been done previously, the mean value of the usability of the OSH-MIS website was 4.24, which was in the good category. Figure 8 shows a graph of the usability value of each variable.

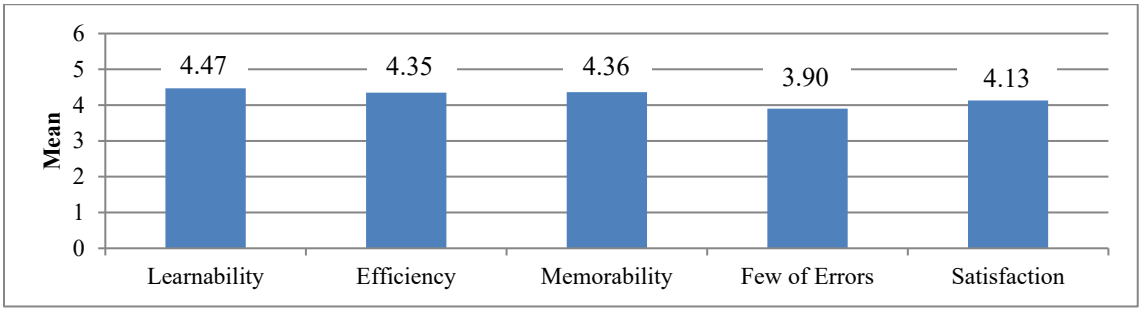


Figure 8. Usability test result of OSH-MIS

All of these variables belong to the good category. However, it can be seen that the variable few of errors has the lowest mean value. This indicates that there are still some operational errors made by the OSH committee when interacting with the system. These errors were in the form of mistakes made by users and technical errors due to the OSH-MIS website which was still under development. The errors made by users were because there were still several OSH committees who had not mastered how to use the HIRARC menu. These technical errors can be in the form of features that have not been able to function according to the directions.

According to Matera (2006), a good information system should have a low error rate. So, users will not make mistakes when using the system so as not to interfere with the task that is being done (Sulistiyono 2017). Widiatmoko and Sofyan (2015) in his research also stated that the more the error increases, the user satisfaction with the system will decrease, and the lower the error rate, the satisfaction value will increase (Widiatmoko and Sofyan 2015).

Learnability Indicator Analysis

The learnability indicator was formed by five statement items where the mean value was 4.47, where the value is included in the good category. The following Figure 9 is the graph of the usability of each statement item in the learnability variable.

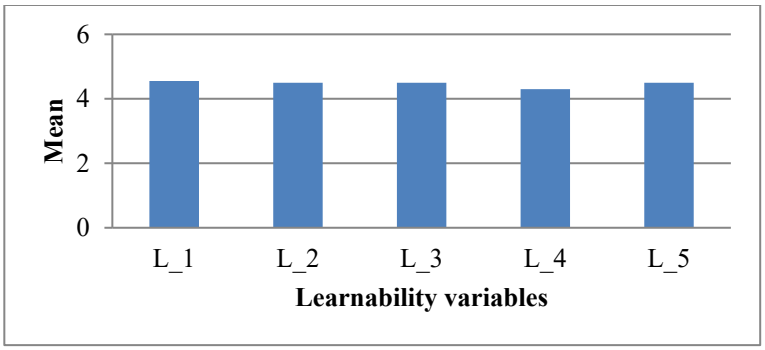


Figure 9. Usability of Learnability variable test result of OSH-MIS

Based on the graph above, it is known that the 5 statement items related to the learnability variable were in the good category. However, it can be seen that the L_4 item has the lowest mean value. L_4 is a statement item which states that the respondent obtains information from the website easily. This shows that the OSH team feels that they were still having problems obtaining information from the OSH-MIS website. Some reasons that made it difficult for the OSH committee to obtain information were because the OSH-MIS website did not yet provide documentation of information (user manual) for every menu available, especially menus that were rarely heard of like HIRARC. So, there was no information assistance to the OSH committee who were not experts on the menu. In addition, the OSH-MIS website also did not yet provide a pop-up feature that explains any menu or sentence that is difficult to understand. Thus, the users experience problems understanding the information or menus on the website. Delivering information that was clear and easily understood by users was one of the most important things in designing a website. Nielsen (2012) states that if a website fails to provide clear information from the site, the user will immediately leave the website and switch to another website (Kadafi 2016). Anggoro (2016) also stated that a good website design is a website that must be able to display information clearly so that visitors are not confused with the information displayed.

Efficiency Indicator Analysis

Based on the NAU questionnaire, the efficiency indicator was formed by three statement items and a mean value of 4.35 was obtained, which was in the good category. The following Figure 10 is the graph of the usability of each statement item on the efficiency variable.

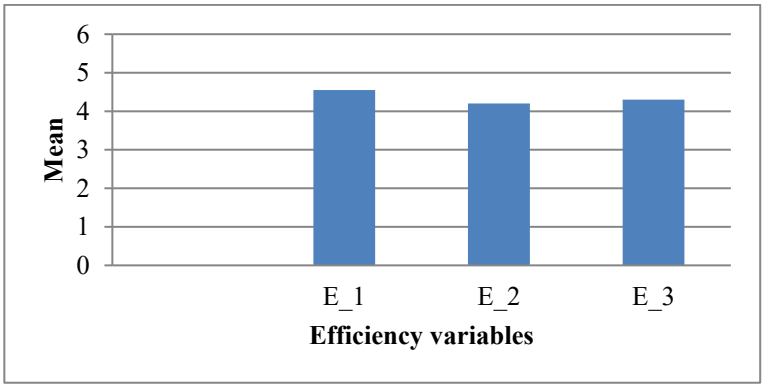


Figure 10. Usability of Efficiency variable test result of OSH-MIS

Based on the graph above, it is known that the three statement items related to the efficiency variable are in the good category. However, it can be seen that E_2 has the lowest mean value compared to other statement items. E_2 is a statement item which states that respondents got information from the website quickly. This shows that there were still OSH committees that felt it took a long time to obtain information from the OSH-MIS website. Some of the reasons that the OSH Committee team felt that they were not quick to obtain information was because the OSH-MIS website did not yet provide a search feature on several pages, such as the main page, the incident list page and the

HIRARC list page. This made the OSH committee team had to search manually, thus prolonging the search process. A website can be classified as good is a website that takes the least amount of time and steps (Ichsani 2018). In general, users want to get information quickly and as expected so they don't have time to read the website manual or try out how the available interface works (Wijaya et al. 2017). Supriyanto (2007) stated that if a site has many pages, the use of a search component (search or search engine) is needed to simplify and speed up the search for the content or information in question (Arum 2018).

Memorability Indicator Analysis

Based on the NAU questionnaire, the memorability indicator was formed by three statement items and the mean value was 4.36 which was in the good category. The following Figure 11 is the graph of the usability of each statement item in the memorability variable.

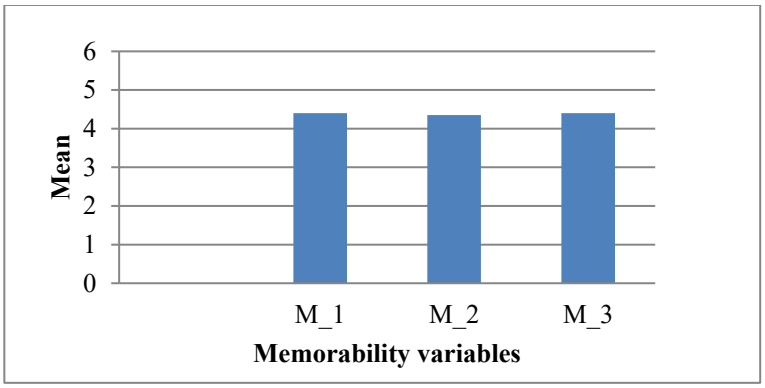


Figure 11. Usability of Memorability variable test result of OSH-MIS

Based on the graph above, it is known that the 3 statement items related to the memorability variable were in the good category and the majority of OSH committees who were respondents in this study agreed that it was easy to remember how to use the OSH-MIS website. However, it can be seen that M_2 has the lowest mean value compared to other statement items. M_2 was a statement item which stated that the respondent was able remember each menu navigation flow and the location of the desired information easily. According to Andriansyah (2016) the navigation structure can be interpreted as the flow of a program that describes the design of the relationship between different areas so as to facilitate the process of organizing all website elements (Fitriyani 2017). Some reasons that made it difficult for the OSH committee to remember each menu navigation flow and the location of the desired information easily were because the OSH-MIS website did not yet provide a pop up feature that explains every menu or sentence that is difficult to understand, so that users had to remember what to do when working on a task on the website. According to Tidwell (2006), navigation problems on a website or an application occur when users are circling to reach a destination, which is how a user knows where they are, where to go next and how to get to their destination from somewhere.

Few of Errors Indicator Analysis

Based on the NAU questionnaire, the error indicator was formed by four statement items and the mean value was 3.90 which was included in the good category. The following Figure 12 is the graph of the usability of each statement item that is on the variable few of errors.

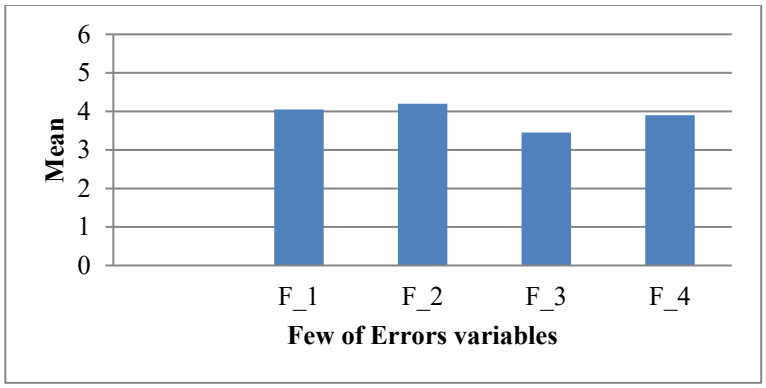


Figure 12. Usability of Few of Errors variable test result of OSH-MIS

Based on the graph above, it is known that the 4 statement items related to the few of errors variable are in the good category. However, it can be seen that F_3 has the lowest mean value compared to other statement items. F_3 is a statement item which stated that the respondent found a clear warning when an error occurs. Kincla (2003) explained that information systems must use user friendly error messages when the server cannot find the required information (Yulianti et al. 2017). There were several reasons why the OSH committee felt that they had not found a clear warning when an error occurs. This was because in reality, not all menus displayed warnings or error messages, either due to errors from the system or errors made by the user. Something can be said to be useful if usability failures can be eliminated or minimized (Handiwidjojo and Ernawati 2016). However, no information system is perfect and error-free. Khoirina (2017) stated that all messages related to errors that occur must be in a language that the user understands so that the user can understand the message.

Satisfaction Indicator Analysis

Based on the NAU questionnaire, the satisfaction indicator was formed from four statement items and a mean value of 4.13 was obtained, which was in the good category. The following Figure 13 is the graph of the usability of each statement item on the satisfaction variable.

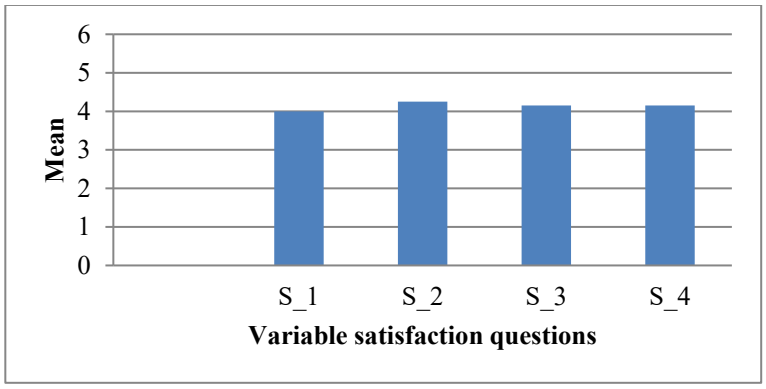


Figure 13. Usability of Satisfaction variable test result of OSH-MIS

Based on the graph above, it is known that the four statement items related to variable satisfaction were in the good category. However, it appeared that S_1 had the lowest mean value compared to other statement items. S_1 was a statement item which stated that overall the respondent felt happy with the appearance of the website design. There were several reasons why the OSH committee still felt unhappy with the appearance of the website design because the design was not attractive, and the color selection used did not describe OSH. Brown (2016) explained that color plays an important role in the design of a website (Yulianti et al. 2017). Nangpal (2014) explained that design plays a big role in influencing people's perceptions. Therefore, investing in a good design that was consistent in terms of fonts, colors, layout and language was very important. (Yulianti et al. 2017). In addition, the OSH-MIS website did not contain any pictures or ornaments that support the impression of OSH.

Recommended Improvements

Recommendations for improving the FT UNDIP Occupational Safety and Health Management Information System (OSH-MIS) website are as follows:

a. Regarding the finding of problems in the learnability variable where there are users who find it difficult to obtain information from the website, it is necessary to add documentation regarding the information on each menu, especially the HIRARC menu. This is because there are still some OSH committees who are not familiar and have not mastered how to use and evaluate the menu. This documentation is provided in order to direct the steps of using the system (Jhonson 2003) in (Ekaputri 2016).

b. Related to the problem of the efficiency variable where there are users who feel it takes a long time to find information from the website, it is necessary to add a search feature to the pages that are needed, so that it will help the OSH committee find and manage the information. This search feature will help increase user efficiency without having to do time-consuming searches (Farkas 2020) in (Leavitt 2006). The following Figure 14 and Figure 15 are the examples of the recommended interface results after adding the search feature.

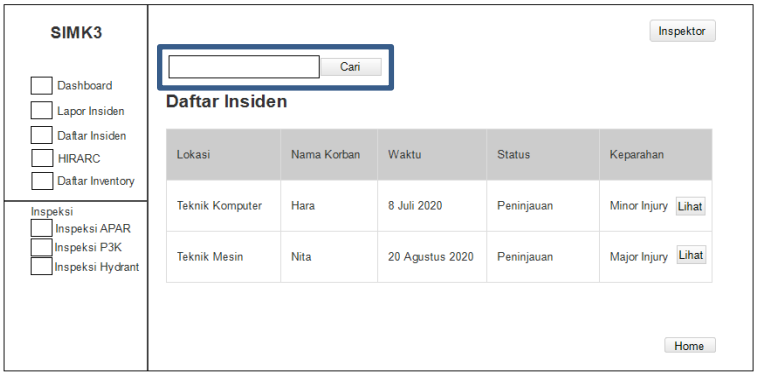


Figure 14. Recommended incident list interface

Figure 15. Recommended HIRARC list interface

c. Regarding the finding of problems in the memorability variable and few of errors, where there are still users who find it difficult to remember each menu navigation flow and the location of the desired information, and there are still users who feel they do not find a clear warning when an error occurs, it is necessary to add a pop-up menu that provides a description or alternative text as feedback when the user interacts with the system (Danino 2001) in (Sangaji 2020). In increasing usability of memorability variables, pop-up menus help users understand any existing menus or unfamiliar sentences, so that users don't have to memorize each menu or sentence. Here's an example of a pop-up menu that helps improve usability variable memorability in Figure 16.

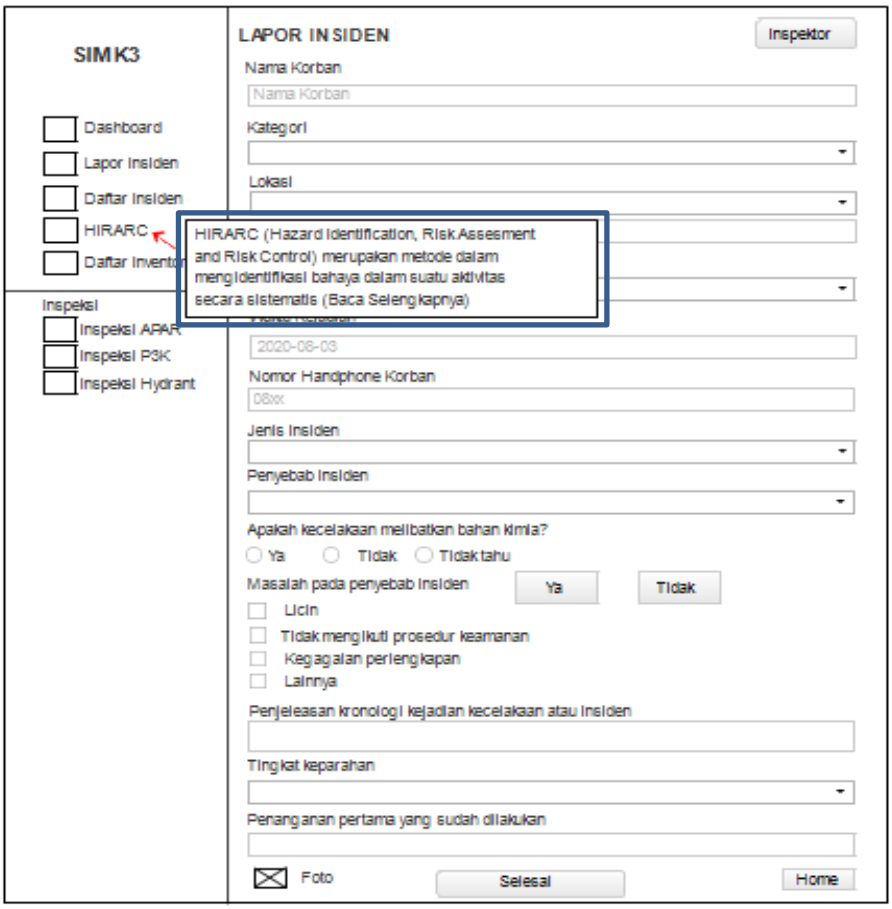


Figure 16. Recommended pop-up menu interface to improve memorability variable of usability

Meanwhile, to increase the usability variable of few of errors, it is necessary to include a pop-up menu which contains alternative text that briefly explains warnings or conditions that must be made by the user when the user makes a mistake or when the system has an error. However, in order to minimize user errors, this pop-up menu is created so that users who accidentally make mistakes can still continue the task they are doing without losing the data that was previously worked on. On the OSH-MIS website, pop-ups should be created on the menu incident report, HIRARC and equipment inspection. Here's an example of a pop-up menu that helps improve the usability of the variable few of errors in Figure 17.

d. Regarding the finding of problems with the satisfaction variable where there are still users who feel unhappy with the appearance of the website design, the OSH-MIS website design needs to be given a touch by adding ornaments, animations or images that show the purpose of the website but in portions that are not excessive, for example images related to OSH (Belson and Ho 2012) in (Aprilian 2014).

5. Conclusion

The Occupational Safety and Health Management Information System (OSH-MIS) is a website that will be used to assist the implementation of the OSHMS program in the FT UNDIP environment. Based on the results of exploration carried out through a review of the ISO 45001: 2018 manual document with the PDCA scheme and the results of an internal audit discussing the OSH findings, it can be seen that the lack of reporting media and equipment management is a problem that must be followed up immediately by the OSH FT UNDIP team. From these problems, it can be concluded that the OSH-MIS website requires an information system that can accommodate any reporting of incidents and potential hazards as well as assisting the management of inspection of existing equipment. This is the basis for creating features on the OSH-MIS website, namely incident reporting, equipment inspection (fire extinguisher and first aid kit) and HIRARC. Incident reporting is useful for collecting all information about accidents that occur in the

FT UNDIP environment. Equipment inspection (fire extinguisher and first aid kit) is useful for assisting the routine inspection process of fire extinguisher equipment and first aid kits owned by FT UNDIP. Meanwhile HIRARC is useful for gathering all information regarding dangerous conditions in the FT UNDIP environment. Prospective users of the OSH-MIS website are the OSH committee, the head of each department and the FT UNDIP general community.

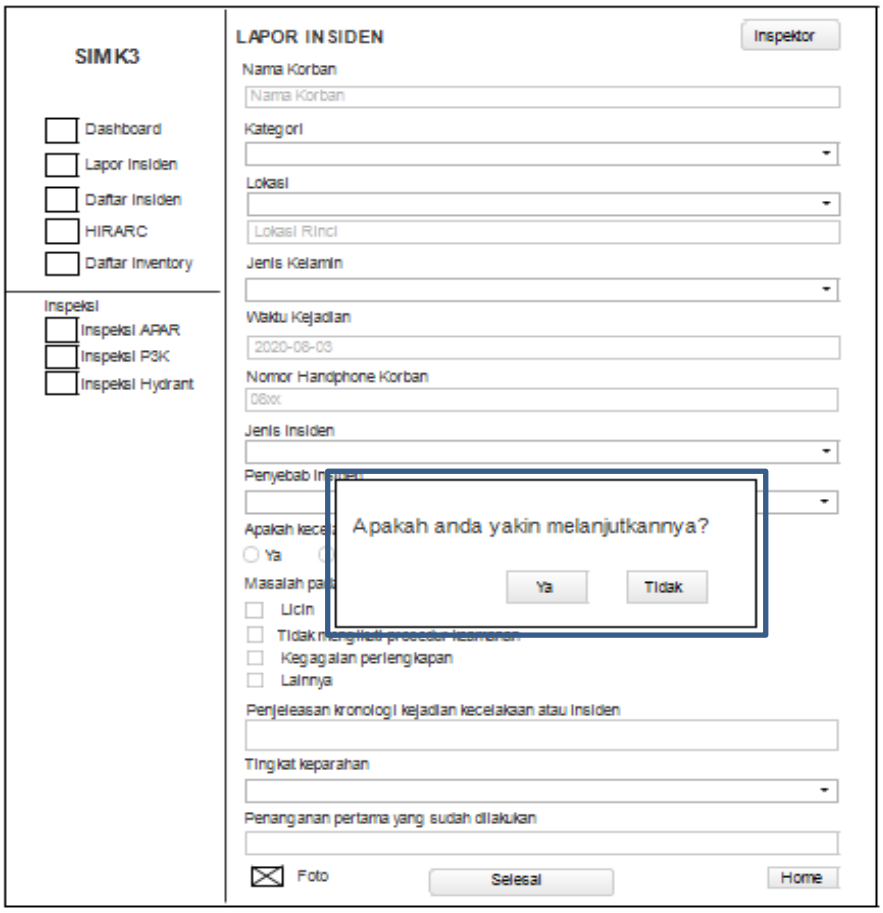


Figure 17. Pop-up menu recommendations to increase few of errors variable of usability

The OSH-MIS website usability assessment conducted on the OSH committee got a mean value of 4.24, where this value is in the good category, which explains that overall the OSH-MIS website has been assessed as good (user friendly) and able to meet every need related to OSH management in FT UNDIP. Of the five variables on the Nielsen principle, it was found that the few of errors variable had the lowest mean value. Therefore, an improvement is needed to increase the usability of these variables. Recommendations for planned improvements are to provide a pop up that provides information when the user makes an error or when the system is in error. In addition, pop ups are also provided that help users avoid errors when using the OSH-MIS website.

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