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Developing a web-based simulator for safety management system training

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ABSTRACT

ICAO Doc 9859 mandates that six stakeholders in its member countries are required to implement a Safety Management System (SMS). SMS training is required to support all personnel in the organization to ensure the achievement of an acceptable level of safety. The implementation of online SMS training since the covid-19 pandemic era provides a pedagogical challenge for the instructor, so methods are needed to stimulate the 4Cs: critical thinking, creativity, communication, and collaboration. These challenges must be faced, one of which is using a simulator media that has pedagogical advantages that not only help teachers but are also expected to enhance the student learning experience. Through Research and Development (R&D) method, starting with a literature study, observation, and interview with safety experts and training administrators result to root cause analysis (RCA) as a first stage captured a limited time in online learning and the unavailability of media to give an experiential learning atmosphere on practical safety risk management. RCA emerge to develop a web-based Hazard Identification and Risk Assessment (HIRA) application product that is integrated with safety reporting. The product presents tables and graphs that are used as evidence of formal processes in safety documentation and monitoring as real working situations. This product has a General Risk Assessment (GRA) used for risk mapping activities as well as standardized presentation materials. Validation from safety experts in the operational field-testing stage has positively given improvement tothe standard operation and user interface of the application.

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Introduction

International Civil Aviation Organization (ICAO) Doc.9859states that a Safety Management System (SMS) is a formal, top-line policy approach throughout the organization to manage safety risks and ensures the control of safety risks(Reason, 2016; Yeun, Bates, Intermodal, & 2014, 2014). These include systematic procedures, practices, and policies for safety risk management. Indonesia as a member of ICAO through Indonesia Civil Aviation Safety Regulation (CASR) Doc.19 required to implement a State Safety Program (SSP) as well as the six existing aviation safety providers in Indonesia, namely: Approved training organizations, Aircraft & helicopter operator, Approved maintenance organization, The organization responsible for the type of design or aircraft manufacturers, Air traffic service providers (ATS), Airport operators(ICAO Annex 19 2nd edition, 2016). Safety Risk Management is a key component of the safety management(Indra Martadinata et al., 2021),

starting from hazard identification, safety risk assessment, safety risk mitigation, and risk acceptance. The rapidly changing aviation environment makes this process an ongoing activity. New hazards are likely to emerge, and some existing hazards may disappear or be replaced. The safety risk mitigation strategy implemented must always be monitored to decide further actions to be taken, including an integrated system to carry out the Hazard Identification and Risk Assessment (HIRA) process, a clear and accessible Reporting System, and a safety documentation(Kirwan, Bettignies-Thiebaux, & Bolger, 2019).

Aviation personnel is anasset for a safer future, but according to (Madeira, Melício, Valério, & Aerospace, 2021)over 80%of aviation accidents are caused by human factors. That is, the ICAO and CASR state that at least an aviation personnel must have competence in the field of human factors and safety awareness to carry out their duties by training. SMS training aims to provide an explicit description of the safety management system situation from the top to the bottom of organizations by emphasizing the role of monitoring and controlling risk by all personnel.On the other hand, the implementation of online SMS training during the pandemic era provides a pedagogical challenge for the instructor(Dhawan, 2020; Sahlberg, 2021), so, methods are needed to stimulate the 4Cs: critical thinking, creativity, communication, and collaboration. These challenges must be faced, one of which is using a simulator media that has pedagogical advantages (Gilakjani, 2012; Sonsona, Talidong, & Toquero, 2021; Volery & Lord, 2000)that not only help instructors but are also expected to provide a more realistic learning experience for giving the experiential learningthat represents the real working situation(Herink, Bělohlav, Jirout, & Bělohlav, 2022; Marcano, Haugen, Sannerud, & Komulainen, 2019)also gives feedback and assessment to the student.

This research aims toimplement a web-based HIRAapplication product that provides an overview of real safety risk management integrated with safety reporting and can be accessed by all students. The product presents tables and graphs that are used as evidence of formal processes in safety documentation and safety monitoring activities with real conditions in the field. This product also has a General Risk Assessment Process simulation feature that can be used for risk mapping activities for training participants as well as standardized presentation materials.There is urgency in product development due to the unavailability of online simulation learning media that can be used by students to improve their field experience (Coman, Gabriel, Meses, Stanciu, & Cristina Bularca, n.d.; Elnasr, Sobaih, Hasanein, & Elnasr, n.d.; N.K.S. Widarini, I.N.A.J. Putra, & N.P.E. Marsakawati, 2021; Volery & Lord, 2000). The product prepares an integrated system between risk management and safety reporting system, the product can be accessed by all students, and the product produced in this study supports the implementation of a safety management system based on International Civil Aviation Organization (ICAO) standards. This application product includes the HIRA processes (Saulina, 2022), namely: a) Risk Identification, b) Risk Analysis, c) Risk Evaluation and d) Risk Mitigation. HIRA can also be widely used in aviation and is expected to assist service providers in achieving continuous improvement in the safety management(Price & Forrest, 2016).In the end, this research hopes that this application can continue to be applied in learning, especially safety management systems, and inspire teaching instructors to utilize technology in a student-centered online learning environment in the post-pandemic world to support the realization of student-centered learning. The results of the product development are also not limited to learning Safety Management System training but also targeting a wide range of users, especially aviation service providers, so the product is expected to have economic value.

Methods

Figure 1. Research and Development Method

This research goes through a Research and Development (R&D) process referred to by Borg and Gall ("Model Penelitian Pengembangan Borg and Gall (1983) - taufiq.net," n.d.) starting with research and information collecting and limited to operational. In this research, the discussion will be limited to the eight stages, which isoperational field testing that includes validation from expertsthat takes three months from March to May 2022 focusing on the development of practical media of safety risk management material on SMS Training Batch XXVII, in Poltekbang Palembang, a member ofICAO approved training organizations.

Results and Discussions

Research and Information Collecting

First Observations were made on the SMS training which was held online during the COVID-19 pandemic by the Poltekbang Palembang. It was found that the syllabus contained 4 (four) hours of theoretical and 12 (twelve) hours of practical Safety Risk Management training material. Students are directed to understand their role in the process of identifying hazards, assessing risk levels, and determining risk mitigation which is presented in groups. Participants were given an open question in the evaluation of the SMS training batch XXVII showing that the safety risk assessment material was the most useful material for increasing competence in completing their work with an evaluation value of 4.32 (very good) but constraints on time and understanding of tasks independently. Interviews with safety management system training instructors showed that the online practical was quite good, and the participants also played an active role in discussion and problem-solving. Limited time in online learning and the unavailability of online media can bring students involved in the whole process of safety risk assessment, starting from the safety reporting system, inspection roles, and safety personnel, such as safety analysts, safety managers, safety experts, as well as a safety action group and safety review board, which is a team formed and tasked with carrying out actual safety management actions.At this stage, a root cause analysis (RCA) was made to describe the result of observation and interview with the SMS Training administrator and student batch XXVII at Poltekbang Palembang.

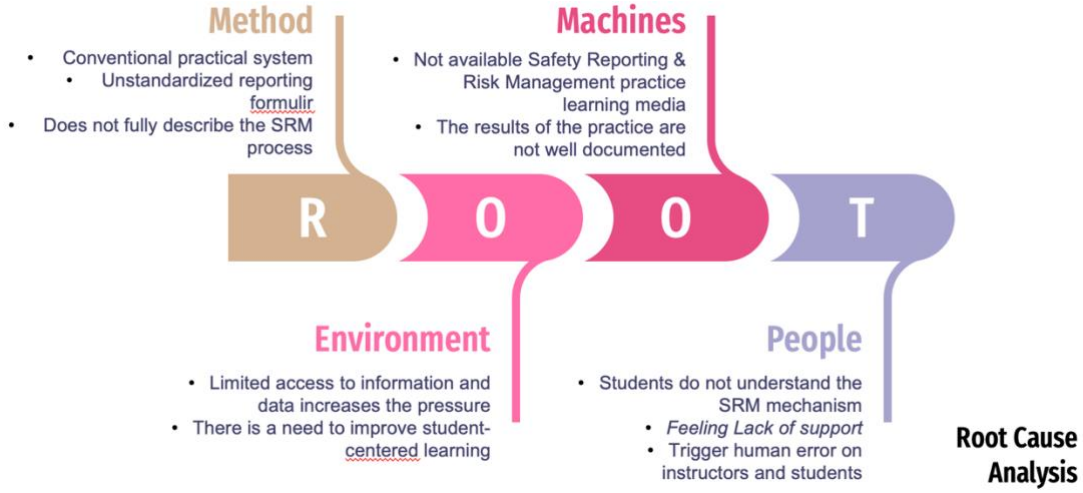

Figure 2. Root Cause Analysis

Second observations were made at the safety unit at the International Airport of Sultan Mahmud Badaruddin II (SMB II), carried out by observing available applications for reporting and risk processing with the safety unit. Observations on airport operators provide researchers with a realistic picture of risk management applications and serve as a benchmark to identify gaps between actual conditions and the applications that will be developed in the study. With these observations, researchers are expected to be able to fill in the existing flaws in the developed product, resulting in a product that meets ideal conditions according to ICAO standards.Photo documentation for the system used in SMB II is confidential and we cannot include it in the report, but from the results of the interview, it can be concluded that SMB II Airport has carried out the HIRA process and already has a management application called Integrated Risk Management System (IRIMS) which is based on ISO 31000. The risk management system is not limited to aviation safety but also the quality and Occupational Health &Safety(Roelen & Klompstra, 2012). Observation results can be seen that the process is the same as the ICAO Document 9859 and Indonesia Civil Aviation Safety Regulation(CASR) 19 standards. Managers have problems in management because the reporting system is still separate from the risk management application, so it must be selected and inputted manually by officers who currently only have 2 (two) personnel in charge.They wish to integrate the management of safety risk management with the safety

reporting system so that the input of hazard identification into the process of safety risk assessment can be managed throughout one dedicated system.

Planning Process

In general, HIRA web-based simulation design works for two activities, it is the safety assessment risk and reporting system(A. Glendon, Clarke, & McKenna, 2016; Management & 2006, n.d.; Pidgeon, 1991). This application requires input types of hazards, evaluation scales, and acceptability objectives(Cui, Zhang, Ren, science, & 2018, n.d.; Insua, Alfaro, …, & 2018, n.d.). While the expected output from this application is a set of risk mapping, root cause analysis, a list of actions needed,or risk mitigation (equipment, procedures, and training).

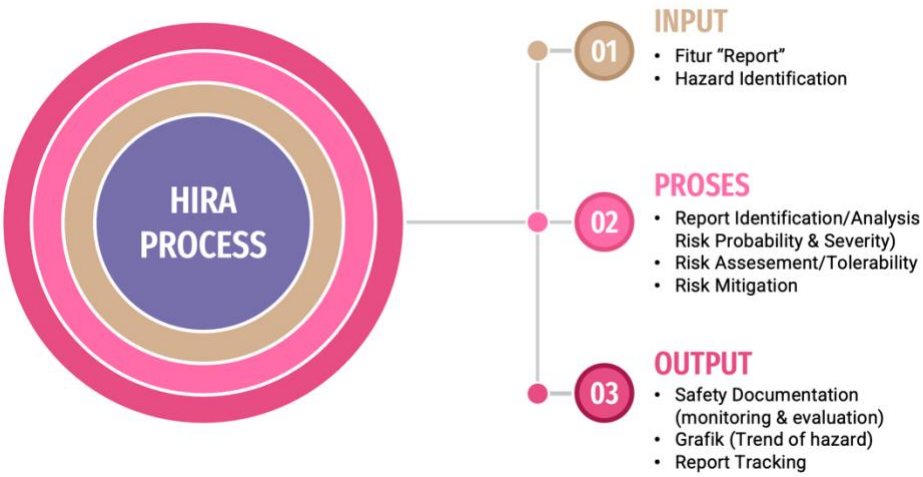

Figure 3. The flow of Safety Risk Management

The way of Online Reporting System (ORS) feature works on HIRAweb-based simulation is that reports inputted by the reporter on the ORS feature can be integrated into the HIRA system with admin approval. The reporter can monitor the status of the report and communicate with the contact us feature! And can view reports like it. In the risk assessment feature, the admin performs Input Hazard activities, Risk Analysis Matrix Severity-Likelihood Scale, Root Cause Analysis, Data Processing, Control and Reduction Action Plan, as well as reporting that can be download(Wong & Gordon, 2006). The results will be presented in the form of a table that can be downloaded as well as an attractive graph to see the HIRA trend. Another very interesting and useful feature is that the HIRA simulation feature is presented in the form of a diagram showing scenarios of hazards, how the impact of a hazard, and the things that cause an accident/incident to occur. This feature can be accessed free of charge by anyone and can be used as a medium for risk mapping practices in the Safety Management System Training and Education or for students out there, where usually Safety Management System applications can never be accessed for free.

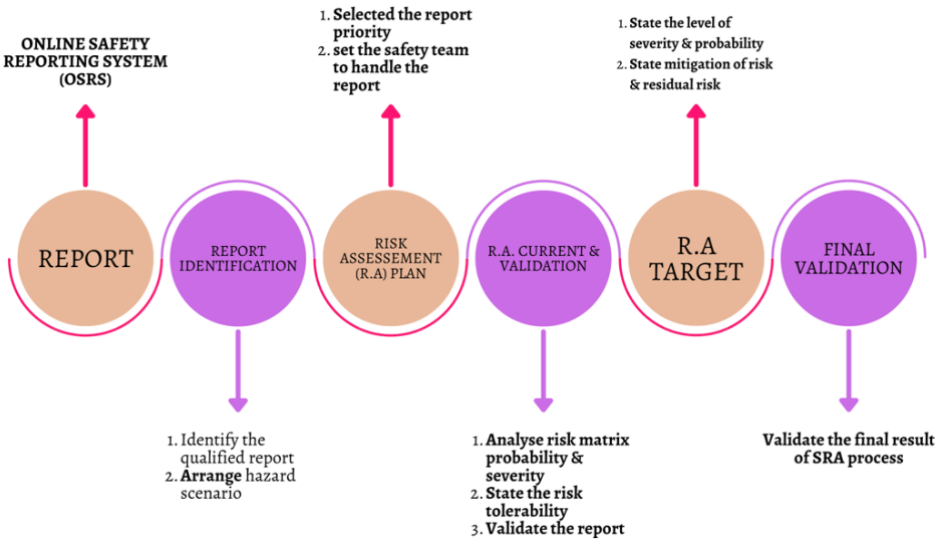

Figure 4. General Description of HIRA web-based simulation

At this stage, a plan is made at each stage in the form of a flowchart (Xinogalos, 2013)which is the formulation of the results of the first stage to produce a research framework. The product development is designed to assist instructors in conveying the objectives of the material and provide students with experience in the world of work in the safety field. The sequence of processes in HIRA is by the sequence of Safety Risk Management activities stated in the ICAO doc.9859, Annex 19, and Indonesia CASR doc.19 so that it can be concluded that it has complied with international standards and standards applicable in Indonesia.At the planning stage, it is determined that there are 3 (three) main users who will use HIRA consisting of a reporter, a safety officer, and a safety group which involved five steps of safety risk management.

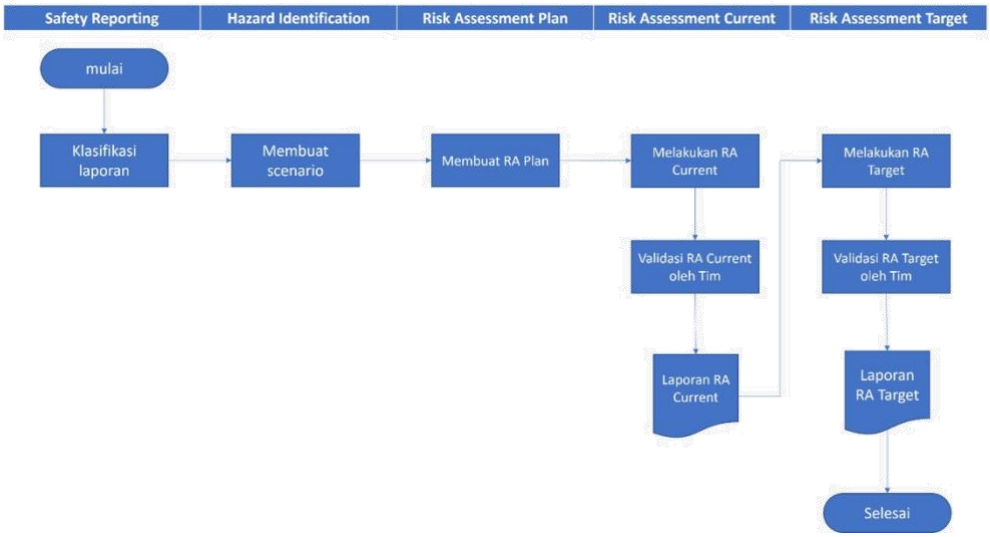

Figure 5. Flowchart of the safety risk management

At preliminary field testing,an initial field trial was carried out with the scope of the researcher who was the SMS instructor of ICAO Poltekbang Palembang, and the IT team referring to the project development framework that was prepared. Analysis using observation method with standard User Interface(Amalia, Cahyono, Septiani, & Kristiawan, 2022; Galitz, 2007; Mandel, 1997)taking into account the ICAO Document 9859 4th edition.In main product revision,this stage revises the initial product, carried out more than once with the team and programmers, according to the input on the limited trial to obtain a draft of the main product that is ready for wider trials.Operational product revision, improving the test results so that the product developed is already an operational model design that is ready to be validated as well as compiling SOPs for the final product.At the operational field-testing stage, validation tests are carried out to assess the expected performance of the product by accessing https://stars.poltekbangplg.ac.id/, login in, and operating the HIRA. The validation was carried out by Mr. Rabindra Soekarsono an ISO consultant from PT. Cakra ManunggalPratama, Mrs. Eka Justiciana, and Mrs. Paramita DwiNastiti as IATA SMS instructors, Mr. Gilang Eka Pradana as ITDeveloper Poltekbang Palembang who have attended IATA SMS training. The expert team invited the product field testing to give a product validation which was assessed from two basic aspects, it is the interface design (UI) aspect and the learning design aspect. Values with a range of 1-5 with a maximum value of 5 (five) from worst (1) to very good (5).

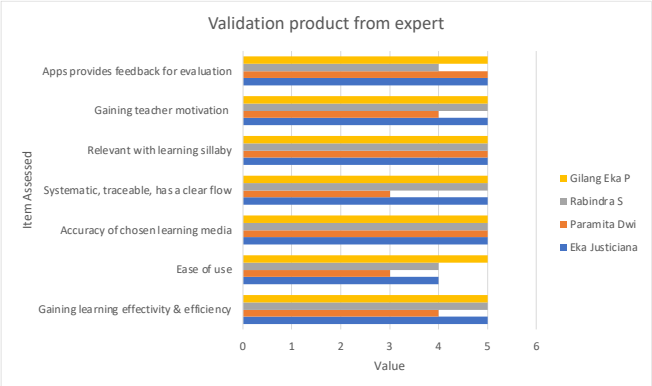

Figure 6. Validation Results

From the results of this validation interview, inputs were obtained, it is:preparing Standard Operating Procedures (SOP), developing user interfaces, and making mobile versions for ease of use. Inputs in the form of SOPs have been prepared and have been included in reference documents that can be accessed at https://stars.poltekbangplg.ac.id/reference and other inputs will be processed as a plan for developing the HIRA application in the future.

ICAO Safety Risk Management (SRM) as one of the key functions of SMS has been discussed in many works of literature since the implementation required collaborative work from bottom to top of the organization. It starts from a role of the bottomof the organization that contributes qualified reports as input to the hazard identification (HI) process which determine the next steps of risk management shown in Figure 3. The flow of Safety Risk Management. Several studies discuss of SRM(A. I. Glendon, Clarke, & McKenna, 2016; Insua et al., n.d.; Leveson, 2004; Price & Forrest, 2016; Safety & 1995, n.d.)described methods, models, and principles regarding ICAO regulations to be adapted and used as a guide in the implementation of risk management activities including a process of safety risk management. The implementation of an online reporting system has also been widely implemented both in aviation and health and so on and has been declared capable of increasing inputs in safety monitoring activities(Riaz, Parn, Edwards, …, & 2017, n.d.; Shimabukuro, Nguyen, Martin, Vaccine, & 2015, n.d.; Thomas, Schultz, Hannaford, & Runciman, 2011). Research related to safety monitoring devices that function as self-assistant in the health sector has been carried out such as (Gee et al., n.d.; Shimabukuro et al., n.d.)and in the construction sector(Riaz et al., n.d.; Sung et al., n.d.). However, we have not found any research that writes the design of data processing applications and safety risk management monitoring or Hazard Identification and Risk Assessment which is used for SMS training based on ICAO Document 9859 4th edition.

Based on previous research at PT. Angkasa Pura II found that there was no product to integrate the risk management process with the reporting system (Amalia, 2019)and the processing of data obtained from reporting was processed separately using an excel-based system (Nugraha, 2019). The Safety Reporting System also separates and is not integrated with the safety risk assessment processing system. The products made in this study have gone through a gap analysis process with field observations carried out in the first phase of research, so deficiencies in the field are expected to be corrected in this research product.

The use of various relevant learning tools is expected to maintain the activeness of students to improvethe social learning space(Elnasr et al., n.d.; Fisher & Baird, 2005; Selim, 2007). Although online learning has many advantages, it still needs to be developed, especially in aspects of interaction and learning evaluation(Bozkurt et al., 2020).One strategy that must be carried out is to use technology in online learning, which is expected to provide added value for students, teachers, and institutions.Online learning media are known as a solution for conducting training,especially in the aviation training system (Masito, Risdianto, Oka, Daryanti, & Fathurrochman, 2021; Oka, Masito, Irfansyah, Purwaningtyas, & Pramono, 2022). Technological developments have brought changes in habits and mindsets, especially for learners. The emerging technology become a solutionwhich considered effective and should be an integral part of the current student-centered learning model in this digital era (Hashim, 2018). As shown inFigure 4. General Description of HIRA web-based simulation offers experiential learning to give a picture ofthe real situation of safety risk assessment activities for participants in safety management system training, the majority of whom are aviation personnel. In the SRM simulation process, students are expected to use applications with the same format and be able toact as teamwork with a specific role as in real conditions of the risk management process as shown in Figure 5. Flowchart of the safety risk management.The outcome of this innovation is the availability of practical media to simulate real situations from safety risk assessment activities in safety management system training which presents tables and graphs that can be used as evidence of formal processes in safety documentation and safety monitoring activities. The product provides with General Risk Assessment (GRA) Process, a simulation feature that aims to conduct risk mapping activities for Safety Management System training participants. The application can also be used by all stakeholders or learners out there because this application can be accessed in general.

Conclusions

This research successfully implemented a web-based application that is integrated and accessible to all students where the product can present tables and graphs that are used as formal evidence. safety documentation processes and safety monitoring activities. This product also has a General Risk Assessment Process simulation feature that can be used for risk mapping activities for Safety Management System training participants as well as uniform presentation materials for students. The results of the expert validation of the expert team showed a positive response and the expert team's input had been followed up in the form of improving the user interface and adding standard operating procedures. Recommendations in the future, so

that the product can be used in SMS training both at Poltekbang Palembang and in other SMS training providers. In the future, the product is expected to develop according to the development plan map and can continue to be developed both in terms of features and technology.

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