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Web-based Electronic Risk Management System for Higher Education Institutions

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Abstract
A risk register is a list of risks, including mitigation steps and the responsible individuals to handle each risk. Typically, the risk register is stored in an Excel file, but this introduces problems such as ineffective collaboration, limited tracking of amendments, poor reporting, and potential security compromises. Hence, an electronic risk management system (eRMS) is introduced to provide a database. This paper discusses the development of a web-based ERMS system used in higher education institutions. It incorporated real-time updates from different geographical locations and utilised data analytics and visualisation for the dashboard and data reporting.

Keywords: Electronic Risk Management System, Risk Management, Visualisation, Web-based system

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1.0 Introduction

Risk can be described as uncertainties that may affect the organization's objectives. Typically, the risk is associated with negative consequences (Mandrakov et al., 2022; Kumar, 2021). However, risk may also lead to positive outcomes, such as improved performance, reduced costs, or accelerated timelines. According to Bobkowska (2018), positive risks are unexpected events that have favorable impacts. Risk identification involves future uncertainty and the potential to influence objectives (Kumar, 2021; Edwards et al., 2020). The role of risk management is to identify and mitigate risks that could derail the organization from its objectives. The organization needs to properly prepare for the event that may happen.

ISO 31000:2018 provides a framework for implementing risk management consistently. Figure 1 shows the risk management guidelines, which involve the risk principles, framework, and processes. Risk principles create value and protect organizations/institutions, and the risk framework is established based on the Plan–Do–Check-Act (PDCA) life cycle. The risk process

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implements risk management, including treatment, monitoring, and improvement (Dikmen et al., 2022; Neto et al., 2021). Risk management must be actionable to ensure the risks are either reduced, avoided, transferred, or accepted.

Instability in the business industry has exposed the limitations of conventional risk management systems based on table-based information (e.g., Excel). Hence, a shift towards an integrated strategy known as Enterprise Risk Management (ERM) is needed (Blanco-Mesa et al., 2019). ERM is a process for developing the overall risk management strategy (Meiryani et al., 2022; Kumar, 2021; Blanco-Mesa et al., 2019) that improves awareness of potential threats, addresses uncertainties, and manages associated risks and opportunities (Blanco-Mesa et al., 2019). Higher Education Institutions (HEIs) do not employ an automated risk management system due to financial resource constraints, limited technical expertise, and competing institutional priorities. Inconsistent risk practices across departments in the HEIs and different risk appetites hinder the organization from fully embracing the culture of enterprise risk management.

A common understanding of risk among team members depends on good communication. ISO 31000:2018 focuses on the significance of clear risk information dissemination because stakeholder decision-making often influenced by risk appetite (ISO, 2028). Risk information misreporting can occur when different individuals from different organizational roles and perspectives try to make sense of the organization's risk registers. (Ioan & Bent, 2012). Text table-based risk registers are often used, particularly in an Excel file format. The approach lacks of data visualization that can help the decision makers to see patterns, relationships and discrepancies (Chy & Buadi, 2023). Different visualization of data helps users to better comprehend the data and make decisions more effectively (Atasoy et al., 2022).

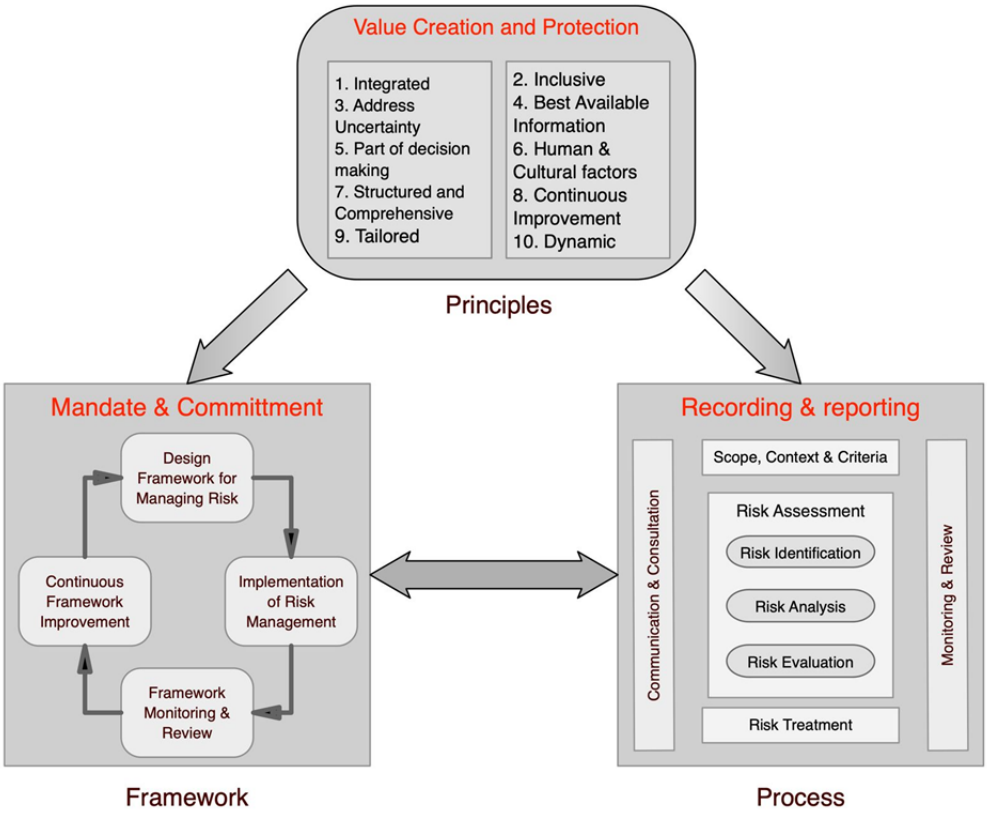

Fig 1: Block diagram of the Risk Management guideline by ISO 31000:2018
(Source: ISO,2018)

The objective of this paper is to discuss the development of an interactive dashboard that consolidates data from the risk registers and visualizes the information to help the decision makers yield insights that may not be observable using a table-like format data representation. In addition, the analytics techniques are implemented to increase accuracy and provide a simplified interface with a lower learning curve for the user. Data from the risk register will be analyzed and presented through heat maps and pie charts in order to assist stakeholders in making decisions.

2.0 Literature Review

It is crucial to identify possible risks early on in the risk management process to guarantee that they are not detrimental to the organization or escalate matters even worse. The Risk Management Unit UiTM (2023) and the Risk Management Unit UPM (2017)

indicated that Higher Education Institutions (HEIs) usually evaluate six types of risks: strategic, financial, operational, regulatory and legal, reputational, and major project risk.

Strategic risk usually focuses on the factors that may hinder the achievement of the HEIs high-level objectives. Financial risk is usually linked to monetary issues, such as financial management procedures, financial solvency, and related matters. Operational risk includes all the work processes that need to be implemented in adherence to standardized procedures, such as record safety, cybersecurity, and sensitive data handling. Legal risk refers to non-compliance with laws, regulations, contracts, or obligations that may cause the HEI to be sued, whereas reputational risk may refer to incidents that may jeopardize the good name of the HEI, such as hosting illicit concerts or hostile and racist political talk. Special project risk usually is categorized in project risk to cater for the university major project, such as developing new student living spaces or optimizing the unused lands. Risk categories can vary among higher education institutions (HEIs) depending on the priority and risk appetite.

After the risks are identified, a risk register can be constructed. A risk register is a record of the list of risks that encapsulate the identified risks. The detailed information of each risk is outlined, including its likelihood of occurrence, potential impact, and the specific actions required to mitigate it. The officer in charge of overseeing the mitigation plan is also recorded so that if the incident truly occurs, the organization can directly instruct the staff to take suitable actions immediately. The electronic data management system (ERMS) is usually used to store the organization's risk register digitally. A risk register usually comprises a risk category, the detailed risk descriptions that include root cause, background, and affected stakeholders to give risk context, and the risk severity value (Mandrakov et al., 2022). Potential risks need to be documented because the organization can use the plan for proper resource planning (manpower, monetary, facilities) for optimizing their ability to address potential challenges. Figure 2 is a snippet of a risk register (Wahid et al., 2022).

Department: Academic Affairs

Risk Register Form

Risk Identification				Risk Evaluation				Risk Controlling			Risk Monitoring		
Risk category	Risk explanation	Risk Causes	Impact of Risk	Probability of Risk	Level of Risk Impact	Risk Severity	Existing Preventive Action	Suggested Preventive Action	Risk Owner	Responsible Department /Unit	Date registered	Date Updated	Risk Status
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Operational Risk/Reputational Risk		High failure rate on critical courses	Need greater allocation of class facilities i.e college/fail to achieve universities' key performance indicator such as GOT (Graduate on Time)	4	3	12	Students' counselling	Students' Advisor Programme Additional hours of teaching for critical courses	Academic Affairs Department	Academic Affairs Department	01/01/18	31/06/18	Failure rate has been reduced. GOT percentage increase to 90%. Achive the organizational quality objective (level of risk reduced)

Fig. 2: Sample of risk register form
(Source: https:// www.assumptionjournal.au.edu/index.php/abacjournal/article/view/7001/3583)

Once the risk severity value has been determined based on the risk evaluation, a mitigation plan is outlined. The risk owner, responsible unit/department, and any existing or suggested preventative action are all recorded. Risk audit trails recorded the date the risk register was registered, the updated risk register, and the current status of the risk register for monitoring. After that, the risk management coordinator receives the form for thorough evaluation and further examination.

An effective dashboard visualization based on the risk register can help shareholders make informed decisions. The dashboard helps prevent issues from getting more severe by permitting the decision maker to make early observations of the risks' impacts. It additionally helps the decision maker to see the risk patterns in such a way that an effective backup plan to address potential future occurrences can be outlined. Data visualization has become a powerful tool that transforms data from different sources into visual representations such as charts, graphs, maps, and color (Muskan et al., 2022; Mahajan & Gokhale, 2020). The risk registers are frequently organized into an Excel list. The table-format risk register strains the user's eyes to read a lot of text, and the insights may be hidden. A visualization tool can simplify the representation of the data in the form of a small chunk, making it easier to understand. Typically, users can directly see the patterns and trends and use the data understanding to deduce insights, which in turn help the decision-making (Muskan et al., 2022).

Risk dashboards are often underutilized. Such a situation occurs because decision-makers do not understand the value of real-time risk visualization. A lot of organizations still use static reports in spreadsheets that do not allow any interactivity. Limited technical expertise of the IT staff in the organization makes the development of an effective dashboard a challenge, and buying the system on the shelf may cost a lot of money that can be used for other pressing needs. Cultural factors also contribute to the resistance to good risk management practices. In some cases, people view risk management as a compliance obligation rather than a continuous improvement process. To complicate matters, a poor integration between risk data and the organization's key performance index can

result in irrelevant dashboards. The user may reject the use of the dashboard completely. As a result, despite its potential to enhance data understanding, the risk dashboard remains an overlooked component in many enterprise risk management strategies.

3.0 Research Methodology

The agile development model is implemented for this project. The changes are made based on customer feedback iteratively until the system meets the requirements (Khan et al., 2020). The first step is requirement analysis, where a literature review on risk categories, components of risk registers, dynamic web visualization elements, and similar electronic risk management systems is conducted. This phase provides the study background, problem identification, and project scope. The next step is system design, which involves the creation of use case diagrams, context diagrams, data flow diagrams (DFDs), entity relationship diagrams (ERDs), and user interface designs. The low-fidelity prototypes are presented to the potential users in the form of online voting to gauge their preferences. The design that is voted highest is selected for development phase. The development phase is where the actual dashboard coding is performed. Subsequently, a testing phase is conducted to test the functionality and user acceptance. The final documentation is then completed to provide the user with a user manual and technical support.

3.1 Requirement analysis

During the initial phase of requirement analysis, an instructional video made by a local college offered some helpful details about risk management. The video explained the way to register risks in a way that works. Various roles are identified as system users, such as department heads, unit heads, and staff members. A risk meeting is organized to find and assess the potential risks to be included in the risk register. In team meetings, each risk that has been identified will be examined closely at and discussed. The team will have an in-depth discussion to develop and implement mitigation strategies to minimize the risk's impact. Different perspectives from different team members can enrich the discussion and provide optimal solutions. Once consensus is reached, the list of risks is registered in the risk management system. The system should let users create, read, update, and delete (CRUD) the risk register. The risk owner is notified to approve or reject the risk register because they are the individuals who hold direct responsibility for managing the identified risks within their respective areas. Accountability is one of the focuses of the ISO 31000:2018. Direct channel of communication allows minimal risk of delays, mistakes, or confusion of the respective person in charge and the mitigation actions.

3.2 Data collection

The data for this project were obtained from an anonymous financial-sector company that operates in 12 departments. The data that was collected is publicly available online at (https://anyflip.com/homepage/xinmp/). 75 identified risks are studied. The attributes of the data consist of a risk description, risk owner, the risk impact score, the current action control, the additional action control, and the department. However, information on risk mitigation is excluded. To address this gap, additional simulated data is incorporated to complete the study. Although the simulated values may not fully represent real risk conditions, they allow the analysis to proceed by offering preliminary insights into possible trends and behaviors. This will enable shareholders and the risk management unit to assess the risk impact levels before and after the execution of the mitigation plan and to provide valuable insights on these strategies.

3.3 System design

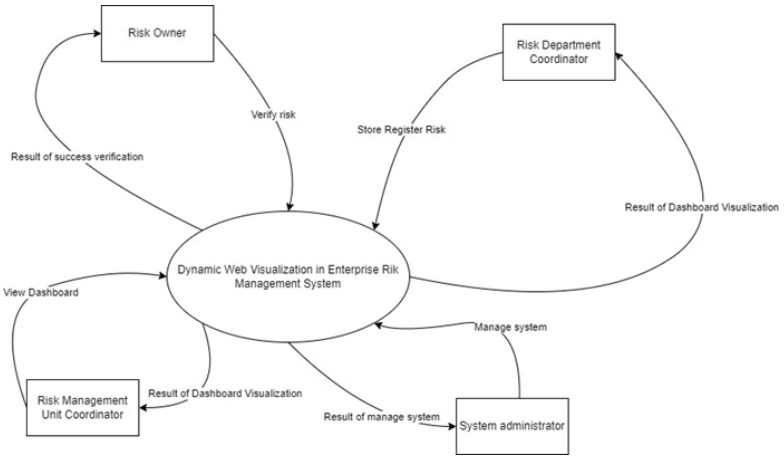

Fig. 3: Context Diagram of the proposed system

System design provides the developer with the data flow, database, and user interface. A case diagram illustrates the interactions between users and the system by outlining functional requirements. Context diagrams and data flow diagrams are employed for data flow design. A Context Diagram provides a high-level view of the system, depicting its boundaries and interactions with external entities. Figure 3 depicts the project's Context Diagram. The system administrator is allowed unrestricted access to all database functions. It allows the creation of RMU and user account permissions and configuration. The Risk Management Unit coordinator may

oversee the entire university risk register. The role analyzes and summarizes the risk registers gathered from the various departments/faculty/and units for university-level reporting. The Department Risk Officer is responsible for inputting the risk list gathered from the departmental meeting into the system. Once the risk is registered, the Risk Owner must be informed and verify it. The process ensures that the risk list is approved in the meeting.

The Data Flow Diagram illustrates how the data is processed within the system. Figure 4 presents a sample of the Data Flow Diagram for the Risk Management Unit Coordinator. An Entity Relationship Diagram (ERD) is used in database design to show the relationships between entities and their attributes. It is important to visualize the database structure. The user interface design is also provided to depict the proposed interface so the user can agree upon it before developing the proposed system.

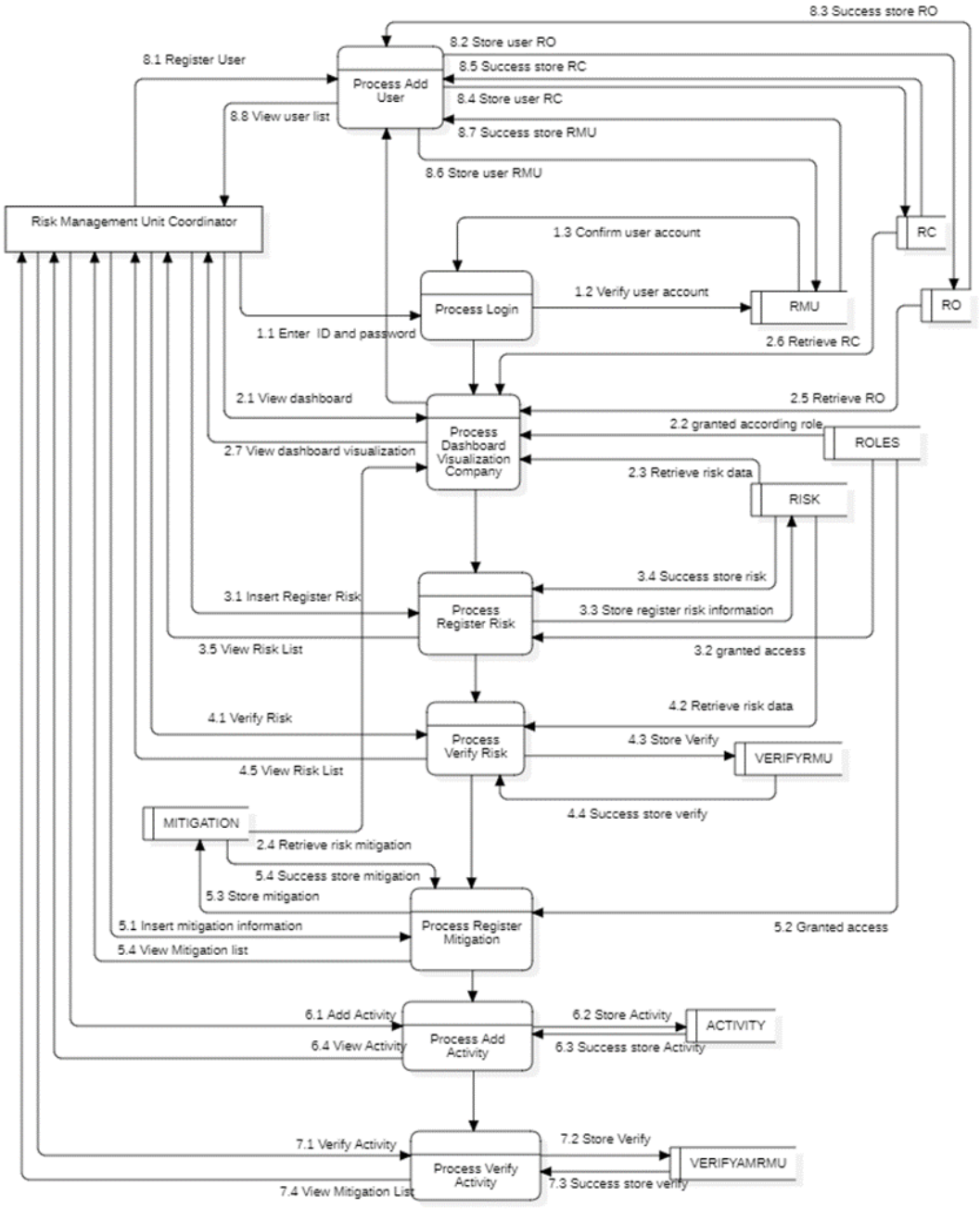

Fig. 4: Data Flow Diagram for Risk Management Unit Coordinator

3.4 System development

A combination of technologies is employed to build the web design platform and visualization charts. The development utilized the Hypertext Markup Language (HTML) for structuring the web pages, Hypertext Preprocessor (PHP) for server-side scripting, Cascading Style Sheets (CSS) for styling and layout, and JavaScript (JS) for interactive elements and dynamic features. The risk data and user information are managed in a MySQL database, with XAMPP software facilitating connections between the web pages and the local database. The visualization charts are created in real time and based on the data obtained in the database. The development

processes are iteratively improved to fulfill user requirements.

3.5 Testing, Implementation, and Evaluation

There are several tests that are conducted in the testing phase, including:

- Functionality: Ensuring the web system can effectively store, add, and update risk data.
- User Authentication: Verifying successful login with appropriate user roles.
- Account Management: Checking the system's ability to add, update, or delete user accounts and roles.
- Risk Calculation Accuracy: Validating the precision of risk severity, risk impact, and risk probability calculation.
- Visualization Relevancy: Ensure that the visualization charts correctly represent risk data.

Moreover, a system integration test is also conducted to ensure visualization charts are displayed correctly on a single dashboard based on user roles and departmental or unit needs. The last step of the evaluation will check the system to make sure it meets the needs of the business. After the system passes the evaluation test, a full final report is made.

4.0 Results and Discussion

The development of a web-based Electronic Risk Management System (ERMS) includes the main risk management process. The user access is granted based on the individual roles. A straightforward interface is created to limit information overload. Figure 5 depicts the registered list in the system from the Risk Management Unit's perspective. The date and RiskID are provided to simplify cross-checking if needed. Users can choose to view the details of the risk item as presented in Figure 6. The user can access the mitigation plan and the activity directly. The system can also capture the additional activities for a single risk item. Such a situation arises because a risk item that requires multiple active actions to improve can evolve. Continuous assessment of mitigation strategies is needed to account for new information, changes in external and internal factors, and the effectiveness of existing measures. Capturing the changes provides an audit trail and pattern of the suitability of the selected mitigation plan.

Fig. 5: Sample of the risk register

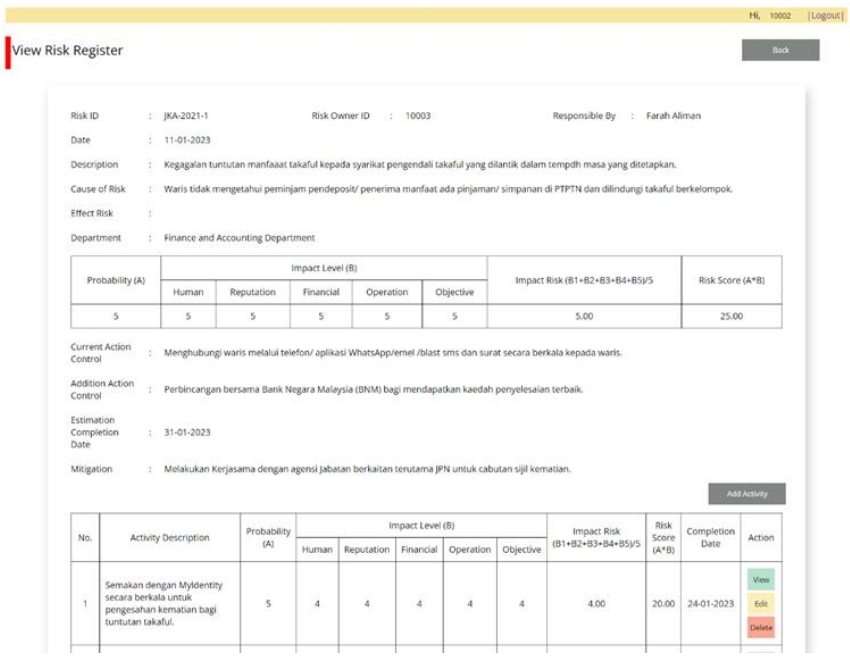

Fig. 6: Sample of detailed risk register with updated mitigation

The main functionality of the proposed system is the visualization in the dashboard, as illustrated in Figure 7. The heat map provides an overview of the organization's risk landscape. Different colors indicate different levels of risk severity. The number in the risk heat map indicates the number of risk registers within the range. Top management can zoom in on prioritizing risk. The word cloud highlights the most frequently mentioned risks or keywords. The highly mentioned word would be larger and denoted by brighter colors. The user can see the trend within the risk register across the department. Finally, the donut chart shows the risk register status of either done, completed, progressed, or pending. It allows a quick assessment of the risks that still need action and gives overall risk management the urgency to act.

A dashboard is crucial for a risk management system because it provides a centralized view of key risk metrics and insights that enable quick decision-making. Moreover, the dashboard allows for real-time risk tracking, enhancing situational awareness. Communication between stakeholders is also improved because complicated data is simplified. The dashboard also facilitates proactive management by identifying rising risk areas and items requiring focus. Hence, dashboard visualization is a must for ERMS.

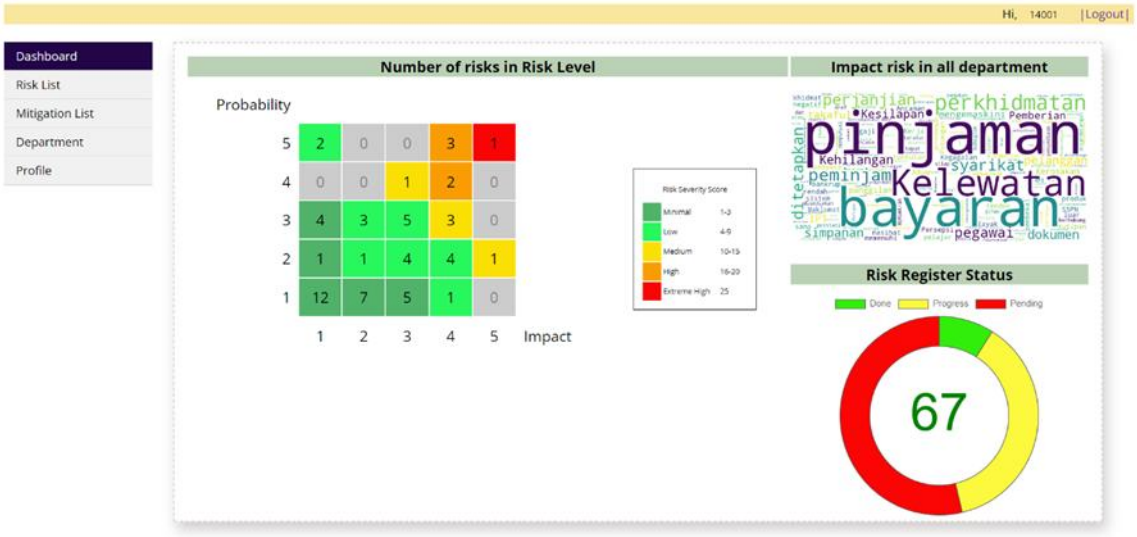

Fig. 7: Sample of detailed risk register with updated mitigation

5.0 Conclusion and Recommendation

Many companies, especially the Institute of Higher Education, often neglect the need to implement risk dashboards because manual reports or spreadsheets are still in use, and the understanding of centralized, visual tools is still minimal. To complicate matters, the lack of budget to develop such a system is always a stumbling block for the organization in realizing the full potential of a comprehensive computing system.

This paper explicitly describes the development of ERMS and demonstrates its significant potential for visualizing risk data. The paper contributes to the development of a functional prototype of a risk dashboard that combines visual analytics (e.g., charts, heat maps) with underlying data processing techniques that can be adopted to represent risk reports to Higher Education Institutions. This approach simplifies data understanding because the visualization dashboard can summarize and convey the important risk register information that is not feasible in table-based text risk reporting. The simple and intuitive design interfaces follow minimalist rules by focusing on the most important information and making it easier to see. Promptly identifying and dealing with risks keeps the organization stable, prevents financial losses, and safeguards its reputation. However, this paper only explored heat maps, donut charts, and word clouds for the dashboard. Such implementation may oversimplify intricate risk data. The selection of visualization tools in this paper may not be able to show how risks change over time or how the risk trends change.

For future research, the project aims to combine the JavaScript and PHP for word cloud generation. This approach will allow word clouds to be dynamically generated in real time. It is also beneficial to make the word cloud more interactive by adding clickable words to display more information. In addition, the heat map should also be improved in a more flexible and personalized way by allowing users to change its size to fit the needs of their organization.

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References

Bishop, K., & Said, I. (2017). Challenges of Participatory Qualitative Research in a Malaysian and Australian Hospital. *Asian Journal of Environment-Behaviour Studies, 2*(4), 1–11.

Collado, S., & Corraliza, J., A. (2017). Children's Perceived Restoration and Pro-Environmental Beliefs. *Journal of ASIAN Behavioural Studies, 2*(2), 1-12.

Fachinger, J., den Exter, M., Grambow, B., Holgerson, S., Landesmann, C., Titov, M., et al. (2004). Behaviour of spent HTR fuel elements in aquatic phases of repository host rock formations, 2nd International Topical Meeting on High Temperature Reactor Technology. Beijing, China, paper #B08.

Atasoy, G., Ertaymaz, U., Dikmen, I., Birgonul, M. T. (2022). Empowering Risk Communication: Use of Visualisations to Describe Project Risks. Journal of Construction Engineering and Management, 148 (5). ISSN 0733-9364 doi: https://doi.org/10.1061/(ASCE)CO.1943-7862.0002265.

Blanco-Mesa, F., Rivera-Rubiano, J., Patiño-Hernandez, X., & Martinez-Montaña, M. (2019). The importance of enterprise risk management in large companies in Colombia. Technological and Economic Development of Economy, 25(4), 600-633. https://doi.org/10.3846/tede.2019.9380.

Bobkowska, A. E., (2018). "Positive Risk of Creativity in Software Projects: an Expected Result, a Threat or an Opportunity?". 11th International Conference on Human System Interaction (HSI), Gdansk, Poland, 2018, 352-355, doi: 10.1109/HSI.2018.8431364.

Chy, M., & Buadi, O. (2023). Role of Data Visualisation in Finance. American Journal of Industrial and Business Management, 13, 841-856. doi: 10.4236/ajibm. 2023.138047.

Dikmen, I., Atasoy, G., Erol, H., Kaya, H. D., & Birgonul, M. T. (2022). A decision-support tool for risk and complexity assessment and visualisation in construction projects. Computers in Industry, 141, 103694. https://doi.org/10.1016/j.compind.2022.103694.

Edwards, P. J., Serra, P. V., & Edwards, M. (2020). Managing Project Risks. First Edition. John Wiley & Sons Ltd. Retrieved May 10, 2023, from https://books.google.com.my/books?hl=en&lr=&id=p1KsDwAAQBAJ&oi=fnd&pg=PP2&dq=Edwards,+P.+J.,+Vaz+Serra,+P.,+%26+Edwards,+M.+(2020) .+Managing+Project+Risks. & amp; ot = DPF_UEizCm&sig=MUFtLOfYniEvwgHAmSnzyOEEsjY #v=onepage&q&f=false.

Ioan, M., & Bent, D. (2012). Risk Management in Collaborative Systems. InTech. doi: 10.5772/50844

ISO (2018). Risk management — Guidelines ISO 31000:2018. (2nd digital ed.). Retrieved April 10, 2023, from https://shahrdevelopment.ir/wp-content/uploads/2020 /03/ISO-31000.pdf.

Khan, M. E., Shadab, S. G. M., & Khan, F. (2020). Empirical Study Of Software Development Life Cycle And Its Various Models. International Journal of Software Engineering,8,16-26. https://www.cscjournals.org/library/manuscriptinfo.php?mc=IJSE-169

Kumar, S. (2021). Risk Management and Enterprise Risk Management. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3891339.

Mahajan, K. N. & Gokhale, L. A. (2018). Comparative Study of Static and Interactive Visualization Approaches. International Journal on Computer Science and Engineering (IJCSE), 10, 3. https://doi.org/10.21817/ijcse/2018/v10i3/181003016.

Mandrakov, E. S., Dudina, D. A., Vasiliev, V. A., & Aleksandrov, M. N. (2022). Risk Management Process in the Digital Environment. International Conference on Quality Management, Transport and Information Security, Information Technologies (IT&QM&IS), Saint Petersburg, Russian Federation, 108–111. doi: 10.1109/ITQMIS56172.2022.9976622.

Meiryani, M., Angeleus, M. E., Nahason, J., Lindrianasari, L., Hadipoespito, M. W., & Kresnandita, S. P. (2022). Impact of Enterprise Risk Management Implementation on Fraud Control in Small and Medium Enterprises. In Proceedings of the 2022

Muskan, Singh, G., S., J., & Prabha, C. (2022). Data Visualisation and its Key Fundamentals: A Comprehensive Survey*. 2022 7th International Conference on Communication and Electronics Systems (ICCES), 1710-1714.

Neto, A., Perkusich, M., Dantas, E., Ramos, F., Costa, A., Almeida, H., & Perkusich, A. (2021). Knowledge-based Risk Management: A Systematic Literature Review. In Proceedings of the XXXV Brazilian Symposium on Software Engineering (SBES '21). Association for Computing Machinery, New York, NY, USA, 320–329. https://doi.org/10.1145/3474624.3474635.

Unit Pengurusan Risiko UiTM (2023). Panduan Pengurusan Risiko Universiti Teknologi MARA. Retrieved June 10, 2023, from https://penang.uitm.edu.my/images/risiko /Rujukan/Panduan_Pengurusan_Risiko.pdf

Unit Pengurusan Risiko, UPM.(2017). Garis Panduan Pengurusan Risiko UPM. Retrieved May 10, 2023, from https://pspk.upm.edu.my/upload/dokumen/ 20211216100937GARIS_PANDUAN_PENGURUSAN_RISIKO_UPM.pdf

Wahid, K. A., Marzuki, M. M., Rosman, M. R. M. Zawawi, M. Z. M. (2022). The Effectiveness of Electronic Risk Management System (ERMS): A Study in Malaysian Higher Learning Institution. ABAC Journal, 42(4), 153–167.

Weichselbraun, A., Hörler, S., Hauser, C., & Havelka, A.(2020). I am classifying News Media Coverage for Corruption Risks Management with Deep Learning and Web Intelligence. In Proceedings of the 10th International Conference on Web Intelligence, Mining and Semantics (WIMS 2020). Association for Computing Machinery, New York, NY, USA, 54–62. https://doi.org/10.1145/ 3405962.3405988.