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DEVELOPMENT OF AUGMENTED REALITY APPLICATION IN TOPIC OF SMART TRAFFIC SIGN FOR SUPPORT AN EXAMINATION OF DRIVER'S LICENSE

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ABSTRACT - The objectives of this research were: 1) to develop and assess the quality of the augmented reality application called Smart Traffic Sign, 2) to compare the academic achievement of learners before and after using the Smart Traffic Sign application, and 3) to evaluate the level of satisfaction among users of the augmented reality application. The target population consisted of individuals who had not yet taken the driver's license exam and were under 60 years old in Rangsit Subdistrict, Thanyaburi District, Pathum Thani Province. The sample group comprised 30 individuals who had not yet taken the driver's license test and were under 60 years old. The tools used in this research included the Smart Traffic Sign augmented reality application, quality assessments from content and learning technology experts, academic achievement tests, and satisfaction questionnaires. The reliability of the learning outcome test was analyzed using Kuder-Richardson's KR-20 formula, while the content accuracy was evaluated for its suitability in the learning process, determining the level of difficulty (p) and classification power (r). The statistical methods used in the research included mean, median, and standard deviation. According to the study results, the quality assessment of the Smart Traffic Sign augmented reality application indicated that the learning outcomes after using the application were statistically significantly higher than before, at the level of .05. The average score was 4.60 with a standard deviation of 0.33, while the average score before was 4.47 with a standard deviation of 0.30. The overall average score was 4.53, with a standard deviation of 0.49.

Keywords: Augmented reality, Application, Smart traffic sign, Driver's license

1. INTRODUCTION

Nowadays people who use vehicles in commuting on roads whether bicycles, cars, public busses, all of those must own their driving licenses by attending some training courses and learning how to drive different vehicles from the Department of Land Transport which takes 2 days in total and the staff of the Department of Land Transport will hand over the all-in traffic signs book and fundamental traffic rules for

them to read in which the test, the 50 items will be randomly selected from the traffic signs and traffic rules book which are alternative tests with choice A-D choices with the 45% of the passing score or equivalent to 90% of the written test and the off-site training of the Department of Transport. There is an application for the applicants to do a trial test, while the problem of teaching using the traffic signs for knowledge purposes lacks the quality of enabling some applicants to understand the lessons. If only traffic signs are implemented in the curriculum, the practical lessons may not be condensed enough. Hence, the organizer team ought to add some more interesting materials using Augmented Reality, such as video, 3D motion pictures, etc., to arouse the learners' interests rather than the slides for the learning.

The technology and the communication has some abrupt advancement in human's daily lives in which computers play a role in living with the Augmented Reality which is the technology blended with the world of the reality with virtual via some devices such as Webcam Camera of a computer, phones, Smart phones or tablets, special glasses for scanning the destined objects such as a book, notebook, pictures, etc. for the media being responded to the user and the user will be able to see the pictures of the objects both in 3D or 2D or in a video form which is overlapped with the media background through the computer screen, phone, smart phones, or special glasses. AR, the abbreviation of 'Augmented Reality', is the adaptation of the graphic pictures from a computer, both in 3D and 2D forms or in a video, to overlap with the real-time background. Augmented Reality is the technology of 2010 which combines the Reality into Virtual via some devices such as phone cameras, computers, etc., together with different software which enables a 3D 360-degree visible of the seen objects on the screen, whether it is an object (people, animals, beasts, spaceship). Hence, the researcher has a concept in creating the 'Smart Traffic Sign' augmented reality application due to the increase of the emerging in the daily life of the augmented reality technology whether applications, various media nowadays which have been presented using Reality Technology to help the learners and to give knowledge about traffic signs in a modern platform which is also interesting which includes the contents of different traffic signs and related video clips. From the mentioned background information and the significance of the problems, it is suitable for those who are interested and those who have no time to study in an institute that provides lessons concerning traffic signs.

Objectives of the research

1. To develop the 'smart traffic sign' augmented reality application.
2. To evaluate the quality of the 'smart traffic sign' augmented reality application.

3. To compare the learning achievement among learners before and after learning with the ‘Smart Traffic Sign’ augmented reality application.
4. To study the satisfactory level of the ‘smart traffic sign’ augmented reality application.

The scope of the procedures

1. The area of the content: Content creation of the ‘smart traffic sign’ augmented reality application to present the information and the details of the 13 different traffic signs.
2. The area of the media: Being able to adapt the ‘smart traffic sign’ augmented reality application into daily lives, and being able to work on devices with higher than Version 3.0 of Android Applications.

The definitions of the research

Augmented reality (AR) is a technology that emerges with the world of Reality with the Virtual World via devices such as Webcam Cameras, phone cameras, computers with using different software enabling the users to be able to see the pictures in forms of objects such as people, animals, stuffs, beasts, spaceship, etc. displaying in the screen of the floating 3D objects over the surface.

Instructional Media

‘Media’ refers to the medium that transfers or brings knowledge in different forms from the senders to the receivers to understand the same meaning. ‘Instructional Media’ refers to different objects, which are humans, materials, and devices, as well as the techniques or methods that are the medium enabling the learners to reach the assigned learning objectives easily and quickly, which is important in learning and teaching procedures.

Benefits gained

1. To be able to develop the skills, the process of making the ‘smart traffic sign’ augmented reality application will be the guideline for media development for those who are interested.
2. To trial the materials of augmented reality to support those who lack the knowledge of traffic rules or those who desire to have a self-study about the law or traffic signs.
3. To create works from ‘unity and Autodesk Maya Program’ and to practice oneself in using the said program, and to have knowledge for additional materials making.

2. MATERIALS AND METHODS

2.1 Population and the sample

1. The population in the research consists of the people who had not yet taken the driver's license and were under 60 years old.
2. The research sample consisted of 30 people without a driving license and who were under 60 years old, selected by a purposive sampling method. The reason for selecting only 30 people is that this group consists of elderly individuals who lack the ability to see and control vehicles, thus they require special training.

2.2 Research Instruments for research procedures

The research instruments for the research procedures are as follows.

1. The 'smart traffic sign' augmented reality application for those who had not taken the driving license and were under 60 years old. They were also able to learn and review as they desired.
2. The same ten items of the four-alternative pre-tests and post-tests of the online lessons to assess the learning before and after using for those without any teaching licenses and who were under 60 years old to evaluate the test results on the traffic signs both before and after the lesson.
3. The satisfaction questionnaire is a survey for those without any driving license and who were under 60 years old toward the 'smart traffic sign' augmented reality application.

2.3 Instrument Creation Procedures

2.3.1 The procedures for creating the 'smart traffic sign' augmented reality application media are as follows:

- 2.3.1.1 Meeting with the teacher teaching at the advance Saimai driving school
- 2.3.1.2 Studying the information and details concerning 13 traffic signs
- 2.3.1.3 Studying the theory of the 'smart traffic sign' augmented reality application media by studying details as well as methods of the 'smart traffic sign' augmented reality application media development
- 2.3.1.4 Defining the learning objectives of the lesson and defining the content to be a guideline for creating the 'smart traffic sign' augmented reality application media. The author team has analyzed

and defined the content for creating the media and has been advised by the advisee and experts, as well as to be trialled for the correctness of the content and appropriateness, which was ready for comments

- 2.3.1.5 Writing a Story Board which comprises contents, descriptions, examples, tests, and consulting with the advisee and submitting to the experts for the content to be checked and corrected
- 2.3.1.6 Developing the improved model version of the storyboard augmented reality into the learning media and submitting it to the experts for quality assessment
- 2.3.1.7 Submitting the invented ‘smart traffic sign’ augmented reality application media to the experts of instructional media development to be checked and its quality to be assessed another time before another revision after suggestions
- 2.3.1.8 Handing over the revised media to the sample group of 30 students
- 2.3.1.9 Improving the media after another suggestion
- 2.3.1.10 Analyzing the research result with the sample to find the efficiency result

2.4 After using the ‘smart traffic sign’ augmented reality application Pre and post-test making

- 2.4.1 Studying the principles and theories about test making from the documents and textbooks about assessment and test making
- 2.4.2 Studying the content and the learning objectives of the learners who had not taken any driving license and were under 60 years old
- 2.4.3 Making a test to cover the content and the learning objectives. The test is a 15-item multiple-choice test with four alternatives
- 2.4.4 Submitting the test to experts for content reliability and having the test evaluated by analyzing the index of item-objective congruence (IOC) to assess its alignment with the objectives. The test should be considered valid if the congruence value is 0.5 or higher
- 2.4.5 Submitting the test for improvement based on additional suggestions from the experts
- 2.4.6 Marking the tests by awarding one point for each correct answer, and assigning zero points for incorrect answers, unanswered questions, or instances where multiple answers are selected
- 2.4.7 Administering the research instrument to the 30 sample participants

2.5 The process of creating a satisfaction evaluation form following the participants' use of the 'smart traffic sign' augmented reality application.

- 2.5.1 Studying the process of making a satisfactory evaluation form
- 2.5.2 Defining the pattern of the satisfaction evaluation form, which uses a five-point Likert scale with the following levels: Very Satisfied, Satisfied, Neutral, Fair, and Improvement Needed. The corresponding scores are 5, 4, 3, 2, and 1, respectively
- 2.5.3 Submitting the completed satisfaction survey form to experts in assessment and evaluation to determine the IOC (Index of Item-Objective Congruence) value and making any necessary revisions based on their suggestions.
- 2.5.4 Collecting the satisfactory survey forms from the learners and using the actual ones with the research sample. Statistical Analysis: Conduct Cronbach's Alpha to measure the reliability of the satisfaction questionnaire.

Procedural Steps and Data Collection

The procedural steps of making the 'Smart Traffic Sign' augmented reality application

1. Preparational Steps: Analyzing the target group, which includes those who had not taken any driver's license and were under 60 years old. The criterion of the analyzation is the easily usable for the learners, without any complications and provides the correct content concerning traffic signs for the efficiency of the application.
2. Designing Step Procedures: Defining the learning objectives for the 'Smart Traffic Sign' augmented reality application and designing the application content for mobile learning on the Android platform, specifying the scope of the content, and creating a storyboard that includes the content, descriptions, and assessments aligned with the learning objectives as well as consulting with the advisor, then submitting the content to traffic signs and traffic rules experts for accuracy and revise it accordingly.
3. Program Creation Procedures: Using the created Story Board, which was approved by the experts, to build the supplementary virtual reality on the Android Application with the instruments of Application creation mentioned in Chapter Two.
4. Evaluation Procedures: Submitting the finished application to the content experts to check for the correctness and appropriateness of the application and to revise.

5. Improving Procedures and Information Sharing: Conducting a trial of the ‘Smart Traffic Sign’ augmented reality application with the sample group and analyze the results afterwards.

2.6 Information Collection: The details of the procedural steps and data collection were followed.

- 2.6.1 Submitting a permission letter and informing the director of Advance Saimai Driving School about the trial of the ‘smart traffic sign’ augmented reality application. The trial involved 30 research participants, all of whom did not have a driving license and were under 60 years old. The trial took place at the 13th-floor Operation and Common School building, which served as the experimental venue.
- 2.6.2 The experimental procedures were
 - 2.6.2.1 Informing the sample group that the experiment was held in September 2024
 - 2.6.2.2 Preparing the operational room and installing the ‘smart traffic sign’ augmented reality application into the smartphones
 - 2.6.2.3 Conducting a trial of the ‘smart traffic sign’ augmented reality application with the sample group, using the application for the experiment. Afterwards, evaluating the participants' satisfaction using the satisfaction evaluation form for the mobile learning application, with feedback from the 30 participants
 - 2.6.2.4 Analyzing the result of the gained information.

3. RESULTS AND DISCUSSION

3.1 The Development Result of the Application on the Android Operating System

The details of the work in the application development of the ‘Smart Traffic Sign’ augmented reality application are divided into three parts.

Part One: The input to the application, which consists of the icon of the supplementary virtual reality

Part Two: Operational Handbook

- Downloading Instructions on the cover
- Traffic Signs Marker page
- The QR Code of the Satisfactory Evaluation Form

Part Three: The Application of the augmented reality

- Show the 13 traffic sign models
- Display the videos concerning the 13 traffic signs

3.1.1 The access to the application, which consists of the icon of the augmented reality



Figure 1. Showing the icon of the augmented reality



Figure 2. 'Smart Traffic Sign' Operational Handbook

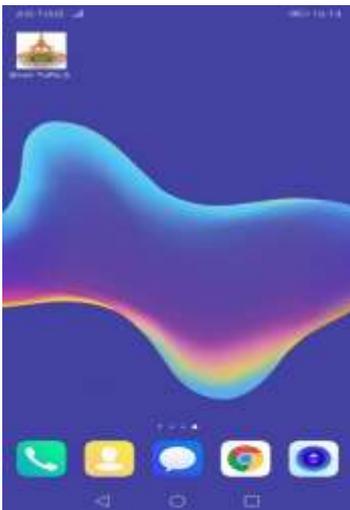


Figure 3. The cover of AR Application



Figure 4. The traffic markers

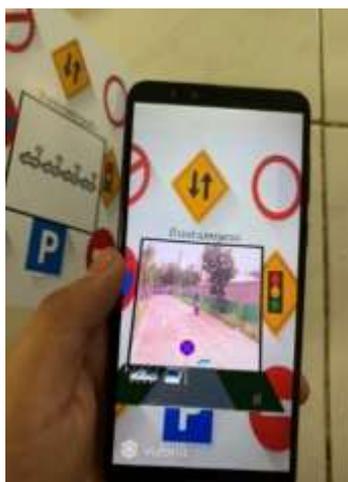


Figure 5. The models and the traffic sign videos



Figure 6. QR Code for the satisfaction survey

3.2 The evaluation results of the content quality by the experts

The evaluation quality results of the ‘smart traffic sign’ augmented reality application by the content experts reveal as follows.

Table 1. Evaluation results of content quality by experts

Evaluation Areas	Evaluation Results		The Interpretation of the Evaluation
	\bar{x}	S.D.	
1. The completeness of the content	4.33	0.94	Good
2. The alignment of the objectives	5	0.00	Very good
3. The appropriateness of Content Sequencing	4.33	0.47	Good
4. The clarity of content explanation	4.66	0.47	Very good
5. The appropriateness of content for the target goals	4.66	0.47	Very good
Total	4.60	0.33	Very good

From Table 1. The overall evaluation of the content quality of the smart traffic sign augmented reality application by experts is rated very good, with an average score of 4.60 and a standard deviation of 0.33. When examining the evaluation items individually, the highest rating was given to the structure and alignment of objectives, which had an average score of 5.00 and a standard deviation of 0.00. The next highest ratings were for clarity of content explanation and the appropriateness of content for

the target goals, which both had an average score of 4.66 and a standard deviation of 0.47. The item with the lowest quality rating was the completeness of the content, with an average score of 4.33 and a standard deviation of 0.94.

3.3 Evaluation results of application quality by experts

The evaluation of the alignment of quality in the media and application of the augmented reality project, smart traffic sign, by experts in the field of applications, is shown in the table below:

Table 2. Evaluation results of application quality by experts

Evaluation Areas	Evaluation Results		The Interpretation of the Evaluation
	\bar{x}	S.D.	
1. How stable is the system?	4.66	0.94	Good
2. Did the application met the specified objectives?	4.33	0.47	Very Good
3. The ease of use of the application	4.66	0.47	Good
4. The easily accessible of the application	4.33	0.47	Very Good
5. The modern is the application	4.33	0.47	Very Good
6. How fast is the system in processing data?	4	0.33	Very Good
7. How convenient is the application to use?	5	0.00	Very Good
Total	4.47	0.30	Good

From Table 2, it can be seen that the evaluation of the application quality of the augmented reality project, Smart Traffic Sign, by application experts is generally rated as good, with an average score of 4.47 and a standard deviation of 0.30. When examining the individual evaluation items, the highest-rated aspect was ease of use of the application, which scored an average of 5.00 with a standard deviation of 0.00. The next highest ratings were for how well the application met the specified objectives and how modern the application is, both of which scored an average of 4.33 with a standard deviation of 0.47. The item with the lowest rating was the system stability, which had an average score of 4.66 and a standard deviation of 0.94.

3.4 Study results on user satisfaction (users without a driving license and were 60 or younger)

From Table 3, the evaluation of the application quality of the augmented reality project, smart traffic sign, by 15 experts with the direct method in the field of

applications is rated good, with an average score of 4.53 and a standard deviation of 0.49. When examining the individual evaluation items, the highest-rated aspect was the appropriateness of the content in the application, which scored an average of 4.53 with a standard deviation of 0.49. The next highest ratings were for the proper categorization of information access (average = 4.46, standard deviation = 0.49) and how smoothly the application functions, which had the lowest quality rating (average = 4.13, standard deviation = 0.83).

Table 3: Evaluation results of user satisfaction (users without a driving license and were under 60 or younger)

Evaluation Areas	Evaluation Results		The Interpretation of the Evaluation
	\bar{x}	S.D.	
Content			
1. How appropriate is the content in the application?	4.53	0.49	Very Good
2. How well is the information categorized for easy access?	4.46	0.49	Good
3. How complete is the information?	4.33	0.59	Good
4. How accurate is the information?	4.33	0.59	Good
Layout and Design			
1. How fast is the application to use?	4.53	0.51	Very Good
2. How aesthetically pleasing is the application?	4.46	0.63	Good
3. How easy is the application to use?	4.40	0.73	Good
4. How well do the videos match the content?	4.33	0.81	Good
5. How interesting are the traffic sign models?	4.53	0.51	Very Good
6. How smoothly does the application operate?	4.13	0.83	Good
7. How well do the videos in the application communicate the information to the user?	4.53	0.74	Very Good
8. How well does the application help users gain knowledge about traffic signs and traffic laws?	4.46	0.63	Good
Total	4.42	0.12	Good

4. CONCLUSION

Based on the research study on the development of the Smart Traffic Sign augmented reality application, the results can be discussed as follows: The design of the system followed the five stages of the system development life cycle (SDLC): analysis, design, development, implementation, and evaluation. The application was tested for efficiency by experts in the three areas of content, application, and user satisfaction.

After receiving feedback from the advisors, adjustments were made before the application was made available for use by the entire sample group. This process aligns with the research by Monchanok Choosringam (2020), as the development of the application followed the principles of the SDLC [3]. This is because the development of the application was based on the recommendations of the advisor and experts, and subsequent revisions were made following the experts' suggestions before it was used with the sample group. It was found that the development of the augmented reality application aligns with the work of Sunsawon Inai and others (2020), as the application developed in this project showed a high level of satisfaction, which is consistent with the project [9]. It was also found that the development of the augmented reality application aligns with the research of Kong Ruksiam (2019), as the application in this project demonstrated a high level of satisfaction, which matches the project's objectives [7]. Furthermore, the development of the augmented reality application aligns with the work of Klang Kuamroo (2019), as the application in this project also showed a high level of satisfaction, which is consistent with the project's goals [4].

REFERENCES

- [1] Chanakan Budrak. (2021) Cloud computing benefit. Retrieved from: <https://blog.openlandscape.cloud/cloud-computing>
- [2] Digital Economy Promotion Office (DEPA). Big Data. Retrieved from: <https://www.tereb.in.th/erp/big-data>
- [3] Monchanok Choosringam. (2020). AR and VR to bring for business. Retrieved from: <https://www.aware.co.th/ar-vr-%E0%B9%83%E0%B8>
- [4] Klang kuamroo. (2019). AR (Augmented Reality) Retrieved from: <https://www.scimath.org/article-technology/item/7755-ar-augmented-reality>
- [5] Kong Ruksiam. (2019). Development AR with Unity 3D and Vuforia. Retrieved from: https://www.youtube.com/watch?v=3Y0vU2dmz_o&t=1230s
- [6] Kong Ruksiam. (2019). Developemnt AR Unity & Vuforia - Build Unity Project to Android. Retrieved from: https://www.youtube.com/watch?v=_Sqtom3Qu38&feature=share
- [7] Kong Ruksiam. (2019). Development AR Unity & Vuforia. Retrieved from: https://www.youtube.com/watch?v=_Sqtom3Qu38&feature
- [8] Right CG. (2561). Utilize Maya all in one clip. Retrieved from: <https://www.youtube.com/watch?v=DOGrQ1XEy4&feature=share&fbclid=IwAR1t>
- [9] Sunsawon Inai and other. (2020). Traffic sign to know. Retrieved from: <https://khaorot.com/drivesafely/aid201910011222>

- [10] Sarasiri Kampiranon. (2020) Thailand's Future Technology. Journal office of the senate secretary. Vol.9 No.9 April 2020. Retrieved from: https://www.senate.go.th/document/Ext21130/21130674_0002.PDF

REVOLUTIONIZING INTERACTIVE LEARNING: UNVEILING VR SPACE PLATFORM INNOVATION IN VIRTUAL REALITY-BASED EDUCATION

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ABSTRACT - This study explores the use of VR technology in vocational education during the Industry 4.0 era, focusing on the usability and motivational impacts of VR Gear on the VR Space platform. Emphasizing the challenges of implementing VR in education, it investigates student perceptions regarding VR Gear use and factors influencing usability and motivation in learning. Utilizing a quantitative approach, questionnaires assessed usability aspects like ease of use, technical support needs, feature consistency, and motivational factors such as interest and engagement levels. Results indicate that most students find VR platforms user-friendly, with a usability average score of 3.93, and motivating, with a motivation average score of 3.91. However, experiences vary individually. Discussions with vocational educators highlight the potential of VR in various fields, the challenges of limited internet infrastructure, and the costs of equipment. The study concludes that VR, especially through VR Space Platform, holds promise in enhancing vocational education, but successful integration requires overcoming connectivity and cost barriers and prioritizing infrastructure development and strategic VR curriculum integration.

Keywords: Virtual Reality, Usability, Learning Motivation, VR Space.

1. INTRODUCTION

The educational sector must innovate in response to rapid technological advancements in Era 4.0, highlighting the importance of integrating technology to enhance learning experiences. This study explores the VR Space Platform as an innovative tool within virtual reality (VR) learning, aiming to provide immersive and interactive educational experiences. VR technology allows users to engage in interactive, computer-generated environments, enhancing immersion [1]. Its unique capabilities can revolutionize pedagogical approaches by presenting content visually and interactively, improving comprehension and retention [2].

Empirical studies demonstrate the feasibility of incorporating BP Neural Networks into VR systems for vocational education, showcasing VR's adaptability in various pedagogical methods [3]. In vocational pharmaceutical education, VR supports safe

learning through virtual experiments [4] and promotes skill acquisition in a risk-free environment [5]. Furthermore, immersive VR methods have shown promise in vocational design education [6], while VR technology has helped overcome geographical and resource limitations, offering quality education in rural India [7]. Previous studies suggest that virtual reality (VR) holds significant promise for enhancing vocational education across various domains, despite challenges such as accessibility, cost, and insufficient high-quality educational content [8][9]. Open-source platforms like Mozilla Hubs and Frame VR could address some of these barriers by improving accessibility for users and developers [10].

Mozilla Hubs enables the creation of virtual spaces for social interaction and collaboration, featuring functionalities such as spatial audio, avatar customization, and 3D object integration, which enhance interactive learning experiences [11] [12]. Research has demonstrated that using VR platforms like Mozilla Hubs can improve student motivation and provide immersive educational experiences [13]. However, integrating VR into education still faces obstacles; for example, [14] identified technical limitations in social VR technologies, noting that platforms are still developing and require enhancements to fulfill the vision of the Metaverse. Additionally, [15] highlighted the importance of understanding the effects of virtual environments on social interactions within collaborative learning spaces.

Despite its significant potential, integrating VR into traditional education presents challenges, with current usage of VR Space falling short and necessitating further exploration. This study introduces a novel analytical methodology, emphasizing students' and educators' reactions to VR Space features, addressing the limited research on user responses to specific functionalities. The research aims to evaluate the usability and effectiveness of these features in enhancing student engagement and motivation, contributing to the field of technology-based education by identifying both opportunities and challenges in modern educational contexts. By focusing on successful integration, the study aligns with Sustainable Development Goal 4, which promotes inclusive and high-quality education for all. Expected findings will offer new insights and practical recommendations for improving the use of VR Space in learning environments, thereby advancing technology-driven instructional methods.

2. MATERIALS AND METHODS

2.1. Research Objective and Questions

The primary research inquiries addressed by this study are as follows:

1. How do students and educators believe the usability of these features within the field of Education?

2. How effective are the features of VR Space contribute to the enhancement of student engagement and motivation within the context of the learning process?
3. What are the challenges and obstacles related to the implementation of VR Space as a learning platform?
4. What recommendations can be proposed to enhance the learning experience utilizing VR Space, based on the feedback received from students and educators?

2.2 VR Platform Proposed

VR Space that utilized in this research is Mozilla Hubs, alternatively referred to as Hubs. The product in question is a Virtual Reality collaboration platform that utilizes the Mozilla Mixed Reality - Web XR technology. Mozilla Mixed Reality is a prominent provider of browser technology on a global scale. Mozilla Hubs was initially launched in 2018 as a cost-free and experimental software designed to facilitate collaboration and exploration of Virtual Reality environments across diverse sectors. It serves as an alternative to conventional conference rooms. The Hubs application developed by Mozilla is commonly referred to as an experimental platform exploring the concept of "open social virtual reality." The application is accessible via virtual reality (VR) headsets or web browsers such as Chrome and Mozilla Firefox. This platform is utilized for the purposes of teaching and learning through the utilization of Virtual Reality technology. The application is accessed via the online platform Mozilla Hubs, which offers access to 3D virtual spaces through a designated hyperlink. According to Bredikhina et al. [16], it enables deep virtual engagement among individuals.

2.3 Research Design

The study utilized a quantitative survey method to explore the perspectives of students and educators on VR Space functionalities. A questionnaire with a Likert scale was developed to measure perceptions of usability and effectiveness. The Purposive Sampling technique ensured participants, including both students and educators, were experienced with VR Space focused on usability, effectiveness, engagement, and motivation. Data analysis involved descriptive and inferential statistics. Reliability and validity assessments were conducted, following a preliminary test, to ensure the questionnaire's accuracy. The goal is to deepen understanding of user experiences in educational settings using VR Space.

2.4 Participants

The study used Purposive Sampling to select participants with digital learning experience, including 95 Technical Education students in their 3rd and 5th semesters and 20 vocational high school teachers from West Java. Students were chosen for their ICT literacy, while teachers had training in virtual technologies like Virtual labs and classes. The focus was on their familiarity with platforms like Mozilla Hubs to provide informed insights into its features and educational effectiveness. The aim was to understand both student and teacher perspectives on integrating and using these digital platforms.

2.5 Instruments

This study employs various quantitative data collection instruments to evaluate the effectiveness of VR Space-based virtual reality (VR) in vocational high school education, utilizing a customized Likert scale from 1 to 5.

1. **Usability Scale Instrument:** The System Usability Scale (SUS) by Brooke [17] measures user satisfaction and ease of use for platforms like Mozilla Hubs. It consists of 10 statements assessing factors like willingness to use the platform regularly (US1), ease of use (US2), need for technical assistance (US4), and overall user experience (US10). The SUS enhances reliability and validity, having been widely validated across usability studies.
2. **Learning Motivation Instrument:** this questionnaire includes 8 statements measuring how VR impacts student motivation and engagement. It examines factors such as potential boredom (M1), motivation compared to traditional methods (M2), desire for more VR integration (M3), comprehension challenges (M4), aesthetic appeal (M5), material effectiveness (M6), interest in learning (M7), and active participation (M8).
3. **Qualitative Instrument:** This instrument facilitates discussions with teachers to gather insights on the challenges of implementing VR Space and recommendations for enhancing the learning experience with platforms like Mozilla Hubs.

2.6 Data Analysis

The Likert scale is used to assess participants' responses in the questionnaire, offering five options from "Strongly Disagree" to "Strongly Agree," with numerical values from 1 to 5. Positive questions receive higher scores to indicate favorable responses, while negative questions have reversed scoring, with lower scores reflecting positive reactions. After data collection, descriptive statistics, including mean values and

standard deviations are calculated. High average scores on positive-connoted questions suggest agreement, whereas low scores on negative-connoted questions indicate disagreement with challenges. A low standard deviation denotes consistent responses, while a high standard deviation indicates variability. In the Usability questionnaire, positive items include US1, US2, US3, US5, US6, US8, and US10, while US4, US7, and US9 are negative. In the Motivation questionnaire, positive items are M2, M3, M5, M6, M7, and M8, with M1 and M4 indicating negative connotations.

2.7 Procedure of Study

The main objective of this study is to assess students' perceptions regarding usability and motivation while utilizing the features offered by the Mozilla Hubs platform, under the guidance of educators. To achieve this, a questionnaire survey will be distributed to a sample of approximately 95 students in their 3rd and 5th semesters of the Technical Education Department who have completed courses in ICT literacy and learning media. The study will involve six units of VR Gear, with one unit allocated for the educator and five for students. The cohort will be divided into 19 groups, each undergoing a single trial cycle, totalling 19 cycles for the entire sample.



Figure 1. Data Collection Procedures

In the planning stage, all VR Gear units will be verified for functionality, battery life, and internet stability before preparing learning materials and establishing a virtual room on Mozilla Hubs. Students will be divided into groups of five, and an orientation session will be conducted to familiarize them with VR Gear and the basics of VR Space.

During the implementation stage, each group will participate in a 20 to 30-minute instructional session using VR Gear connected to VR Space. Participants will join a virtual room, initially spending three minutes adjusting audio settings and selecting avatars. They will then engage in a 15-minute session in a simulated classroom environment, where the instructor will guide them in exploring features like virtual seating, chat communication, and screen sharing. Following this, a five-minute "Breakout Room" session will promote interaction among learners and facilitate discussions in a confidential setting. Finally, participants will spend five minutes in a library room with resources accessible through hyperlinks.

In the evaluation stage, a classroom discussion will be held to gather students' reflections on their experiences with VR Gear and VR Space functionalities. A survey will be conducted to collect feedback on the effectiveness of this pedagogical approach and identify areas for improvement in future implementations. The study will conclude with a comprehensive overview of the learning activities and an appreciation for the students' engagement throughout the instructional process.

3. RESULTS AND DISCUSSION

3.1. Usability Questionnaire Evaluation Results

The usability questionnaire results from students, summarized in Table 1, indicate that the VR Space platform is generally perceived as user-friendly. With an average score of 3.86 for question US1, there was some variability in user experiences (SD = 1.15). Most respondents found the platform easy to use, as demonstrated by question US2 (average = 4.00, SD = 0.92) and US3 (average = 4.11, SD = 0.94). Most users felt they did not need technical assistance (US4: average = 3.98, SD = 0.34) and expressed confidence in engaging with learning activities (US5: average = 4.04, SD = 0.923). Further, the platform is considered not complex (US7: average = 3.83, SD = 0.41), and users reported comfort (US8: average = 3.94, SD = 0.42) and minimal additional learning needs (US9: average = 3.80, SD = 0.44). Question US10 reflected a positive view of the platform's ease of use in learning (average = 3.89, SD = 0.43), suggesting it effectively facilitates the learning process.

Table 1. Usability Evaluation Result

Code	Questionnaire	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Average	Standard Deviation
US1	I want to use this platform regularly in learning.	30	28	15	6	5	3.86	1.15
US2	Using this platform feels easy without the need for extra effort.	30	29	20	5	0	4.00	0.918
US3	In my opinion, this platform is simple and easy to use.	36	27	15	6	0	4.11	0.94
US4*	I feel the need for technical assistance to	0	5	22	28	30	3.98	0.34

	fully utilize this platform.							
US5	The features of this platform feel consistent and support learning activities.	31	31	16	6	0	4.04	0.92
US6	I am confident many people will quickly understand how to use this platform.	29	28	17	6	4	3.86	1.15
US7*	Sometimes, I find this platform somewhat complicated to use.	0	10	20	28	26	3.83	0.41
US8	I feel confident and comfortable when using this platform.	33	27	14	6	4	3.94	0.42
US9*	I think I need to learn more before I can be truly comfortable using this platform.	0	10	22	27	25	3.80	0.44
US10	Overall, this platform is easy to use in the learning process.	32	26	15	7	4	3.89	0.43

3.2. Motivation Questionnaire Evaluation Results

The findings from the questionnaire assessing student motivation while using VR Gear on the VR Space platform are summarized in Table 2. The results indicate that participants generally do not find VR boring, with an average response of 3.93 for M1 (SD = 0.995). However, M2 showed a neutral average of 3.55 regarding the effectiveness of VR compared to other methods (SD = 0.762). Participants expressed strong agreement with M3 (average = 4.01, SD = 0.87), indicating a desire for more VR usage in class. M4 revealed a neutral stance (average = 3.52, SD = 1.12) on the difficulty of understanding material through VR. Positive consensus was reported for M5 about the platform's visual appeal (average = 4.15, SD = 0.83). M6 demonstrated a neutral to agreeing view on material comprehension (average = 3.68, SD = 0.94), while M7 showed high agreement that VR increases interest in the material (average

= 4.24, SD = 0.72). Finally, M8 indicated that VR enhances eagerness to participate in discussions (average = 4.18, SD = 0.82). Overall, students showed high interest and a willingness to engage with the VR platform in their learning process.

Table 2. Motivation Evaluation Result

Code	Questionnaire	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Average	Standard Deviation
M1	Using VR platform as a learning medium makes me feel bored.	0	10	15	30	29	3.93	0.995
M2	My motivation to learn using the VR platform is greater than my motivation to learn using other learning methods.	10	30	40	4	0	3.55	0.76
M3	I hope teachers will use more VR platforms like this in my class.	32	28	18	5	1	4.01	0.87
M4	Understanding the material I have already learned through this VR platform is quite difficult.	5	12	20	28	19	3.52	1.12
M5	The design of the VR platform is visually appealing.	36	30	13	5	0	4.15	0.83
M6	I understand the material taught after using this VR platform.	19	25	34	6	0	3.68	0.94
M7	Using the VR platform increases my interest in the material being taught.	35	34	15	0	0	4.24	0.72
M8	Learning experiences with the VR platform make me more eager to actively participate in class and discussions.	35	32	14	3	0	4.18	0.82

3.3. Motivation Questionnaire Evaluation Results

The evaluation involved consultations with vocational educators from various fields, including Culinary Arts, Architecture, and Business and Management, revealing key insights into the potential use of Virtual Reality (VR) technology via the VR Space platform in vocational education.

In Culinary Arts, VR Space facilitates realistic simulations for skills like table setting and dining etiquette, enabling students to practice in a virtual environment with real-time instructor guidance. In Architecture, the platform allows users to explore 3D visualizations of building designs, promoting collaboration and design review while simulating environmental conditions. This aligns with Movania et al. [18], who used VR Space for a virtual end-of-year project exhibition, allowing students to showcase their work. For Business and Management, VR Space serves as a collaborative tool for business simulations and management training, enabling virtual meetings and market analyses, thus fostering interactive learning experiences.

However, several challenges were identified in implementing VR technology. From a technical perspective, the limitations of internet infrastructure—particularly in areas with poor connectivity—present a major obstacle, as VR applications require stable, high-speed connections for optimal functionality. Financial constraints are also significant, since the cost of acquiring and maintaining VR devices poses budgeting difficulties for many schools. Beyond these issues, pedagogical readiness is equally critical: educators often require additional training to integrate VR effectively into existing curricula, while the lack of technical support staff may hinder sustainable implementation. Health-related concerns further complicate adoption, as some students experienced nausea and dizziness, symptoms commonly associated with cybersickness, which may reduce engagement and learning effectiveness. Accessibility and equity concern also arise, as students from less-resourced schools may have limited opportunities to benefit from VR-based learning. Despite these hurdles, educators continue to acknowledge the transformative potential of VR in vocational education, envisioning its role in practical training, certification processes, and skill assessments. Addressing these challenges systematically—both technical and human-centered—will be essential to ensure that the pedagogical advantages of VR can be fully realized.

3.4. Finding and Discussion

This section identifies key findings from the research on the integration of virtual reality (VR) technology in education. A major concern is the limited accessibility of

VR devices, suggesting that personal computers or smartphones might serve as alternative solutions, despite offering less immersion. During implementation, several students reported experiencing nausea and dizziness while using the VR gear. These adverse effects align with previous studies [19], which associate VR use with motion sickness symptoms, commonly referred to as cybersickness. Such symptoms are typically caused by sensory conflicts between the visual and vestibular systems, latency in motion tracking, or extended exposure to immersive environments. To mitigate these challenges in future applications, strategies such as limiting session duration, incorporating regular breaks, and employing adaptive rendering techniques may be considered. Addressing these issues is crucial to ensure that the pedagogical benefits of VR can be maximized without compromising student well-being. While platforms like Mozilla Hubs and Frame VR offer various educational features, they also have limitations such as restricted simulation capabilities and generic designs that may not fully meet specific educational needs.

Feedback from students and educators regarding the virtual classroom's interior design indicated a demand for revisions, emphasizing the impact of classroom aesthetics on student motivation and comfort, warranting further investigation. Significant findings also revealed a potential decline in learning efficacy with prolonged VR use, particularly with inappropriate avatar choices that could distract peers. Therefore, structured guidelines for avatar selection and interactions are essential to align VR use with educational goals.

Moreover, VR technology, although capable of replicating detailed environments, struggles to replicate the authenticity of face-to-face interactions, especially during practical activities. Despite these limitations, VR can effectively serve as a preliminary phase before direct practical sessions, allowing students to prepare and enhance their understanding. When integrated thoughtfully, VR technology has the potential to enrich the educational experience and better equip students for real-world applications.

4. CONCLUSION

In the context of the Industry 4.0 era, marked by rapid advancements in digital technology, there is an urgent requirement for educational institutions to engage in a significant transformation with the goal of successfully responding to the demands of interactive and adaptable learning. The present study investigates the feasibility of incorporating VR Space as a learning platform based on Virtual Reality (VR) technology, with the aim of enhancing interactive learning experiences. The findings of the study suggest that VR Space provides a learning experience that is both immersive and profound. Nevertheless, there exist various obstacles that must be

confronted, including constraints in interpersonal communication and the possibility of being diverted by specific functionalities. However, through meticulous planning and the implementation of suitable learning scenarios, this platform has the potential to serve as a valuable tool for augmenting the standard of education in the contemporary digital age. Furthermore, the constraints pertaining to social interaction and practicality underscore the significance of integrating traditional and digital educational approaches in order to attain the most favorable learning results. In conclusion, the incorporation of VR Space into the educational curriculum can be regarded as a progressive measure in response to the educational needs of the Industry 4.0 era. However, a systematic and all-encompassing approach is necessary to guarantee its successful execution.

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REFERENCES

- [1] Sherman, W. R., & Craig, A. B. (2018). *Understanding virtual reality: Interface, application, and design*. Elsevier. <https://doi.org/10.1016/C2013-0-18583-2>.
- [2] Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, 70, 29-40. <https://doi.org/10.1016/j.compedu.2013.07.033>
- [3] Li, J., & Chen, R. (2023). Development of a Virtual Reality-based Implementation System for Vocational Education Orientation Training Mode using BP Neural Network in the Production and Teaching Combination. *Computer-Aided Design & Applications*, S14, 135-149. <https://doi.org/10.14733/cadaps.2023.S14.135-149>.
- [4] Zhou, X. (2022). Discussion on the Application of Virtual Reality Technology in Pharmacy Vocational Education. In *Proceedings of the 2nd International Conference on Internet, Education and Information Technology (IEIT 2022)* (pp. 465-469). Atlantis Press. https://doi.org/10.2991/978-94-6463-058-9_76
- [5] Asria, S., Riska, M., Patta, A. U., & Purnamawati. (2023). Stepping Into the Future of Vocational Education: Exploring the Role of Virtual Reality Technology. In *Proceedings of the 2nd World Conference on Social and Humanities Research (W-SHARE 2022)* (pp. 127-133). Atlantis Press. https://doi.org/10.2991/978-2-38476-084-8_18
- [6] Kim, K. G., Oertel, C., Dobricki, M., Olsen, J. K., Coppi, A. E., Cattaneo, A., & Dillenbourg, P. (2020). Using immersive virtual reality to support designing skills

- in vocational education. *British Journal of Educational Technology*, 51(6), 2199-2213. <https://doi.org/10.1111/bjet.13026>
- [7] Bhavani, B., Srividya, S., & Unnikrishnan, R. (2010). Vocational Education Technology: Rural India. In *Proceedings of the 1st Amrita ACM-W Celebration on Women in Computing in India (Article 21)*. Association for Computing Machinery. <https://doi.org/10.1145/1858378.1858399>
- [8] Freina, L., & Ott, M. (2015). A literature review on immersive virtual reality in education: state of the art and perspectives. In *The International Scientific Conference eLearning and Software for Education (Vol. 1, p. 133)*. "Carol I" National Defence University
- [9] Hussein, M., & Nätterdal, C. (2015). The benefits of virtual reality in education: A comparison study. Bachelor's Thesis in Software Engineering, University of Gothenburg. <http://hdl.handle.net/2077/39977>
- [10] Cheng, L., & Tsai, C. C. (2019). Affordances of augmented reality and virtual reality for students' learning in higher education. *Journal of Computer Assisted Learning*, 35(3), 273-283.
- [11] Mozilla (2020). Mozilla Hubs: A new way to get together. Retrieved from <https://hubs.mozilla.com/>
- [12] Korečko, Š., Hudák, M., Sobota, B., Sivý, M., Pleva, M., & Steingartner, W. (2021). Experimental Performance Evaluation of Enhanced User Interaction Components for Web-Based Collaborative Extended Reality. *Applied Sciences*, 11(9), 3811. <https://doi.org/10.3390/app11093811>
- [13] Sun, Y., Albeaino, G., Gheisari, M., & Eiris, R. (2022). Online site visits using virtual collaborative spaces: A plan-reading activity on a digital building site. *Advanced Engineering Informatics*, 53(1), 1-20. <https://doi.org/10.1016/j.aei.2022.101667>
- [14] Cheng, R., Wu, N., Varvello, M., Chen, S., & Han, B. (2022, October 25). Are we ready for metaverse? *Proceedings of the 22nd ACM Internet Measurement Conference*. IMC '22: ACM Internet Measurement Conference, Nice France. <https://doi.org/10.1145/3517745.3561417>
- [15] Williamson, J., Li, J., Vinayagamoorthy, V., Shamma, D. A., & Cesar, P. (2021, May 6). Proxemics and social interactions in an instrumented virtual reality workshop. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. CHI '21: CHI Conference on Human Factors in Computing Systems, Yokohama Japan. <https://doi.org/10.1145/3411764.3445729>
- [16] Bredikhina, L., Sakaguchi, T., & Shirai, A. (2020). Web3D Distance Live Workshop for Children in Mozilla Hubs. In *Proceedings of the 25th International Conference on 3D Web Technology (Web3D '20)*. Association for Computing Machinery. <https://doi.org/10.1145/3424616.3424724>

- [17] Brooke, John. (1996) "SUS - A quick and dirty usability scale". Redhatch Consulting Ltd.,12 Beaconsfield Way,Earley, Reading Rg6 2ux,United Kingdom.
- [18] Movania, M.M., Samad, A., & Raza, S.S. (2023). Exploring the Mozilla® HUBS® Platform for Virtual Final Year Project Exhibition. In Y. Cai, E. Mangina, & S.L. Goei (Eds.), *Mixed Reality for Education. Gaming Media and Social Effects* (pp. xx-xx). Springer. https://doi.org/10.1007/978-981-99-4958-8_7
- [19] Al-Ashwal, W., Asadi, H., Mohamed, S., Alsanwy, S., Kooijman, L., Nahavandi, D., Alqumsan, A. A., & Nahavandi, S. (2021, October 17). Cybersickness measurement and evaluation during flying a helicopter in different weather conditions in virtual reality. *2021 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*. 2021 IEEE International Conference on Systems, Man, and Cybernetics (SMC), Melbourne, Australia. <https://doi.org/10.1109/smc52423.2021.9659215>

INDUSTRY EXPECTATIONS AND SATISFACTION LEVEL TOWARDS ENGINEERING GRADUATES IN SPACE UTM

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ABSTRACT - Rapid and drastic changes in economic growth are creating more employment opportunities. Labour market is becoming more competitive and depends on the quality of knowledge and skills of fresh graduates to increase their chances of employment. Employers in general have high expectations on engineering graduates to perform in their organizations once they are hired. Hence, it is crucial for employability skills to be developed during student years. This study aims to identify the expectations and satisfaction level of employers towards engineering students who underwent internship in their final semester during their diploma years. This study also aims to reduce mismatch between skills and knowledge provided by higher education and the needs of the market and to match industrial demands. The gap between their expectations and satisfaction plays an important role in determining key employability skills that engineering students need to adopt to match with industrial demands. A total of 43 respondents have participated in this study which are the targeted respondents consisting of employers in charge of engineering internship students. Findings state that based on 12 critical employability skills, there is a significant gap between the expectation and satisfaction levels of employers towards engineering internship students. The mean value of the expectation level of employers is 4.79, and the mean value for their satisfaction level is 3.96 with a difference of 0.83. Besides that, the percentage of achievement for the expectation level is 95.8% and satisfaction level is 79.20%. This shows a difference of 16.6% which exposes the gap between employer's expectation and satisfaction level. To further breakdown, from the findings, the skills that show the maximum significant gap are interpersonal skills and the minimum gap is problem solving. This shows that students are good at problem-solving but show lack of interpersonal skills. The existence of these gaps reduces the chances of employment for our UTM graduates; hence the goal is to minimize the gaps. By doing so, UTM graduates can match industrial demands hence increasing chances of employability for UTM graduates is SPACE UTM.

Keywords: graduates; key employability skills; industrial demand; engineering, employment.

1. INTRODUCTION

Graduate employability is an important criteria to college and university graduates and is also used by higher education institutions to attract student admission. Unemployment is an issue that has been around for quite a while in this country. If it

is not addressed, unemployment will retard the nation, society and even the country. Furthermore, if the nation's unemployment continues to worsen, riots and insurgency will happen across the country, disrupting national stability and trade. This dangerous situation could result in significant losses for the nation [1].

To tackle the matter of unemployment, several studies have been conducted to find the factors of unemployment among engineering graduates. One of the factors is the readiness of the graduates to enter the workforce. They lack the employability skills needed by employers, such as communication skills and teamwork, lack competencies or capabilities, and are not equipped with relevant skills [2]. The unemployment issues in Malaysia will also be reflected in the higher education system when graduates are not meeting the industry's expectations. Even with improvement done in the education system, there are still complaints received from employers that fail to produce future workers with the kinds of skills required by today's industries [3].

According to Tholibon (2021), employers' satisfaction is influenced by four key skills: knowledge acquisition, personality, generic skills, and soft skills which are essential for industrial training students at Institutes of Higher Education (IPT) and found that strong knowledge acquisition contributes to a higher level of personality development, while soft skills may also impact generic competencies [4]. Mastery of skills in the psychomotor and affective domains plays a crucial role in education, especially in bridging academic knowledge with industry expectations. Based on employers' evaluations, most industrial training students demonstrate proficiency in both domains, indicating that the engineering program's curriculum aligns well with industry requirements [5]. Furthermore, comprehensive guidelines for industrial training can further enhance students' readiness and reporting capabilities, ensuring they meet industry standards [6]. Overall, industrial training serves as a fundamental element in bridging the gap between academic knowledge and practical application, fostering a skilled workforce ready to meet industry demands [7]. Employer satisfaction regarding the skills of engineering graduates is influenced by various competencies and contextual factors indicate that employers prioritize problem-solving abilities and teamwork skills among engineering graduates, highlighting these as critical competencies for satisfaction in the workplace.

Additionally, a study focusing on Malaysian graduates found that both fundamental general skills and specific engineering skills are essential for employer satisfaction, suggesting that a well-rounded skill set is crucial for employability [8]. Moreover, factors such as institutional curriculum, industry training, and social skills practice significantly impact employer satisfaction, particularly in the context of engineering IT graduates in India [9]. The role of employer impression is important to emphasize

the perception of graduates' skills and highlight the importance of soft skills and interpersonal dynamics [10].

These findings underscore the importance of both technical and soft skills in enhancing employer satisfaction with engineering graduates. Industrial training is crucial for preparing students for the workforce, as it enhances their professional competencies and adaptability to real-world environments. According to Sinha (2020), engineering IT graduates in India show that employer satisfaction is greatly impacted by aspects such as industry interaction and institutional framework [11].

2. MATERIALS AND METHODS

This study employed a quantitative research design using a structured questionnaire as the primary data collection instrument. The research methodology is illustrated in Figure 1 below, which outlines the sequential process of the study, beginning with identifying the problem, designing the instrument, collecting and analysing the data and interpreting the findings in relation to the research objectives.

A total of 43 employers who had supervised engineering students during their internship were selected as respondents. The questionnaire was distributed to these employers and the collected data were analysed using descriptive statistics to determine the mean, standard deviation, percentage and frequency. The mean scores were interpreted based on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

2.1. Population and Sample

The target population consisted of employers who had accepted engineering diploma students for industrial training. A total of 43 responses were successfully collected and analysed. This purposive sampling technique was chosen to ensure that only relevant and experienced respondents provided input on the evaluation of student performance.

2.2. Research Instrument

A structured questionnaire was developed and used to gather data on employer expectations and satisfaction towards the employability skills of engineering students. This method allowed for efficient data collection and provided a consistent basis for comparison across respondents.

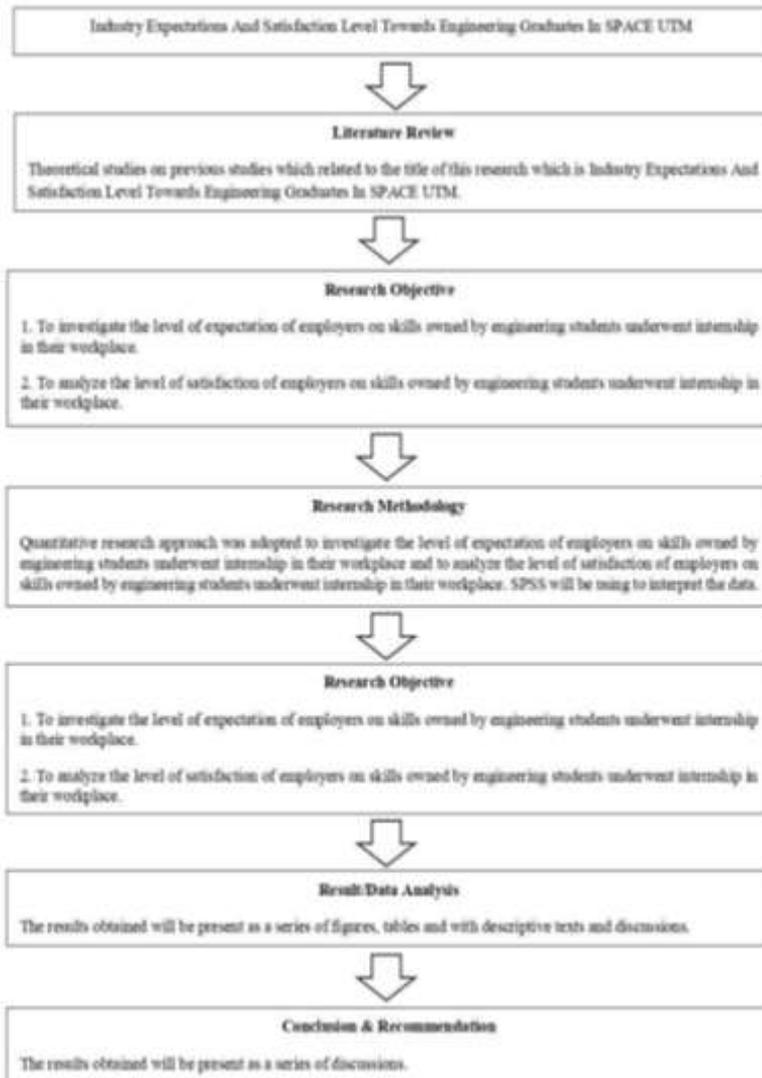


Figure 1: Research Methodology

2.3. Questionnaire Design

2.3.1 Questionnaire Survey

This is an efficient method of acquiring information in which respondents are given a set of questions to answer. This is an effective way to collect data from a large group

of people. It can help reduce the time it takes for respondents to react. There are 3 sections for the questionnaire survey.

- **Section A – Respondent’s Background**

This section is to find out the demographic background of the respondents and consists of hierarchical level, years of experience, company size, engineering disciplines and functional area.

- **Section B - To investigate the level of expectation of employers on skills owned by engineering students who underwent an internship in their workplace. This section is to consist of likert scale to see the expectations of the employers.**
- **Section C - To analyse the level of satisfaction of employers with the skills owned by engineering graduates underwent internship in their workplace. This section also consists of likert scale to see the satisfaction of the employers.**

2.4 Analytical Approach

The analysis focused on comparing employer expectations with actual satisfaction levels to identify gaps in employability skills among engineering graduates. The approach to discussion aligns with the research framework shown in Figure 1, which emphasises the relationship between industrial demands, student competency and curriculum effectiveness. Each stage in the framework, from problem identification to findings interpretation, guides the structured evaluation of key employability skills such as communication, technical competence, teamwork and problem-solving. This alignment ensures that the discussion of results directly reflects the objectives and methodological flow of the study, enabling practical recommendations to be made based on the identified gaps.

3. RESULTS AND DISCUSSION

A total of 43 respondents, which consists of employers that host engineering internship students involved in this study. Table 1 shows the comparison between employers' expectations and their satisfaction levels across twelve (12) employability skills adopted from the EAC Manual and the Ministry of Higher Education.

Table 1. Gap between Employers' Expectation and Satisfaction

Key Employability Skills	Expectation	Satisfaction	Gap
Communication Skills	4.37	4.00	0.37
Teamwork and Collaboration	4.47	4.02	0.45
Problem-solving Skills	4.37	4.16	<u>0.21</u>
Adaptability and Flexibility	4.40	3.95	0.45
Technical Skills	4.26	3.72	0.54
Leadership and Management Skills	4.58	4.07	0.51
Time Management	4.47	4.09	0.38
Interpersonal Skills	4.56	3.77	<u>0.79</u>
Self-Motivation and Initiative	4.58	4.09	0.49
Ethical and Professional Conduct	4.44	3.86	0.58
Digital Literacy	4.33	3.86	0.47
Lifelong Learning	4.37	4.00	0.37
Mean	4.79	3.96	

As seen in the table above, employability skills scored highly in the expectation column, ranging between 4.26 and 4.58 on a 5-point scale. This is in contrast with the satisfaction scores that range between 3.72 and 4.16.

Out of twelve employability skills, Leadership and Management Skills, and Self-Motivation and Initiative scored the highest at 4.58. This indicates that employers are not just hiring individuals who complete assigned job tasks but are looking for future leaders who can guide a team, take responsibility, and make decisions. Employers also seek graduates who can stand on their own and go beyond expectations. The results in the satisfaction column, however, show the opposite. It seems that there is a disconnect between industry expectations and actual graduate performance.

The biggest gap is in interpersonal skills, which is 0.79. Employers are expecting high levels of interpersonal skills from these internship students, considering these skills to be essential for them. However, the mean satisfaction score is notably lower than their expectation. This shows that employers are not fully satisfied with the level demonstrated by the interns. This gap highlights the need for improvement in the preparation of these students for internships. In contrast, the smallest gap between the employer’s expectation and satisfaction level is in problem-solving skills. These mean numbers reflected on how the implementation of one of the key employability skills in a student's curriculum helps in matching industrial demands. Even if the value of the gap is minor, it is still showing concerns of dissatisfaction from the employers because it is still not achieving their expectations.



Figure 2. Mean Value of Expectation and Satisfaction Level of Employers.

Employers’ expectations often come from their experience of how they expect their employees to be. It can be essential due to their experience and involvement in the industry, especially when dealing with clients and handling big projects. Therefore, their expectations of engineering graduates can be considered credible. These gaps, even if they are minor or major, are still a number that is less than what the employers

expected. Hence, both universities and students should take proactive steps in bridging the gap between industry expectations and actual graduate performance. Institutions should improve teaching strategies, and employability skills should be embedded into the curriculum. On the other hand, students must take their own initiative to develop themselves. Only with this collaborative effort can engineering graduates meet industry expectations.

4. CONCLUSION

Employers expect qualities from graduates, but the existence of significant gaps in these qualities needs to be diminished. Integrating experiential learning and soft skills training into the curriculum is recommended to meet industry demands. Active participation in internships, leadership roles, and collaborative projects can further enhance interpersonal and problem-solving skills, making graduates more workforce-ready.

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REFERENCES

- [1] Hossain, M. I., Yagamaran, K. S. A., Afrin, T., Limon, N., Nasiruzzaman, M., & Karim, A. M. (2018). Factors influencing unemployment among fresh graduates: A case study in Klang Valley, Malaysia. *International Journal of Academic Research in Business and Social Sciences*, 8, 9, 1494-1507.
- [2] Zaharim, A., Yusoff, Y. M., Omar, M. Z., Mohamed, A., & Muhamad, N. (2008). Employers' perceptions and expectations toward engineering graduates: A case study. In *Proceedings of the 6th WSEAS International Conference on Engineering Education*.
- [3] Azmi, A. N., Kamin, Y., & Noordin, M. K. (2018). Competencies of engineering graduates: What are the employer's expectations? *International Journal of Engineering & Technology*, 7, 2.29, 519-523.
- [4] Tholibon, D. A., Nujid, M. M., Mokhtar, H., Rahim, J. A., Aziz, N. F. A., & Tarmizi, A. A. A. (2021). Relative Importance Index (RII) in Ranking the Factors of Employer Satisfaction towards Industrial Training Students. *Online Submission*, 2(4), 493-503.

- [5] Mohd Saim, N., Mohd Nor, N. A., Alias, R., & Rosli, S. H (2021). Evaluation of Programme Outcomes Under the Psychomotor and Affective Domain for Diploma Civil Engineering Students Through Industrial Training: A Statistical Study from Employers' Perspective in Malaysia. *International Journal of Engineering Pedagogy*, 11(5), 70-186.
- [6] Oraison, H., Konjarski, L., & Howe, S. (2019). Does university prepare students for employment?: Alignment between graduate attributes, accreditation requirements and industry employability criteria. *Journal of Teaching and Learning for Graduate Employability*, 10(1), 173-194.
- [7] Bühler, M. M., Jelinek, T., & Nübel, K. (2022). Training and preparing tomorrow's workforce for the fourth industrial revolution. *Education Sciences*, 12(11), 782.
- [8] Hassan, R. S., Amin, H. M., & Ghoneim, H. (2024). Decent work and innovative work behavior of academic staff in higher education institutions: the mediating role of work engagement and job self-efficacy. *Humanities and Social Sciences Communications*, 11(1), 1-19.
- [9] Chand, P. K., Kumar, A. S., & Mittal, A. (2019). Emotional intelligence and its relationship to employability skills and employer satisfaction with fresh engineering graduates. *International Journal for Quality Research*, 13(3), 735.
- [10] Mansi Varma, D. S. B. (2024). To study the role of emotion regulation in interpersonal communication skills and life satisfaction among young adults.
- [11] Sinha, S., Jawahar, I. M., Ghosh, P., & Mishra, A. (2020). Assessing employers' satisfaction with Indian engineering graduates using expectancy-disconfirmation theory. *International Journal of Manpower*, 41(4), 473-489.

TATANÉN DI BALÉ ATIKAN PROGRAM FOR THE INTEGRATION OF SUSTAINABILITY VALUES IN SCHOOLS

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ABSTRACT - Sustainable Development Goals (SDGs) require individuals who understand, are aware, and are committed to taking action to achieve them. Education for Sustainable Development (ESD) is essential for fostering knowledge, awareness, and real action among students. One of the important initiatives is Tatanén di Balé Atikan, an educational program based on local wisdom in Purwakarta Regency, West Java Province, Indonesia. The program aims to promote sustainable development through its mission of "caring for the earth and learning from the earth", emphasizing the principles of justice, sustainability, and local wisdom rooted in Pancaniti (the five principles or paths to achieve a harmonious and meaningful life in Sundanese culture). This study aims to describe the implementation of the Tatanén program in Balé Atikan in integrating sustainable values in elementary schools. This research is a type of qualitative research, where data is obtained through interviews, questionnaires, observations, and document analysis conducted between January and July 2024. This research focuses on six elementary schools in Purwakarta, which were deliberately selected from clusters of achievement of upper, middle, and lower based on data from the Education Office. The findings show that the program has been successfully implemented in schools in the upper and middle clusters. However, its implementation in low-performing schools has faced significant challenges, such as limited access to school land and inadequate knowledge among teachers, parents, and a lack of support from the wider community. These constraints hinder the program's ability to reach its full potential in these schools. To address these challenges, the study recommends the provision of targeted training and capacity building programs for teachers, parents, and community members. This support is essential to optimize the impact of the program and ensure its principles are embraced and practiced at all levels of education. Through these efforts, Tatanén di Balé Atikan has the potential to become a model for integrating local wisdom and sustainability values into education, especially in primary education, contributing meaningfully to the achievement of the SDGs in the country.

Keywords: Sustainability values, Tatanén di Balé Atikan, schools, SDGs.

1. INTRODUCTION

An increasing population and rapid development of the world of industry has triggered overpopulation, greater pollution, deaths and destruction caused by the spill and discharge of toxins, massive deforestation in the world's forests for commercial purposes, losses resulting from many oil spills, the destruction of wildlife habitats, among others, used for the construction of settlements and human activity [1]. This activity also occurs in Indonesia and causes many environmental crises or consequences such as: loss of biodiversity, threats to food security, damage from floods, soil erosion, poor environmental health, and social unrest due to limited rights to water and land [2]. Consequently, in order to solve such issues, particular focus must be given to raising public awareness and fostering an environmentally friendly mindset and way of living. Sustainable development proposes to achieve this goal. Sustainable development requires understanding, awareness and commitment from all parties, especially teachers, students, parents and local governments. The active role of every element of society is very important to achieve sustainable development goals [3], [4]. However, until now, good understanding of the concept and practice of sustainable development is still not evenly distributed at various levels of society, including in the education sector [5]. The educational community must integrate the values of sustainability into the curriculum to support the realization of Education for Sustainable Development (ESD), as education can instil the knowledge and real actions of students to cultivate sustainability values within them [6], [7]. Therefore, integrating ESD with the learning curriculum becomes one of its own challenges in running ESD [8].

To answer this challenge, the Purwakarta Regency Government has initiated the *Tatanén di Balé Atikan* (TdBA) program as a concrete step to actualize sustainable development through education. This program is designed to integrate the values of sustainable development in the educational process with the mission of "caring for the earth and learning from the earth." TdBA is based on the principles of justice, sustainability and local wisdom from *pancaniti*, and aims to instil ecological awareness and social responsibility in students from an early age [9], [10]. The TdBA program with the *Pancaniti* model is a hierarchy of learning based on the value of local wisdom in Sunda society that has five stages, namely: *niti harti*, *niti surti*, *niti bukti*, *niti bakti*, *dan niti sajati*.

Through the TdBA program, Purwakarta Regency is trying to make schools into learning laboratories that provide meaningful learning experiences based on agriculture and local wisdom. This program is not just a farming activity in schools but is also an effort to strengthen character education that is in line with 21st century

learning competencies [11]. Students are at the centre of these activities and can encourage the development of knowledge, skills, and attitudes thoroughly and comprehensively in students. By involving all school members and stakeholders, TdBA is expected to be able to create a generation that has characters that are in accordance with their nature, and the nature of the times, and is committed to sustainable development.

Based on the description above, this research was conducted to answer the following questions:

1. What is the learning profile in the implementation of the TdBA program?
2. How to integrate sustainability values in learning?

2. MATERIALS AND METHODS

2.1. Material

This study aims to describe the implementation of the TdBA in integrating sustainable values in elementary schools. The participants of this study were elementary school teachers from six schools in Purwakarta Regency, West Java Province. These schools were deliberately selected and grouped into three categories (upper, middle and lower) based on their students' graduation results and achievements recorded in the Education Office. Three of those schools are public, while the remaining three are private. To maintain anonymity, the schools are coded as A, B, C, D, E, and F. Data on the number of students in the research school are shown in Table 1 below:

Table 1. Number of students in the research school

Cluster/ School code	Number of Students	Boys	Girls
Upper			
A	737	381	356
B	735	369	366
Middle			
C	319	179	140
D	400	211	189
Lower			
E	162	91	71
F	467	237	230

Source: School's document

This research focuses on integrating sustainability values into learning through the TdBA program. The selected school is an active implementer of the TdBA program.

2.2. Method

The research follows a systematic procedure starting from the preparation stage, data collection and data analysis. In the preparation stage, the researchers identified problems through a review of the literature related to education for sustainable development and socio-scientific decision-making, in particular, environmental and social awareness issues. This review synthesizes theories that support the research's assumptions and provides a basis for fieldwork. Correspondence between theories and field findings is used to validate or develop existing theories, contributing to the novelty of research.

In the second stage, the qualitative data collection process involves: 1) Identifying relevant research participants and locations; 2) Obtain access and permissions; 3) Determine the type of information needed; 4) Designing protocols and instruments for data collection; and 5) Processing collected data while adhering to ethical standards. So that the researcher developed data collection instruments in the form of interview instruments, questionnaires, observation sheets, and document study sheets. The indicators guided the study: 1) the learning profile in implementing TdBA; 2) the integration of sustainability values in learning. Data was gathered through interviews with school principals, teachers, and developers involved in TdBA learning. Interviews and learning videos were transcribed, interpreted, and analyzed using triangulation to ensure validity. The analysis process consisted of data condensation, data display, and conclusion drawing or verification.

3. RESULTS AND DISCUSSION

3.1. Learning profile in the implementation of the TdBA program

The profile of integrating sustainability values in Purwakarta Regency Elementary Schools is seen based on 5 (five) indicators, data collection based on the results of observations, questionnaires, documentation and interviews with school principals and teachers. The results of the data that have been obtained are grouped into Table 2 as follows:

Table 2. Profile of implementation of the TdBA program in elementary schools

Indicator	School Cluster					
	Upper		Middle		Lower	
	School A	School B	School C	School D	School E	School F
Vision and mission contained in integrating sustainability values	+++++	++	+++++	++++	+++	+++
Integrating sustainability values in learning	+++++	++	+++++	++++	+++	++
Integration in everyday habits at school and at home	+++++	++	+++++	+++	+++	+++
Teachers' experience participating in TdBA training	+++++	+	++++	+++	+	++
The teacher's education background	Indonesian Language	Educational Management	Educational Psychology	Basic Education	Basic Education	Islamic Education

Information:

- + = Not Enough
- + + = Enough
- + + + = Good
- + + + + = Excellent
- + + + + + = Very Good

Based on Table 2, the profile of integrating sustainability values shows significant variation between the upper, middle, and lower school clusters. Schools in the upper and middle clusters (A and C) show excellent integration, both in terms of vision and mission, learning, and daily habits, which shows a strong commitment to the holistic application of sustainability values. This is also supported by the diverse background of teachers and the experience of participating in TdBA training in high intensity. In contrast, schools B and D were in the category of good to moderate, where

sustainability integration was seen but not yet fully consistent across all indicators. Meanwhile, the lower cluster schools (E and F) tend to be in the good category, especially in the aspect of daily habits, but are still limited in integration in the vision and mission and experience of TdBA training. This difference in achievement shows that the stronger of institutional commitment and the more experience teachers have in training, the more optimal the integration of sustainability values in vision, learning, and daily practices in schools. In line with research, the vision and mission of schools has an effect on the development of potential in basic knowledge and practical skills in schools [16]. The teacher's education background also plays an important role in the success of integrating sustainability values in schools. Teachers with related education backgrounds can more effectively implement sustainability concepts in their learning and teaching methods [17].

3.2. Profile Integrating Sustainability Values in Learning

The integration of sustainability values in the teaching-learning process is a crucial step that goes beyond knowledge transfer, because it fundamentally aims to develop essential skills, values, and attitudes, such as critical and collaborative thinking, to equip students to face future environmental, social, and economic challenges [18]. This integration in learning varies across schools, influenced by clusters and school resources. Strategic effectiveness in integrating sustainability practices is highly dependent on institutional groupings (clusters), where asset- and network-driven clusters show significant positive outcomes in terms of the management of the Institute's resources and assets [19]. *Upper cluster.* Schools in this cluster focus on teaching sustainable agriculture, social justice, and sustainable living skills. These lessons are in line with the global Sustainable Development Goals (SDGs), which emphasize environmental conservation and character building. For example, School A uses a structured six-stage value integration process in the TdBA program. Activities include a variety of planting tasks that are assigned based on grade level to suit students' abilities. The use of school gardens as a learning resource is an essential contextual pedagogical strategy, which not only enhances theoretical understanding of sustainability and the environment, but effectively bridges the gap between formal knowledge transfer and students' real-world experiences, in line with the school cluster's emphasis on agricultural practices and the development of ecological character [20].

Middle Cluster. Schools in this cluster emphasize the efficient management of resources and the social impact of environmental practices. They integrate sustainability values into environmental education and local content, such as clean

water and sanitation principles. School C, for example, utilizes school garden beds for agricultural activities, fostering ecological awareness through experiential learning.

Lower cluster. Schools in this group are in the early stages of sustainability integration, focusing on basic concepts such as waste management and planting. These activities often occur in extracurricular environments, building ecological responsibility from an early age. For example, School E engages students in soil cultivation, gradually increasing complexity based on grade level.

There is an interesting discovery about how TdBA is carried out, which is using permaculture-based agricultural management, which uses a variety of planting techniques and local resources to promote sustainability. Permaculture activities differ across schools: School A, assigning tasks based on grade level, ranging from environmental observation to growing diverse crops; in School C, using the school space available for agricultural projects; in School E, focusing on soil cultivation and plant nutrition tailored to students' abilities; in Schools B and D, face the challenge of fully implementing permaculture.

The TdBA policy is based on the values of local wisdom of the Sundanese people in education, known as *Pancaniti* [2]. Etymologically, *Pancaniti* consists of two words: "*panca*" which means five, and "*niti*" which means stages [9]. These stages are *niti harti* (observation stage), *niti surti* (understanding stage), *niti evidence* (verification stage), *niti bakti* (problem solving and evaluation stage), and *niti sajati* (presentation and publication stage). *Pancaniti* has similarities with the cognitive level of Bloom's taxonomy. The *Pancaniti* learning model is based on the stages of the learning process that must be completed sequentially, starting with the process of watching, understanding, proven, assessing, and obtaining results [2], [12]. *Pancaniti* activities in schools A and D are used to teach environmental problem solving through projects, while others, such as E and F, still struggle with incomplete understanding and application. The TdBA is in line with several Sustainable Development Goals (SDGs). The relevance of TdBA to the SDGs can be seen in Figure 1.

First, supporting Goal 4 (Quality Education) by combining character education and ecological-based learning. It fosters critical thinking, creativity, and collaboration through real-life environmental experiences, allowing students to make dynamic decisions and think intuitively [13]. *Second*, it discusses Goal 6 (Clean Water and Sanitation) through sustainable resource management. By engaging in school garden activities, participants learn efficient water conservation, ensuring access to clean water, which is essential for human development and combating malnutrition [14].

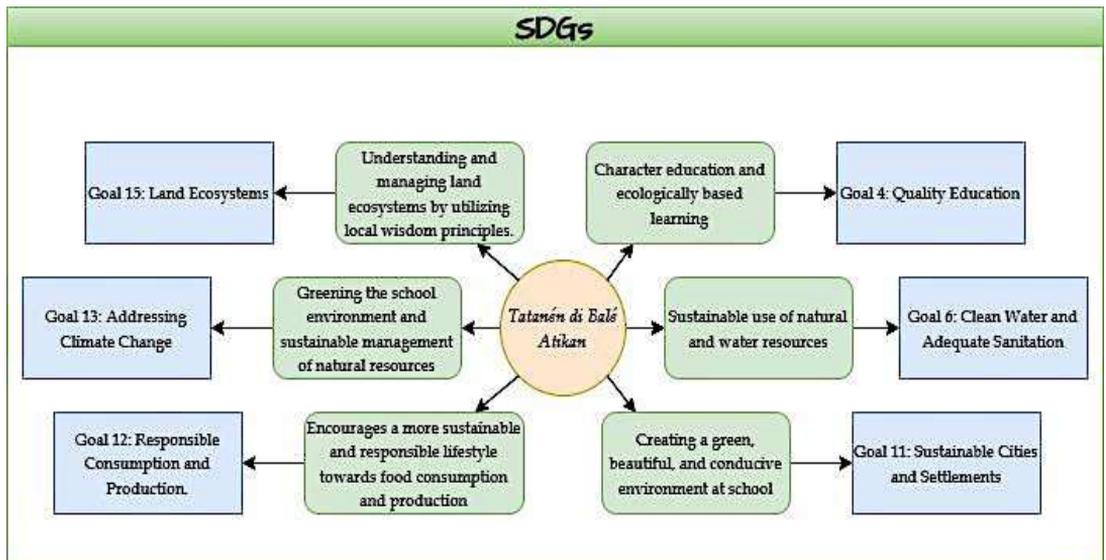


Figure 1. The Relevance of TdBA and the SDGs

Third, the program also supports Goal 11 (Sustainable Cities and Communities) by creating a green and sustainable school environment that promotes social well-being and ecological balance. *Fourth*, for Goal 12 (Responsible Consumption and Production), it teaches sustainable farming practices to minimize waste and encourage responsible eating habits. *Fifth*, addressing Goal 13 (Climate Action), the program's greening initiative combats climate change by reducing pollution and increasing environmental resilience [15]. *Sixth*, Goal 15 (Life on Land) is supported through vermiculture and land optimization, maintaining soil health and biodiversity. Finally, Goal 16 (Peace, Justice, and Strong Institutions) is advanced by building student character and fostering a culture of sustainability and justice, shaping a future generation that is socially responsible. Some of the integration of sustainability values in schools is shown in Figure 2.

Based on Figure 2, it can be seen that each school integrates sustainability values through TdBA activities in a variety of ways according to their respective contexts. School A makes the school yard a learning resource, which fosters students' awareness to appreciate the surrounding environment as a natural laboratory. School B and School E plant and harvest vegetables and rosella tea trees, which in addition to teaching farming skills also instill the value of independence and responsibility in the management of natural resources.



Figure 2: Integration of Sustainability Values in Elementary Schools

School C uses papaya leaves to make eco-prints on clothes, as a form of creativity and appreciation for natural materials while reducing the use of synthetic materials. Meanwhile, School D integrates the *Pancaniti* approach in the classroom, emphasizing reflective learning that connects knowledge with the value of life and sustainability. School F accustomed students to do TdBA exercises regularly, so that sustainability practices become part of their daily lives. This variety of activities shows that the integration of sustainability values not only equips students with knowledge, but also forms attitudes of caring for the environment, life skills, and real behavior in maintaining ecological and social sustainability.

The TdBA program developed is an educational innovation that integrates sustainability values, character education, and ecological awareness in the teaching and learning process. This innovation was born from a deep awareness that education must function as a laboratory of life, combining the philosophical approach of *Pancaniti* with the Permaculture agricultural system to foster the awareness of ecological life and the character of students to be in harmony with the nature of nature and their times [21][22]. Through this approach, students not only acquire academic

knowledge, but also 21st century skills such as critical thinking, creativity, collaboration, and social care needed to achieve the Sustainable Development Goals (SDGs) [23]. The real activities carried out, such as farming, crop processing, and the use of natural materials as learning media, have fostered a culture of caring for the environment while supporting the achievement of the Sustainable Development Goals

(SDGs), especially quality education, sustainable production and consumption, and action on climate change.

Although its implementation still faces various challenges, ranging from limited resources, funding, to consistency of implementation, this program has proven that schools are capable of being agents of change for sustainable development. This can be seen from how school residents are starting to get used to integrating sustainability values in learning and in daily practice. Therefore, strengthening the TdBA program is very important, not only so that it is more embedded in the habits of the school community, but also to be replicated in other schools in Indonesia and other country. As a practical step, the implementation of TdBA in other areas can begin with mapping the potential of the environment around the school, such as yards, gardens, or local resources that can be used as learning laboratories. Furthermore, these activities can be integrated into the curriculum based on local wisdom, for example through the practice of cultivation, processing of crops, or creative works made from natural materials. The role of teachers is essential to direct and guide, so continuous training needs to be provided. The support of parents, the community, and partnerships with various parties are also key factors in the success of the program.

With this strategy, the school not only focuses on academic achievement, but also forms a generation that cares about the environment, is independent, creative, and globally competitive. Education based on local wisdom through TdBA can ultimately be one of the real ways for schools in Indonesia to contribute to the achievement of the sustainable development agenda (SDGs) more broadly.

4. CONCLUSION

The Tatanén di Balé Atikan (TdBA) program integrates sustainability values, character education, and ecological awareness into elementary schools. It fosters 21st-century skills through environmental conservation, supports SDGs goals, and builds social responsibility. Despite challenges like limited resources, it succeeds in shaping schools as agents of change for sustainable development. Therefore, it is important to carry out further strengthening so that this program becomes more embedded in the habits of the school community.

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REFERENCES

- [1] Erhabor, N. I., and Don, J. U.,(2016). Impact of environmental education on the knowledge and attitude of students towards the environment, *International Journal of Environmental & Science Education*, 11, 12, 5367–5375.
- [2] Rachman, E. A., Sari, D. Y., Humaeroh, D., Wahidin, D., and Hanafiah, H., (2022). The model of pancaniti learning in character education, *Journal of Educatio*, 8, 4, 1533–1546.
- [3] Widodo, A., Sriyati, S., Purwianingsih, W., Rochintaniawati, D., Solihat, R., and Siswandari, P., (2023). Development of sustainability values through science lessons, UPI Press, Bandung.
- [4] Eliyawati, E., Widodo, A., Kaniawati, I., and Fujii, H., (2023). Effectiveness of teacher training on environmental education: challenges and strategy for future training program, *Jurnal Penelitian Pendidikan IPA*, 9, 8, 6056–6066, doi: 10.29303/jppipa.v9i8.3153.
- [5] Fiksel, J., Tarsha, E., Frederickson, and Herbert, (2012). A framework for sustainability indicators at EPA, Washington DC: US. Environmental Protection Agency. [Online]. Available: <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=af768fd03660ea37ed5c093f302acc0c19a4ad2d>
- [6] Boeve-de Pauw, J., Olsson, D., Berglund, T., and Gericke, N., (2022). Teachers' ESD self-efficacy and practices: a longitudinal study on the impact of teacher professional development, *Environmental Education Research*, 28, 6, 867–885, doi: 10.1080/13504622.2022.2042206.
- [7] Wahyudin, D., (2018). Peace education curriculum in the context of education sustainable development (ESD), *Journal of Sustainable Development Education Research*, 2, 1, 21-32, doi: 10.17509/jsder.v2i1.12354.
- [8] Educate A Child, (EAC) and FHI 360 (2016). Education and the SDGs, Occasional Paper#2., 13–28, [Online]. Available: <http://educationaboveall.org/uploads/library/file/2a8e15847d.pdf>
- [9] Purwakarta Education Office, (2020). A Guide to tatanen di bale atikan, No. 1. 2020, 1–296. - Purwakarta.
- [10] Purwakarta Regional Government, (2021). Regent Regulation No. 103 of 2021 concerning Tatanen in Bale Atikan. - Purwakarta.
- [11] Wulandari, D., Narkum, N., Supendi, D., Mukti, S., and Setiawan, U., (2023). Building the ecological awareness of school residents through agricultural IHT in education at SDN 3 Nangewer, Darangdan District, Purwakarta Regency, *El-Mujtama Journal of Community Service*, 4, 2, 1482–1491, doi: 10.47467/elmutjama.v4i2.5665.
- [12] Azizah, A., Alindra, A. L., Nisa, F. F., Rosyada, A. A., Nengsih, N. W., Fireli,

- P., Prayogo, R. S., (2024). Ecologists school program for the development of environmental awareness, *Jurnal Pendidikan Tambusai*, 8, 1,1262–1271.
- [13] Nazar, R., Chaudry, I. S., Ali, S., and Faheem, M., (2018). Role of quality education for sustainable development goals (SDGs), *PEOPLE International Journal of Social Science*, 4, 2, 486–501, doi: 10.20319/pijss.2018.42.486501.
- [14] Shehu B., and Nazim, F., (2022). Clean water and sanitation for all: study on SDGs 6.1 and 6.2 targets with state policies and interventions in Nigeria, *Environmental Science Proceeding*, 15, 71, 1-12, doi: 10.3390/environsciproc2022015071.
- [15] Al-Delaimy, W. K., Ramanathan,V., and Sorondo, M. S., (2020). Health of people, health of planet and our responsibility: climate change, air pollution and health. Springer Open, Switzerland. doi: 10.1007/978-3-030-31125-4.
- [16] Suswardana, G. (2021). The Implementation of the School's Vision and Mission in Realizing Teaching and Learning Activities at SDLBN Kedungkandang Malang" (2022) *Vocat : Journal of Catholic Education*, 1,2, 95–104. doi:10.52075/vctjpk.v1i2.33.
- [17] Istiningsih, M. Pd. (2020). Integration of Education for Sustainable Development (PPB) in Teacher Education in Southeast Asia: A Guide for Educators. Yogyakarta: CV. Beautiful graphics. ISBN: 9798205405.
- [18] Cahyono H. (2024). Strategies for integrating continuing education into the curriculum. *J Prophetic*, 5, 1, 15-30. doi:10.24127/prophet.v5i1.7466.
- [19] Takahashi S, Kudo S, Konno S, Teshima Y, Kawamoto H. (2020). Strategic Options for Campus Sustainability: Cluster Analysis on Higher Education Institutions in Japan. *Sustainability*,12,6, 2527. doi:10.3390/su12062527.
- [20] Prasetya F, Wibowo S, Mulyadi D. (2022) The use of school gardens as a learning resource for environmental education to increase the ecological awareness of elementary school students. *J Basic Educator*. ,14,1,15–26. doi:10.17509/jptk.v14i1.43015.
- [21] Ismelani N, Mahmudah R, Rosmaladewi O. (2023). Implementation of the Independent Curriculum in Realizing the Pancasila Student Profile Through the Tatanen Program at Bale Atikan, Purwakarta Regency. *Islam Educ J*, 5, 1, 17. doi:10.37081/iej.v5i1.503.
- [22] Yusuf M. (2021). Agricultural Movement in the Classroom: Contextual Education Innovation in Purwakarta. *J Basic Educator Innovation*, 6, 1, 45–53. <https://doi.org/10.23969/jp.v10i2.25573>.
- [23] Kartika D, Hamidah IN, Gaol NML, Hindun S, Anggraeni DN, Iskandar S. (2021). Agricultural Counseling in Improving 21st Century Competency Through TDBA's STEM-Based Project-Based Learning. *Lantern of Educational Work J Devotion to the Masy*, 1, 2, 70–81. doi:10.17509/lentera.v1i2.34552.

CIRCULAR WAREHOUSING AND WORK SKILLS: A SYNERGY FOR A SUSTAINABLE FUTURE

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ABSTRACT - Circular Economy (CE) has been adopted in various sectors, including the logistics industry. CE aims to decouple the value of consumption, production, and resources, resulting in sustainable production and consumption aligned with Sustainable Development Goal (SDG) 12. This transition to CE is supported by Circular Logistics, where the transformation of logistics activities such as warehousing will depend on adequate skills. Existing literature does not sufficiently describe the skills required for the circular transition, and few studies address this topic. This study research, particularly on professional job profiles and warehousing skills, using an integrated review method to identify and categorize skills that can be adopted in circular practices in warehousing. The data comprises research from the past five years, with 15 primary references deemed most relevant. This was further complemented by interviews with logistics practitioners with over 20 years of experience. The findings of the study reveal that the identified skills are systematically and structurally organized. The core skills identified include reverse logistics management, waste reduction strategies, sustainable inventory control, digital competency in tracking circular materials, and interdisciplinary collaboration. These competencies are essential for ensuring a smooth transition to circular warehousing practices. Based on these findings, the research proposes a set of professional job profiles and ideal skills for warehousing, along with actionable recommendations through educational and training activities. The study suggests that vocational training programs, competency-based learning models, and industry-academia collaborations play a crucial role in developing skilled professionals for circular logistics. This study contributes to providing practical insights into skilled and sustainable human resources for circular warehousing. By bridging the skill gap in the logistics workforce, the research supports the broader agenda of sustainable industrial transformation. Future research should explore the integration of emerging technologies, such as AI-driven logistics and blockchain for supply chain transparency, to further enhance circular warehousing efficiency and sustainability.

Keywords: Circular Economy, Circular Warehousing, Competency

1. INTRODUCTION

The concept of Circular Economy (CE) has been widely adopted by industries to achieve sustainable production and consumption [1], [2]. CE strongly supports global

development through the 17 Sustainable Development Goals (SDGs), particularly Goal 12, which focuses on responsible production and consumption [3]. Circular Logistics (CL) is a crucial component of CE as it provides the necessary infrastructure and logistical processes that enable products and materials to continuously circulate within the CE system [2]. Without efficient and sustainable logistics management, CE cannot function optimally, as material and product flows in the recycling or reuse chain heavily depend on logistical efficiency [4], [5], [6]. Research conducted in 2019 projected that by 2030, more job opportunities would emerge [7]. According to the presentation by Indonesia's Directorate General of Vocational Education at the Vocational Education Reform FGD, there is a potential for 27-46 million new jobs, with 10 million being entirely new job types. This perspective highlights that new job roles will require new skills [8]. This shift will necessitate a transformation in the labor market [9]. Circularity will impact the workforce in both job profiles and required skill sets.

Existing research does not comprehensively address the competencies needed for the circular transition, with only a few studies exploring this aspect [10], [11]. The absence of specific competencies to support circular activities will delay the implementation of CE, which is inherently complex [1]. Without a clear framework, neither companies nor governments can effectively invest in upgrading and upskilling the workforce. Several studies have started to focus on the role of skills in CE. Neri and Simone [12] conducted research identifying four core competencies that support CE in the fashion industry, while [13] explored key skills needed for CE in the construction industry. Additionally, [11] examined the required skills and job roles in the manufacturing sector using a Systematic Literature Review (SLR). In 2022, Rebecca Clube investigated new job roles related to CE. Other studies supporting CE include [7] on workers in the circular economy.

The purpose of this study is to review existing literature to identify the skills and competencies required by the production industry in implementing CE strategies through CL activities. Additionally, the study aims to map and propose a framework for defining new job requirements that support CE. Therefore, this research seeks to answer the research question: "What skills are required for each job profile in warehousing that adopts CE strategies?" The remainder of this article is structured as follows: Section 2 describes the methodology employed to achieve the research objectives; Section 3 presents and discusses the results, including the framework and essential skills required to support CE implementation, particularly for professional job profiles in warehousing, to realize circular warehousing. Section 4 concludes the study, highlighting its limitations and future research opportunities.

2. MATERIALS AND METHODS

This study employs an integrated review as a research method to synthesize and analyze diverse studies covering various methods, issues, and current findings regarding the skills required for CE by companies operating within the context of warehousing activities. Through synthesizing existing literature, this integrative review aims to identify patterns, trends, and research gaps while providing insights to guide future research directions, policymaking, and interventions to identify the necessary skills for implementing CE strategies in warehousing.

The integrated review approach consists of five stages that guide the review design: (1) problem identification, ensuring that research questions and objectives are precisely defined; (2) literature search, characterized by the design and implementation of a comprehensive and systematic search strategy; (3) data evaluation, involving a thorough examination of the authenticity, methodological quality, informational value, and representativeness of the available primary sources; (4) data analysis, encompassing data reduction, presentation, comparison, and conclusion drawing; (5) presentation, synthesizing findings into a comprehensive model through an integrated process overview, explanation of research implications, and acknowledgment of limitations within the review.

A qualitative approach is incorporated to strengthen this research through interviews with practitioners with over 20 years of experience in logistics, particularly in warehousing. This effort aims to reinforce the findings of the integrated review. The interview stage serves as an additional step to confirm the results of the integrated review, providing a clearer picture of warehousing job skills. The methodological stages are illustrated in Figure 1.

Figure 1 illustrates the research procedure undertaken by the researcher. This study aims to address the research objectives by employing a systematic integrated review method, ensuring the inclusion of accurate and credible sources to maintain research quality. Detailed information on each research procedure stage is elaborated in sections 2.1 to 2.5.

2.1 Problem Identification

This study identifies the essential skills required in logistics warehouses supporting Circular Economy (CE) strategies. The problem identification highlights a literature

gap regarding workplace skills across various warehouse professions. The research question focuses on defining these essential competencies.

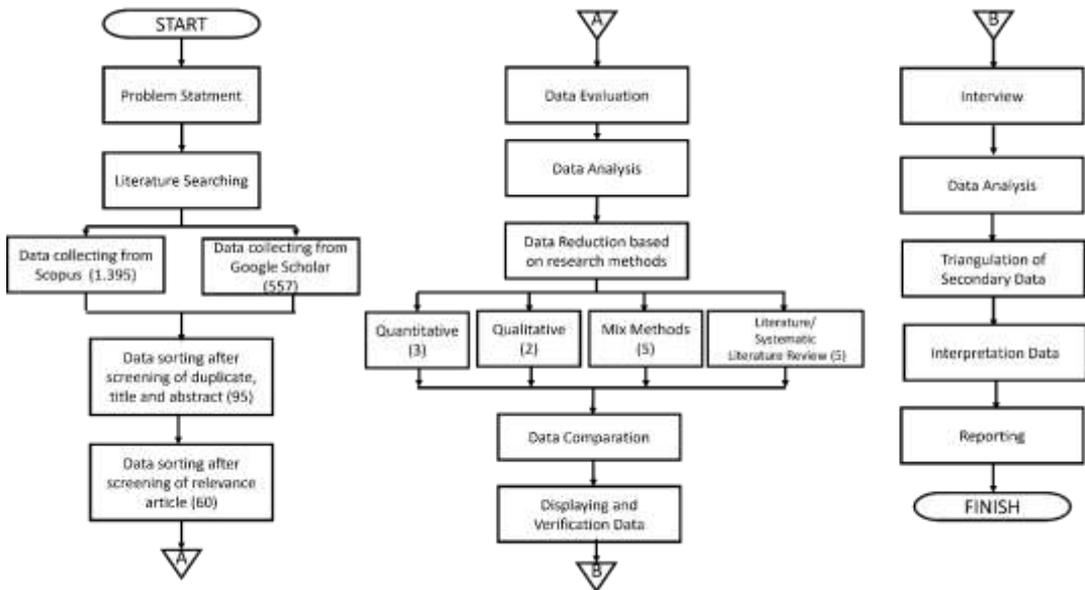


Figure 1. Research Steps

2.2 Literature Research

The literature search employs three strategies: database searches (Scopus, ScienceDirect, ProQuest), internet searches (Google Scholar, Google), and snowball sampling. The review includes peer-reviewed sources from 2001–2024, emphasizing transferable and interdisciplinary skills while excluding technical skills. A total of 1,952 sources were screened, with 60 meeting the final inclusion criteria.

2.3 Data Evaluation and Analysis

The data evaluation phase assesses study credibility using CASP criteria, identifying eight key warehouse job profiles. Data analysis follows five steps: reduction, display (via tables), comparison, interpretation, and verification. The study systematically categorizes research methodologies and synthesizes findings to map essential competencies across warehouse roles, ensuring reliability through cross-validation and

analytical rigor. This study examines the competencies required across various job profiles in the logistics and warehousing industry to support the implementation of the circular economy (CE). Based on a comprehensive literature review, the study identifies key competency areas discussed by various scholars between 2014 and 2024. These competencies encompass occupational skills, logistics management, warehouse operations, information technology, leadership, and the implementation of logistics management systems and CE principles. The analysis focuses on eight professional roles within warehousing: Warehouse Manager, Inventory Control Specialist, Forklift Operator, Receiving Clerk, Shipping Clerk, Warehouse Associate, Quality Control Inspector, and Warehouse Coordinator. Each role entails specific responsibilities, including operational supervision, inventory management, packaging and shipping, and quality control.

2.4 Qualitative Approach

This research employs a qualitative approach, incorporating interviews with logistics practitioners with over 20 years of experience. The interviews, conducted in person in December 2024, comprise 20 structured questions derived from the literature review. Data analysis involves interview transcription, manual coding, and the identification of relationships between responses. Data triangulation is performed by comparing interview findings with secondary research sourced from Scopus to enhance the validity of the results.

2.5 Interpretation

In the data interpretation phase, the findings are contextualized within relevant theoretical frameworks and literature to gain a deeper understanding of the competencies required in warehousing to support CE. The reporting process follows a narrative format, integrating direct interview quotations and literature review findings, accompanied by visual representations of the competencies essential for warehousing professionals. This study provides in-depth insights into the skill sets essential for the logistics and warehousing workforce, particularly in fostering sustainability and advancing the principles of the circular economy.

3. RESULTS AND DISCUSSION

This section presents a descriptive analysis based on the literature research to systematically examine the literature related to transversal skills. Figure 2 illustrates the trend in the use of transversal skills over time, highlighting a growing interest and increasing number of publications in this area. This upward trend indicates the rising importance of transversal skills across various professional and educational contexts, emphasizing their critical role in adapting to dynamic workplace demands and enhancing individual competencies.

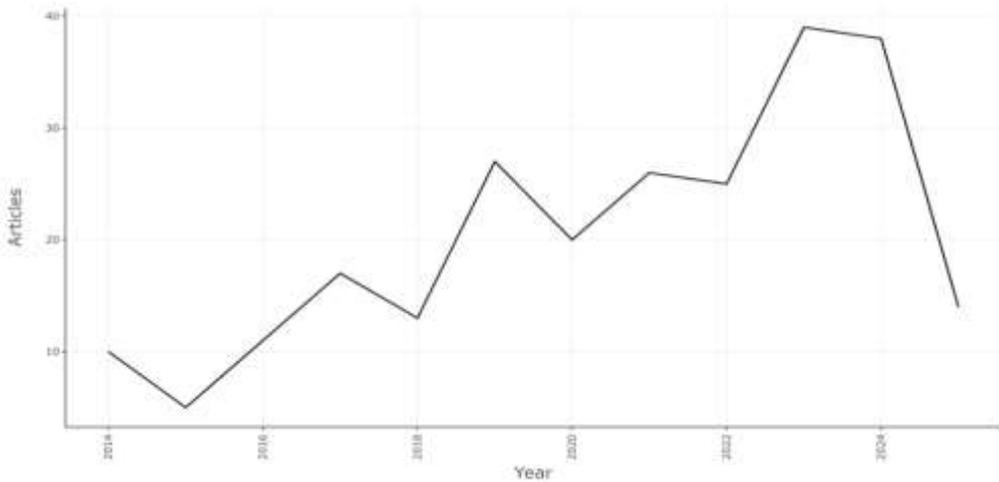


Figure 2. Evolution of Transversal Skills in 10 years

Figure 2 illustrates that publications on transversal skills have seen a significant increase since 2014, with a sharp surge beginning in 2019 and reaching a peak in 2023 with 39 articles. This upward trend highlights a growing academic interest in the role of transversal or cross-cutting skills—such as communication, critical thinking, collaboration, and adaptability—in enhancing graduates’ employability and lifelong learning. These skills are increasingly recognized as essential in navigating the demands of the 21st-century workforce, particularly in rapidly evolving and interdisciplinary environments. Figure 3 presents the distribution of the number of articles that use various research methods in the study of skills and transversal skills. Each horizontal bar represents the number of articles found based on a particular

method, making it easier to identify the methods most frequently used by researchers in the past ten years.

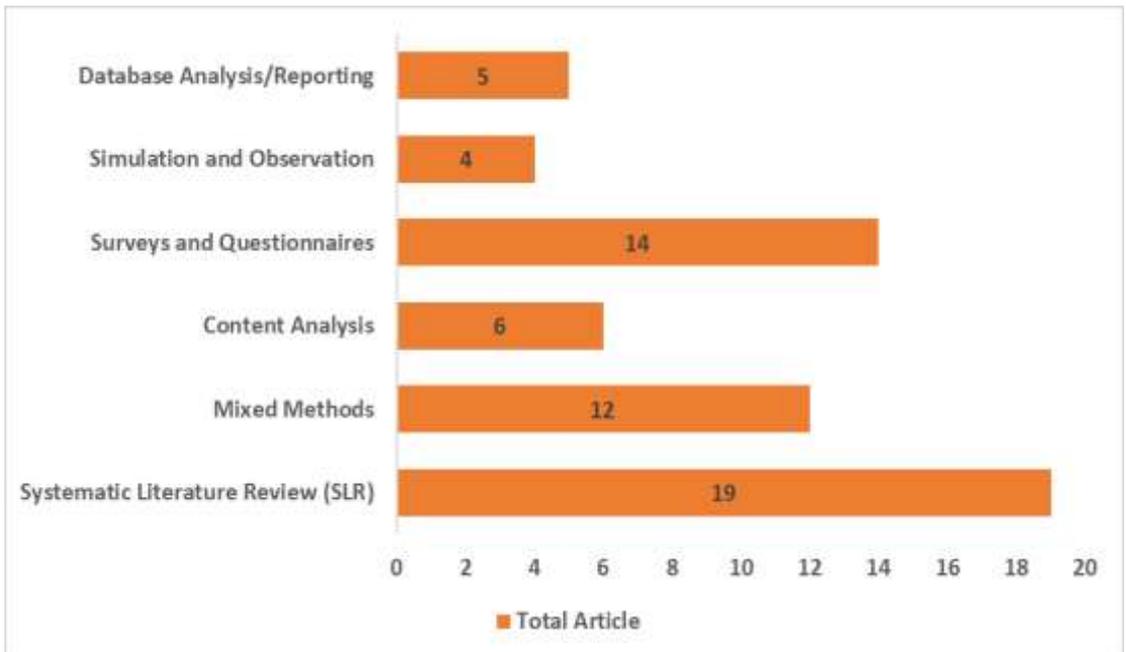


Figure 3. Article Based on Methods

Figure 3, it can be seen that the Systematic Literature Review (SLR) method dominates with 19 articles, indicating strong attention to a comprehensive and replicable approach in identifying skills related to logistics and the circular economy. The Surveys and Questionnaires method ranks second with 14 articles, reflecting efforts to

collect large-scale quantitative primary data. Mixed Methods are also quite significant with 12 articles, highlighting the importance of data triangulation to enhance research validity. Meanwhile, Content Analysis was used in 6 articles and Database Analysis/Reporting in 5 articles, showing interest in document-based analysis and standardized databases. The least-used method is Simulation and Observation with 4 articles, likely due to the more complex experimental conditions required. Overall, this pattern indicates the dominance of literature-based and survey methods in logistics research, while observational and simulation methods remain relatively limited in use.

A comprehensive content analysis of these publications is crucial to derive precise conclusions regarding professional job profiles and the essential skill sets required in warehouse operations. Each role in circular warehousing demands a distinct combination of competencies. For instance, a Warehouse Manager must possess strong time management skills to oversee inventory flow and meet deadlines, ensuring seamless supply chain operations. Leadership is also vital, enabling effective team motivation and direction to create a productive and efficient work environment. Proficiency in Warehouse Management Systems (WMS) enhances inventory tracking and layout optimization, improving accuracy and productivity. Furthermore, knowledge of occupational safety procedures ensures compliance with safety standards, protecting employees from hazards and maintaining operational continuity [14, [15].

Supporting the Warehouse Manager, an Inventory Control Specialist requires high attention to detail to manage stock accurately, minimize recording errors, and maintain up-to-date inventory data. Familiarity with inventory systems facilitates efficient stock tracking, while an understanding of stock cycles ensures optimal availability. Strong data analysis capabilities aid decision-making by identifying stock trends, procurement needs, and mitigating overstock or shortages.

A Forklift Operator must hold certification to demonstrate proficiency in safe and efficient operation. A thorough understanding of safety protocols, such as the proper use of personal protective equipment (PPE) and adherence to safety procedures, reduces workplace risks. Coordination skills are essential for navigating busy warehouses and ensuring precise material handling. Other key roles include the Receiving Clerk, responsible for meticulous quality and quantity checks upon delivery; the Shipping Clerk, ensuring timely and secure packaging; and the Warehouse Coordinator, overseeing workflow efficiency. Each position collectively enhances warehouse productivity and supply chain reliability.

Interviews indicate that warehouse workers require a combination of technical competencies and strategic understanding of Circular Economy (CE) principles [11], [14], [15]. Mastering these principles is fundamental to ensuring that warehouse operations support sustainability. CE prioritizes resource efficiency through reuse,

recycling, and waste reduction (3R principles). One of the key technical competencies Circular Material Management, which enables workers to track reusable materials, directly influencing warehouse efficiency. Additionally, Technology and Digitalization play a crucial role in enabling real-time inventory tracking, particularly in reverse logistics and waste management. As one interviewee stated:

"Workers must understand the concepts of reuse, recycling, and reduction, as well as how to apply them in warehouse operations. Without this knowledge, integrating CE into workflows becomes challenging. Additionally, the ability to track recycled goods and secondary raw materials is crucial to maintaining supply chain quality." (E.S., December 2024)

These findings align with studies from the World Economic Forum and logistics industry reports, which highlight that CE implementation, particularly the 3R approach, can reduce operational costs by up to 30% [1], [11]. Research from the Journal of Cleaner Production emphasizes that tracking recycled goods and secondary raw materials enhances supply chain sustainability [11]. This aligns with Government Regulation No. 81/2012 on Waste Management, which mandates industry compliance with 3R principles. Beyond technical skills, soft skills are essential for effective CE implementation. Collaboration and communication ensure cross-functional teams work in harmony, while creative problem-solving drives innovations that transform waste into economic value. Environmental awareness fosters a sustainability mindset, which is critical for CE adoption.

Key challenges arise from both internal and external factors. The lack of training indicates a need for workforce upskilling to align competencies with CE principles. Infrastructure limitations, such as inadequate facilities for sustainable processes, pose operational barriers. Additionally, resistance to change highlights cultural challenges in adopting new mindsets. Interview data reinforce that warehouse efficiency relies on seamless collaboration across various roles. As stated by E.S.:

"Warehouse operations depend on multiple roles, from the Warehouse Manager overseeing operations to the Forklift Operator ensuring safe material movement. Inventory Control Specialists and Receiving Clerks maintain stock accuracy, while

Shipping Clerks ensure timely dispatch. Warehouse Associates support daily operations, and Quality Control Inspectors uphold product standards. The Warehouse Coordinator integrates all activities, ensuring smooth communication and workflow." (E.S., December 2024).

These findings align with insights from DHL Supply Chain and research in the International Journal of Logistics Management, which indicate that team coordination can boost productivity by 25% [7], [8], [9]. The Council of Supply Chain Management Professionals (CSCMP) also highlights that clearly defined roles contribute to responsive logistics systems.

In the context of transversal skills, professional profiles in warehousing—such as the eight identified job profiles—require competencies that extend beyond technical tasks to include skills applicable across various occupational domains. This study does not provide explicit guidelines delineating the distinctions and specific skill requirements within warehousing. However, based on the findings, the authors attempt to illustrate these transversal skills, which encompass six essential competencies, as depicted in Figure 4.

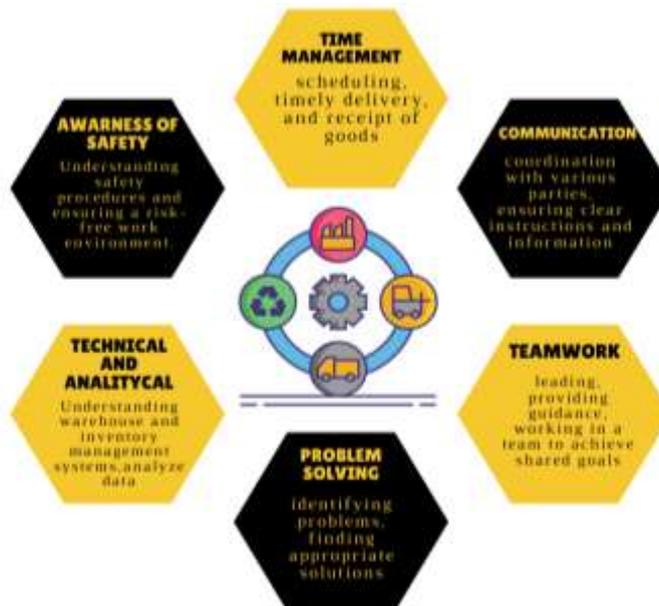


Figure 4. Primary Skills in Circular Warehousing

Based on Figure 4, warehouse professionals with strong time management skills can effectively schedule tasks to ensure timely delivery and receipt of goods. This competency is increasingly critical in logistics and supply chain operations that rely on just-in-time (JIT) delivery models, where delays can cause significant disruptions and financial losses [16]. Effective communication skills enable them to coordinate with teams and stakeholders, ensuring clear instruction dissemination. In multicultural and globalized supply chain environments, communication also involves cross-cultural competence and the ability to use digital collaboration tools to maintain operational efficiency [17].

Leadership and teamwork abilities are crucial for achieving shared objectives, while problem-solving skills allow them to respond swiftly and effectively in dynamic situations. These skills are especially relevant as warehouses adopt automation and digital technologies, requiring professionals to collaborate with both human colleagues and smart systems in hybrid work settings [18]. Additionally, technical and analytical competencies—such as warehouse management systems, inventory control, and data analysis—support accurate decision-making. The integration of Artificial Intelligence (AI) and predictive analytics into warehouse operations has further heightened the demand for analytical skills, enabling predictive maintenance, demand forecasting, and process optimization [19], [20].

A high level of safety awareness ensures adherence to protocols, fostering a secure work environment. This is critical not only for compliance with occupational health and safety standards but also for minimizing risks associated with automated equipment and hazardous materials handling [21].

Following the analysis of required competencies for each warehouse professional profile, the need for upskilling and upgrading must be further emphasized. Educational institutions, particularly those preparing students for the workforce, should focus on sustainable warehousing skills that align with Circular Economy (CE) principles. For instance, waste reduction, reverse logistics, and resource optimization should be embedded in the curriculum to prepare graduates for green logistics practices [22], [23]. Integrating theoretical knowledge with practical application is essential to bridge technical and soft skills, ensuring that warehouse professionals are equipped with the

competencies necessary for an evolving industry landscape. Partnerships between Technical and Vocational Education and Training (TVET) institutions and industry stakeholders can create work-integrated learning pathways, ensuring that graduates meet both current and future labor market demands [22], [23].

Ultimately, developing warehouse and logistics competencies requires a holistic approach that combines technical expertise, soft skills, and sustainability awareness. TVET systems must not only respond to the current needs of industry but also anticipate future disruptions such as digital transformation, e-commerce growth, and the green transition. This means embedding lifelong learning pathways, fostering adaptability, and promoting innovation-driven mindsets among learners. By doing so, warehouse professionals will be empowered to navigate uncertainties, enhance operational resilience, and contribute to building sustainable and competitive supply chains in the global market [23], [24].

The findings of this study highlight the urgent need for TVET institutions to integrate Circular Economy (CE) principles into logistics and warehousing curricula. Embedding core topics such as reverse logistics, waste reduction, sustainable inventory management, and resource optimization can align graduates' competencies with SDG 12. Competency-based and work-integrated learning models—through apprenticeships, internships, and industry projects—are essential to bridge theoretical knowledge with practical application, while ensuring that learners develop both technical and soft skills needed in circular logistics practices.

At the policy level, continuous upskilling and reskilling programs must be supported through short-term courses, certifications, and digital competency training, including AI-driven analytics and blockchain for supply chain transparency. Cross-disciplinary collaboration among TVET institutions, universities, and industry can foster innovation labs and joint modules that strengthen sustainability-oriented skills. Governments and regulatory bodies should provide incentives, frameworks, and recognition for institutions pioneering CE-aligned education, while embedding lifelong learning pathways to prepare professionals for future challenges in digital transformation, e-commerce growth, and the green transition.

4. CONCLUSION

This study highlights the importance of both technical and transversal skills in ensuring the success of warehouse operations. Key competencies such as time management, communication, leadership, teamwork, problem-solving, and safety awareness play a crucial role in enhancing efficiency and promoting sustainability in circular warehousing. These skills enable professionals to adapt to industry demands, optimize resource utilization, and contribute to environmentally responsible logistics practices. The findings emphasize that sustainable warehousing is not solely reliant on technological advancements but also on a well-trained workforce capable of integrating circular economy principles into daily operations. Developing these competencies through vocational education and industry collaboration is essential for preparing future logistics professionals. For future research, exploring job profiles in other industries could provide a broader perspective on skill requirements across different logistics sectors. Additionally, examining cross-functional competencies within the logistics field may offer deeper insights into how diverse skills interact to improve operational effectiveness. Strengthening these areas will further support the transition toward a more sustainable and efficient warehousing system. For future research, exploring job profiles in other industries could provide a broader perspective on skill requirements across different logistics sectors. Additionally, examining cross-functional competencies within the logistics field may offer deeper insights into how diverse skills interact to improve operational effectiveness. Strengthening these areas will further support the transition toward a more sustainable and efficient warehousing system, while also opening opportunities to expand research into other logistics sectors beyond warehousing.

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experience, whose insights were crucial in validating our findings on professional job profiles and warehousing skills for circular logistics. We also appreciate our colleagues from the Logistics Engineering, Family Welfare Education, and Technical and Vocational Education Study 64 program at UPI for their valuable feedback. Furthermore, we acknowledge scholars whose works contributed to our integrated review. Lastly, we thank our families and friends for their unwavering support. This study aims to advance sustainable logistics and develop a skilled workforce for circular warehousing. Any shortcomings remain our responsibility.

REFERENCES

- [1] Ferreira, J. J., C Fernandes, A. J., & Ramírez-Pasillas, M. (2024). Start-ups and entrepreneurial ecosystems in the circular economy: A multi-level approach for safe and just planetary boundaries. *International Small Business Journal: Researching Entrepreneurship*, 42(4), 416–445. <https://doi.org/10.1177/02662426231210765>
- [2] Tantranont, N., & Sawatdeenarunat, C. (2023). School Management for Sustainable Development in Energy and Environmental Excellence. *Pertanika Journal of Social Sciences and Humanities*, 31(1), 401–422. <https://doi.org/10.47836/pjssh.31.1.21>
- [3] Woschank, M., & Pacher, C. (2020). Program planning in the context of industrial logistics engineering education. *Procedia Manufacturing*, 51(2019), 1819–1824. <https://doi.org/10.1016/j.promfg.2020.10.253>
- [4] Al-Minhas, U., Ndubisi, N. O., & Barrane, F. Z. (2020). Corporate environmental management: A review and integration of green human resource management and green logistics. *Management of Environmental Quality: An International Journal*, 31(2), 431–450. <https://doi.org/10.1108/MEQ-07-2019-0161>
- [5] Boysen, N., & de Koster, R. (2024). 50 years of warehousing research—An operations research perspective. *European Journal of Operational Research*, 320(3), 449–464. <https://doi.org/10.1016/j.ejor.2024.03.026>
- [6] Buch, R., Marseille, A., Williams, M., Aggarwal, R., & Sharma, A. (2021). From waste pickers to producers: An inclusive circular economy solution through development of cooperatives in waste management. *Sustainability (Switzerland)*, 13(16). <https://doi.org/10.3390/su13168925>
- [7] Burger, M., Stavropoulos, S., Ramkumar, S., Dufourmont, J., & van Oort, F. (2019). The heterogeneous skill-base of circular economy employment.

- Research Policy*, 48(1), 248–261. <https://doi.org/10.1016/j.respol.2018.08.015>
- [8] Foundation, E.M., 2014. *Towards the Circular Economy: Vol. 1: Economic and Business Rationale for an Accelerated Transition*, vol. 1. Ellen MacArthur Foundation.
- [9] Hofmann Trevisan, A., Acerbi, F., Dukovska-Popovska, I., Terzi, S., & Sassanelli, C. (2024). Skills for the twin transition in manufacturing: A systematic literature review. *Journal of Cleaner Production*, 474, 143603. <https://doi.org/10.1016/j.jclepro.2024.143603>
- [10] Irving, H. (2016). Paper salvage in Britain during the Second World War. *Historical Research*, 89(244), 373–393. <https://doi.org/10.1111/1468-2281.12135>
- [11] Lagorio, A., Colombo, B., Cimini, C., & Gaiardelli, P. (2024). The future of green skills for the manufacturing sector. *IFAC-PapersOnLine*, 58(19), 533–538. <https://doi.org/10.1016/j.ifacol.2024.09.267>
- [12] Dwiyanti, V., Wulansari, D. N., & Okitasari, H. (2021). Competencies Needed for Vocational Education Graduates in Logistic Industry: A Systematic Review. *Online Journal for TVET Practitioners*, 6(2), 11–20. <https://penerbit.uthm.edu.my/ojs/index.php/oj-tp/article/view/7992>
- [13] Elena Beducci, Federica Acerbi, Marta Pinzone, Marco Taisch,. (2024). Unleashing the role of skills and job profiles in circular manufacturing, *Journal of Cleaner Production*, Volume 449, 2024, 141456, ISSN 0959-6526, <https://doi.org/10.1016/j.jclepro.2024.141456>.
- [14] Neri Karra Sillaman, Simone de Colle. (2024). Four core competencies toward the circular economy: Insights from a born-sustainable firm, *Journal of Business Venturing Insights*, Volume 22, e00475, ISSN 2352-6734, <https://doi.org/10.1016/j.jbvi.2024.e00475>.
- [15] Roland Quashie, Frank D.K. Fugar, Prince Antwi-Afari, S. Thomas Ng.,(2024). Evaluating the key competency skills of construction professionals for the attainment of circular construction in developing economies, *Cleaner Production Letters*, Volume 6, 100060, ISSN 2666-7916, <https://doi.org/10.1016/j.clpl.2024.100060>.
- [16] Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2020). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768. <https://doi.org/10.1016/j.jclepro.2016.12.048>
- [17] Gunasekaran, A., Papadopoulos, T., Dubey, R., Fosso Wamba, S., Childe, S. J., Hazen, B., & Akter, S. (2022). Big data and predictive analytics for supply chain and organizational performance. *Journal of Business Research*, 70, 308–317. <https://doi.org/10.1016/j.jbusres.2016.08.004>
- [18] International Labour Organization. (2022). *Safety and health at the heart of the future of work: Building on 100 years of experience*. ILO.

- <https://www.ilo.org/global/topics/safety-and-health-at-work/lang--en/index.htm>
- [19] Kumar, A., Singh, R. K., & Modgil, S. (2022). Exploring the relationship between Artificial Intelligence and sustainable manufacturing: A framework for future research. *Journal of Cleaner Production*, 257, 120508. <https://doi.org/10.1016/j.jclepro.2020.120508>
- [20] Organisation for Economic Co-operation and Development. (2022). *Skills outlook 2022: The future of work*. OECD Publishing. <https://doi.org/10.1787/df80bc12-en>
- [21] Tran, T., & Daim, T. U. (2023). Cross-cultural communication and collaboration in global supply chains. *International Journal of Production Research*, 61(12), 4021–4039. <https://doi.org/10.1080/00207543.2022.2123456>
- [22] UNESCO-UNEVOC. (2023). *Greening technical and vocational education and training: A practical guide for institutions*. UNESCO-UNEVOC International Centre for TVET. <https://unevoc.unesco.org/pub/greening-tvet-guide.pdf>
- [23] World Economic Forum. (2023). *The future of jobs report 2023*. World Economic Forum. <https://www.weforum.org/reports/the-future-of-jobs-report-2023>
- [24] Xu, X., Lu, Y., Vogel-Heuser, B., & Wang, L. (2023). Industry 4.0 and smart manufacturing: A review of engineering education perspectives. *Engineering*, 5(4), 760–770. <https://doi.org/10.1016/j.eng.2019.01.018>

INTEGRASI KECERDASAN BUATAN DALAM MODUL KURSUS ASAS HAJI: KAJIAN KES PELAJAR DIPLOMA HAJI DAN UMRAH DI KOLEJ PROFESIONAL MAIWP

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ABSTRAK - Kajian ini menilai kesesuaian dan keberkesanan integrasi Kecerdasan Buatan (AI) dalam Modul Kursus Asas Haji (KAH) oleh Tabung Haji sebagai bahan rujukan pembelajaran pelajar Diploma Haji dan Umrah di Kolej Profesional MAIWP. Kajian kuantitatif ini telah menggunakan kaedah tinjauan melalui soal selidik dalam talian yang melibatkan 38 responden yang mengikuti sesi pengajaran dan pembelajaran berasaskan modul tersebut. Instrumen kajian merangkumi empat aspek utama iaitu penilaian kandungan modul, kaedah penyampaian, integrasi AI, dan tahap kepuasan keseluruhan pelajar. Hasil analisis menunjukkan bahawa majoriti pelajar menilai modul ini pada tahap memuaskan hingga sangat memuaskan, khususnya dalam aspek penjelasan mengenai rukun haji, larangan ihram, serta susunan topik yang sistematik dan mudah difahami. Penggunaan bahan visual, simulasi, kuiz interaktif, serta nota ringkas yang dijana melalui AI turut didapati berkesan dalam meningkatkan kefahaman pelajar terhadap amalan praktikal ibadah haji. Keberkesanan ini membuktikan bahawa integrasi AI dalam modul ini bukan sahaja mampu memperkayakan pengalaman pembelajaran pelajar, tetapi juga memudahkan mereka memahami konsep dan langkah ibadah secara lebih mendalam dan interaktif. Secara keseluruhan, kajian ini menyimpulkan bahawa integrasi AI dalam Modul Kursus Asas Haji adalah relevan dan wajar diaplikasikan secara lebih meluas di peringkat diploma dengan penambahbaikan yang berterusan agar selari dengan keperluan akademik semasa dan perkembangan teknologi terkini. Dapatan kajian ini memberikan implikasi penting terhadap pembangunan kurikulum serta pendekatan pengajaran Haji dan Umrah di institusi pengajian tinggi di Malaysia, khususnya dalam memanfaatkan teknologi moden bagi meningkatkan kualiti pendidikan agama. Dengan adanya teknologi AI, proses pembelajaran menjadi lebih dinamik dan menarik, sekali gus membantu memastikan pelajar mendapat pemahaman yang lebih menyeluruh dan praktikal.

Katakunci: Modul Kursus Asas Haji (KAH); Kecerdasan Buatan (AI); Integrasi; Diploma Haji dan Umrah; Kolej Profesional MAIWP

1. PENDAHULUAN

Ibadah haji merupakan salah satu daripada rukun Islam yang tidak boleh disangkal lagi kewajibannya, dan ianya dilaksanakan oleh setiap Muslim yang berkemampuan [8].

Kewajiban ini bertitiktolak daripada firman Allah SWT dalam Surah Ali ‘Imran ayat ke-97:

“Di situ ada tanda-tanda keterangan yang nyata (yang menunjukkan kemuliaannya; di antaranya ialah) Makam Nabi Ibrahim. Dan sesiapa yang masuk ke dalamnya aman tenteramlah dia. Dan Allah mewajibkan manusia mengerjakan ibadat Haji dengan mengunjungi Baitullah iaitu sesiapa yang berkemampuan sampai kepadanya. Dan sesiapa yang kufur (ingkarkan kewajipan ibadat Haji itu), maka sesungguhnya Allah Maha Kaya (tidak berhajatkan sesuatu pun) dari sekalian makhluk” [Surah Ali ‘Imran, 3: 97].

Rentetan daripada firman Allah tersebut yang mengisyaratkan adanya aspek “berkemampuan” sebagai syarat wajib perlaksanaannya, maka para sarjana ataupun Ulama telah mengupas secara mendalam berkenaan perincian syarat-syarat tersebut. Imam an-Nawawi dalam Minhaj al-Talibin menjelaskan bahawasanya ibadah haji wajib dilaksanakan bagi sesiapa yang memenuhi tiga kriteria ini iaitu beragama Islam atau Muslim, mampu menanggung taklifan atau mukallaf serta berkemampuan. Bagi menjelaskan maksud berkemampuan itu, beliau menyatakan bahawasanya berkemampuan terbahagi kepada dua iaitu berkemampuan dengan sendirinya seperti mempunyai belanja pergi dan pulang, kenderaan serta berkeadaan aman ketika pergi serta pulang dari haji. Adapun berkemampuan jenis yang kedua adalah berkemampuan dengan bantuan orang lain semisal mereka yang melaksanakan badal haji kerana sakit atau telah meninggal dunia dalam keadaan berkemampuan melaksanakannya semasa hidup [3]. Kesemua hal ini menuntut seseorang Muslim supaya memahami perincian aspek “berkemampuan” agar tidak terkeliru di kemudian hari. Justeru, pelaksanaan Haji bukan sahaja menuntut persediaan secara fizikal mahupun kewangan, malah memerlukan kefahaman mendalam mengenai tatacara serta falsafah ibadah tersebut. Oleh itu, pelbagai usaha telah dijalankan oleh pihak berwajib dalam memperkasakan ilmu dan kefahaman masyarakat terhadap ibadah haji, termasuklah melalui penganjuran Kursus Asas Haji (KAH) oleh Lembaga Tabung Haji [6]. KAH yang disediakan oleh Tabung Haji telah menjadi rujukan utama dalam kalangan bakal jemaah haji sebagai panduan pelaksanaan ibadah haji yang sah dan sempurna.

Modul KAH merupakan program bimbingan ibadat haji dan umrah yang dianjurkan secara percuma serta terbuka kepada seluruh lapisan masyarakat tanpa terhad kepada jemaah haji yang terpilih sahaja. Kursus ini dilaksanakan selama empat bulan bermula dari bulan Rabiulakhir hingga Jamadilakhir pada setiap tahun, dengan sesi pengajaran yang dijalankan pada hujung minggu iaitu hari Sabtu atau Ahad. Setiap sesi

diperuntukkan selama dua jam, namun selepas semakan modul pada tahun 2019, tempoh pembelajaran dipanjangkan kepada dua jam tiga puluh minit, manakala bilangan minggu pengajian dipendekkan daripada 17 siri kepada 13 siri. Modul KAH merangkumi 12 topik iaitu 10 topik berkaitan ibadat haji dan umrah serta dua topik berkaitan kesihatan dan pengurusan haji sama ada di tanah air atau di Tanah Suci. Secara keseluruhan, modul ini dapat dihuraikan kepada tiga bahagian utama, iaitu tujuh topik berkaitan haji dan umrah, dua topik berfokus kepada permasalahan wanita, serta satu topik mengenai taharah dan solat [1]. Walaubagaimanapun, modul ini juga berpotensi untuk dimanfaatkan dalam konteks pendidikan formal, khususnya di Institusi Pengajian Tinggi (IPT) yang menawarkan program pengajian berkaitan haji dan umrah, antaranya adalah Kolej Profesional Majlis Agama Islam Wilayah Persekutuan (KPMAIWP), yang menawarkan program Diploma Haji dan Umrah bagi melahirkan graduan yang berkemahiran dalam bidang pengurusan ibadah haji dan umrah serta mampu menjadi tenaga pengajar atau pembimbing ibadah haji pada masa hadapan [7].

Namun begitu, tahap kesesuaian dan keberkesanan modul KAH sebagai bahan rujukan pembelajaran dalam kalangan pelajar Diploma Haji dan Umrah secara khusus masih belum dikaji secara mendalam. Persoalan seperti adakah modul ini memenuhi keperluan akademik dan pembelajaran pelajar di peringkat diploma serta sejauh manakah ia dapat membantu pelajar memahami aspek teori dan praktikal ibadah haji secara menyeluruh masih perlu diteliti. Malahan, dunia kini yang mula fokus kepada Kecerdasan Buatan (AI) juga menuntut supaya kaedah pembelajaran secara integrasi dengan AI diwujudkan [4]. Justeru, kajian ini dijalankan untuk meninjau pandangan pelajar Diploma Haji dan Umrah KPMAIWP terhadap penggunaan Modul KAH sebagai rujukan pembelajaran mereka serta keberkesanan integrasi Kecerdasan Buatan (AI) dalam Modul KAH. Intihannya, dapatan kajian diharapkan dapat memberikan implikasi penting terhadap pembangunan kurikulum serta pendekatan pengajaran Haji dan Umrah di institusi pengajian tinggi di Malaysia.

2. METODOLOGI

Kajian ini menggunakan pendekatan kuantitatif berbentuk tinjauan bagi menilai kesesuaian Modul Kursus Asas Haji (KAH) serta keberkesanan integrasi kecerdasan buatan (AI) dalam proses pengajaran dan pembelajaran (PdP) pelajar Diploma Haji dan Umrah di Kolej Profesional MAIWP (KPMAIWP). Populasi kajian terdiri daripada 200 orang pelajar program Diploma Haji dan Umrah, dan seramai 38 orang

pelajar dipilih sebagai responden menggunakan kaedah persampelan bertujuan, iaitu melibatkan pelajar yang telah menggunakan Modul KAH dan terdedah kepada aplikasi AI dalam PdP. Instrumen kajian ialah soal selidik berstruktur yang dibangunkan melalui *Google Form* dan merangkumi tiga konstruk utama, iaitu kandungan modul, kaedah penyampaian termasuk penggunaan AI, serta tahap kepuasan pelajar secara keseluruhan. Setiap item diukur menggunakan skala Likert empat mata (“sangat memuaskan” hingga “tidak memuaskan”) bagi mengelakkan kecenderungan respon neutral dan memperoleh penilaian yang lebih jelas terhadap keberkesanan modul dan integrasi AI. Data dianalisis menggunakan analisis statistik deskriptif melibatkan kekerapan, peratusan dan min dengan bantuan perisian *Statistical Package for the Social Sciences (SPSS)*. Analisis ini bertujuan mengenal pasti tahap penerimaan pelajar terhadap Modul KAH, keberkesanan aplikasi AI dalam menyokong pembelajaran, serta aspek penambahbaikan modul selaras dengan keperluan pembelajaran digital semasa.

3. ANALISIS DAN DAPATAN

3.1 Kutipan Data

Bagi memperoleh data yang mencukupi dan berkredibiliti, kutipan data dilaksanakan melalui borang soal selidik yang telah dibuat menggunakan aplikasi *Google Form*. Responden yang terdiri daripada pelajar Diploma Haji dan Umrah, KPMAIWP telah menjawab borang soal selidik ini secara atas talian. Seramai 38 orang responden telah terlibat dalam kajian ini dan berjaya memberikan kerjasama penuh dengan menjawab semua soalan yang diutarakan. Borang soal selidik ini mengandungi tiga bahagian utama yang merangkumi penilaian terhadap kandungan Modul Kursus Asas Haji (KAH), kaedah penyampaian modul, serta tahap kepuasan keseluruhan pelajar terhadap modul tersebut. Soalan-soalan yang disediakan berkaitan dengan kefahaman pelajar tentang ibadah haji dan umrah, dan responden diminta menjawab berdasarkan 4 skala likert yang terdiri daripada pilihan “Sangat Memuaskan (4), Memuaskan (3), Kurang Memuaskan (2), Tidak Memuaskan (1)”, dengan analisis menggunakan *Statistical Package for the Social Sciences (SPSS)*. Bagi integrasi AI pula, beberapa inisiatif seperti penggunaan bahan visual, simulasi, kuiz, serta nota ringkas yang dijana melalui AI juga disertakan sepanjang sesi Pengajaran dan Pembelajaran (PdP) berlangsung selama 14 minggu.

Bahagian A:

Bahagian ini mengandungi soalan yang menilai tahap kesesuaian dan keberkesanan kandungan Modul KAH sebagai bahan rujukan pembelajaran dalam kalangan pelajar Diploma Haji dan Umrah. Antara aspek yang dinilai termasuklah kejelasan dalam penerangan rukun-rukun haji, susunan topik dalam modul, serta kefahaman terhadap larangan ihram. Responden perlu memberikan maklum balas terhadap beberapa pernyataan berdasarkan pengalaman dan pandangan mereka setelah menggunakan modul tersebut dalam sesi pembelajaran.

Bahagian B:

Bahagian ini merangkumi soalan-soalan yang menilai kesesuaian kandungan Modul KAH sebagai bahan rujukan pembelajaran dalam kalangan pelajar. Soalan-soalan ini menyentuh aspek kefahaman pelajar terhadap susunan topik, penjelasan rukun dan larangan ihram, serta tahap keberkesanan isi kandungan modul. Terdapat 4 soalan yang perlu dijawab bagi mendapatkan gambaran umum tentang persepsi responden terhadap isi modul tersebut.

Bahagian C:

Bahagian ini menilai keberkesanan pendekatan dan kaedah penyampaian Modul KAH, termasuk penggunaan bahan visual, gaya pengajaran pensyarah, serta penerimaan terhadap kaedah simulasi dan tunjuk ajar. Ia juga mengukur tahap kepuasan keseluruhan responden terhadap penggunaan modul dalam konteks pembelajaran formal di institusi pengajian tinggi. Bahagian ini mengandungi beberapa soalan yang direka bentuk untuk mengetahui sejauh mana pendekatan penyampaian memberi kesan kepada pemahaman pelajar.

Bahagian B dan C menggunakan skala Likert empat mata untuk mendapatkan maklum balas, skala likert ini diklasifikasikan seperti berikut:

Jadual 1: Penerangan empat skala likert

Tahap	Penerangan
4	Sangat Memuaskan
3	Memuaskan
2	Kurang Memuaskan
1	Tidak Memuaskan

Bahagian D:

Bahagian ini memaparkan aplikasi AI dalam sesi Pengajaran dan Pembelajaran (PdP) subjek Pengenalan kepada Haji dan Umrah (PPM 2113) yang menjadi subjek wajib kepada semua pelajar Diploma Haji dan Umrah. Beberapa inisiatif seperti penggunaan bahan visual, simulasi, kuiz, serta nota ringkas yang dijana melalui AI juga disertakan dalam sesi PdP bagi meningkatkan kefahaman pelajar berkenaan teori dan praktikal ibadah Haji serta Umrah.

3.2 Analisis Data

Borang soal selidik yang telah diedarkan secara dalam talian ini akan diproses dan disemak untuk menganalisis data tersebut. Data-data tersebut disunting menggunakan aplikasi Microsoft Excel. Data-data yang berjaya dikutip akan disunting menjadi cara yang lebih mudah untuk dianalisis. Segala rekod data akan diubah suai menjadi carta pai dan bentuk jadual. Skala likert empat mata digunakan bagi menganalisis bahagian ini. Skor yang digunakan adalah sangat memuaskan dengan skor 4, memuaskan dengan skor 3, kurang memuaskan dengan skor 2 dan tidak memuaskan dengan skor 1. Data yang diproses menggunakan statistik yang melibatkan peratusan dan min. Soal selidik ini juga dibina berdasarkan skala Likert 1 hingga 4 berdasarkan Statistical Package for the Social Sciences (SPSS) yang telah dikategorikan dan diinterpretasikan kepada empat tahap seperti dalam jadual.

Jadual 2: Interpretasi purata skor min

INTERPRESTASI PURATA	INTERPRESTASI
1.00 – 1.49	Tidak Memuaskan
1.50 – 2.49	Kurang Memuaskan
2.50 – 3.49	Memuaskan
3.50 – 4.00	Sangat Memuaskan

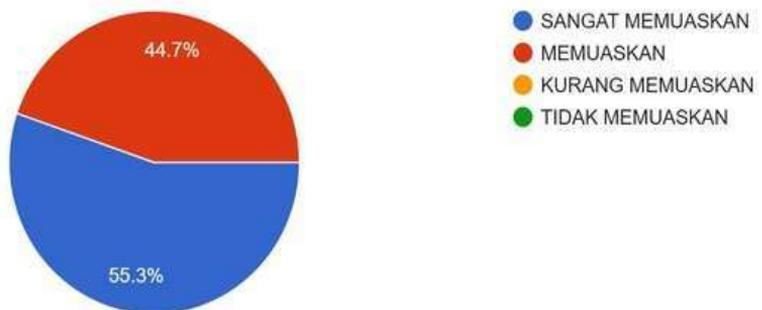
Bahagian A: Penilaian Kandungan Modul KAH

Analisis data bahagian ini dihuraikan secara holistik bagi mengenalpasti tahap kepuasan pelajar Diploma Haji dan Umrah berkenaan kandungan Modul KAH.

Item 1

1. Kandungan Modul KAH membantu saya memahami rukun-rukun haji dengan jelas.

38 responses



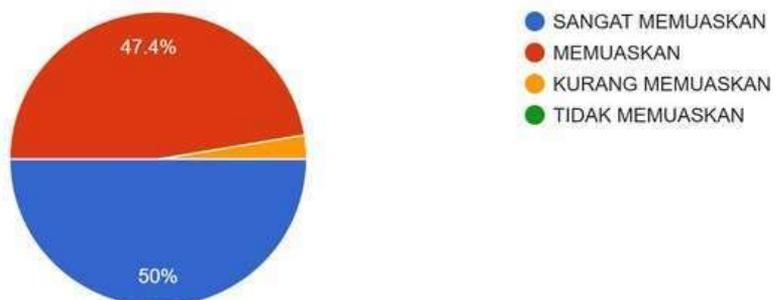
Rajah 1. Kandungan Modul KAH membantu pemahaman rukun haji

Berdasarkan Rajah 1 di atas, peratusan sebanyak 55.3% sangat berpuas hati dengan kandungan Modul KAH, bersamaan dengan 21 orang pelajar. Seterusnya, responden yang mencatatkan respons “memuaskan” pula adalah sebanyak 44,7%, bersamaan dengan 17 orang responden. Jumlah bagi responden dengan respon “kurang memuaskan” ialah 0.0% manakala responden dengan respon “tidak memuaskan” ialah 0.0%. Data ini menunjukkan bahawa majoriti responden sangat memuaskan terhadap kandungan Modul KAH dan memperoleh manfaat berdasarkan Modul KAH.

Item 2

2. Topik-topik dalam Modul KAH disusun secara teratur dan mudah difahami.

38 responses



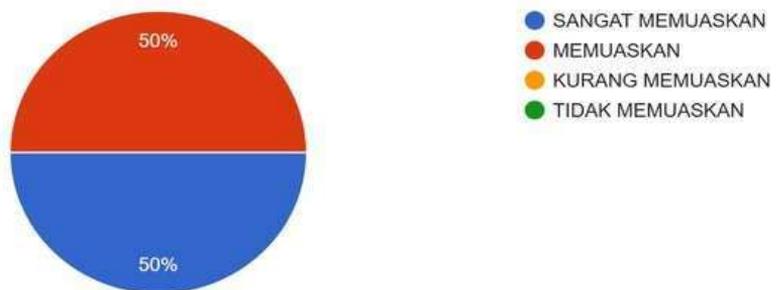
Rajah 2. Topik dalam Modul KAH adalah teratur dan mudah difahami

Berdasarkan Rajah 2 di atas, kutipan data menunjukkan peratusan sebanyak 50.0% responden dengan respon “sangat memuaskan”, bersamaan seramai 19 orang. Seterusnya, jumlah peratusan bagi respon “memuaskan” adalah sebanyak 47.4% iaitu berjumlah 18 orang. Peratusan bagi responden “kurang memuaskan” hanya sebanyak 2.6% dan responden dengan respon tidak memuaskan ialah 0.0%. Analisis data menunjukkan bahawa majoriti besar responden sangat berpuas hati terhadap topik-topik Modul KAH yang disusun secara teratur dan mudah difahami.

Item 3

3. Penjelasan tentang larangan ihram dalam Modul KAH mudah difahami.

38 responses



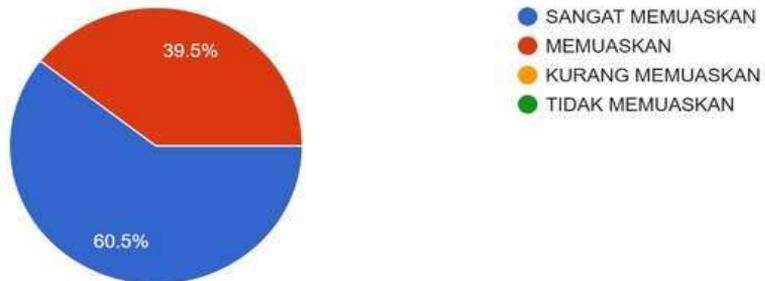
Rajah 3. Penjelasan Modul KAH mengenai larangan ihram mudah difahami

Berdasarkan Rajah 3, didapati bahawa 50.0% responden menyatakan “sangat memuaskan” terhadap penjelasan berkaitan larangan ihram dalam Modul KAH. Seterusnya, 50.0% responden yang lain menyatakan “memuaskan” manakala tiada responden yang memilih kategori “kurang memuaskan” (0.0%) atau “tidak memuaskan” (0.0%). Dapatan ini menunjukkan bahawa penjelasan mengenai larangan ihram dalam Modul KAH diterima secara positif oleh kesemua responden, sama ada pada tahap sangat puas atau puas. Hal ini membuktikan bahawa kandungan modul tersebut berkesan dalam memberikan kefahaman yang jelas mengenai larangan ihram, sekaligus menepati objektif modul dalam menyampaikan maklumat yang relevan kepada semua para peserta yang mengikuti sesi pembelajaran Modul KAH tersebut.

Item 4

4. Modul KAH sesuai digunakan sebagai rujukan pembelajaran di peringkat diploma.

38 responses



Rajah 4. Kesesuaian Modul KAH sebagai rujukan pembelajaran di peringkat diploma

Berdasarkan Rajah 4, sebanyak 60.5% responden menyatakan respon “sangat memuaskan” berkenaan Modul KAH dijadikan sebagai bahan rujukan pelajar peringkat diploma. Sementara itu, 39.5% responden menyatakan “memuaskan”, manakala tiada responden memilih kategori “kurang memuaskan” (0.0%) atau “tidak memuaskan” (0.0%). Dapatan ini menunjukkan bahawa kesemua responden memberikan penilaian positif terhadap Modul KAH sebagai rujukan akademik. Hal ini sekaligus menggambarkan keberkesanan modul tersebut dalam menyokong proses pembelajaran pelajar diploma.

Bahagian B: Penilaian Kaedah Penyampaian

Analisis data bahagian ini bertujuan untuk mengenal pasti tahap kepuasan pelajar tentang kaedah penyampaian Modul KAH yang diajarkan oleh para pensyarah, Kolej Profesional MAIWP (KPMAIWP).

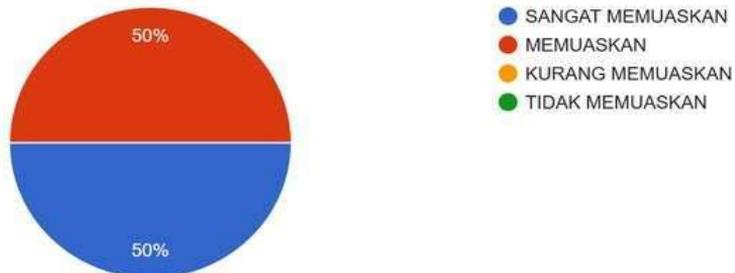
Berdasarkan Rajah 5, sebanyak 50.0% responden menyatakan respon “sangat memuaskan” terhadap kaedah pengajaran Modul KAH, manakala baki 50.0% responden menyatakan “memuaskan”. Tiada responden yang memilih kategori “kurang memuaskan” (0.0%) atau “tidak memuaskan” (0.0%). Dapatan ini menunjukkan bahawa kesemua responden memberikan penilaian positif terhadap kaedah pengajaran Modul KAH. Hal ini membuktikan bahawa pendekatan pengajaran yang digunakan dalam modul tersebut oleh para pensyarah dianggap menarik, jelas,

serta mudah diikuti oleh pelajar, sekali gus meningkatkan keberkesanan proses pembelajaran yang dijalankan bersama para pelajar.

Item 5

5. Kaedah pengajaran berdasarkan Modul KAH menarik dan mudah diikuti.

38 responses

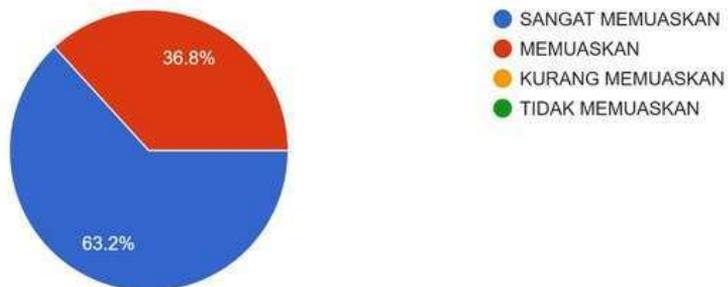


Rajah 5. Kaedah pengajaran Modul KAH menarik dan mudah diikuti

Item 6

6. Bahan visual (gambar, rajah) dalam Modul KAH membantu saya memahami topik.

38 responses



Rajah 6. Modul KAH membantu pemahaman topik

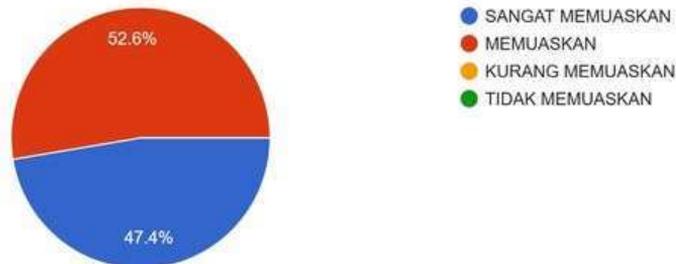
Berdasarkan Rajah 6, sebanyak 63.2% responden menyatakan respon “sangat memuaskan” terhadap bahan visual dalam Modul KAH, manakala 36.8% responden menyatakan “memuaskan”. Tiada responden yang memilih kategori “kurang memuaskan” (0.0%) atau “tidak memuaskan” (0.0%). Dapatan ini menunjukkan bahawa kesemua responden memberikan penilaian positif terhadap bahan visual yang

digunakan dalam Modul KAH. Hal ini membuktikan bahawa penggunaan bahan visual dalam modul tersebut berkesan dalam membantu pelajar memahami topik dengan lebih jelas, menarik, serta mudah difahami.

Item 7

7. Pendekatan yang digunakan oleh pensyarah dalam menyampaikan Modul KAH adalah berkesan.

38 responses



Rajah 7. Pendekatan yang digunakan oleh pensyarah dalam menyampaikan Modul KAH adalah berkesan

Berdasarkan Rajah 7, sebanyak 47.4% responden menyatakan respon “sangat memuaskan” terhadap pendekatan yang digunakan oleh pensyarah dalam penyampaian Modul KAH, manakala 52.6% responden menyatakan “memuaskan”. Tiada responden yang memilih kategori “kurang memuaskan” (0.0%) atau “tidak memuaskan” (0.0%). Dapatan ini menunjukkan bahawa kesemua responden memberikan penilaian positif terhadap pendekatan pengajaran yang digunakan oleh pensyarah. Hal ini menjelaskan bahawa pendekatan penyampaian modul tersebut dianggap sesuai, jelas, serta mampu meningkatkan pemahaman pelajar dalam proses pembelajaran yang dilaksanakan dalam kelas.

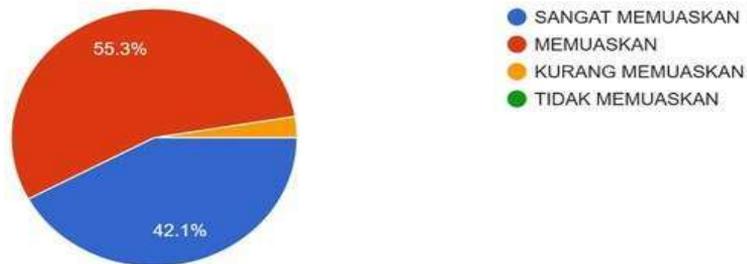
Berdasarkan Rajah 8, sebanyak 42.1% responden menyatakan respon “sangat memuaskan” terhadap kaedah tunjuk ajar dan simulasi dalam Modul KAH yang membantu meningkatkan kefahaman tentang praktikal haji, manakala 55.3% responden menyatakan “memuaskan”. Tiada responden yang memilih kategori “kurang memuaskan” (0.0%) atau “tidak memuaskan” (0.0%). Dapatan ini menunjukkan bahawa kesemua responden memberikan penilaian positif terhadap kaedah tunjuk ajar dan simulasi yang digunakan dalam modul tersebut. Hal ini membuktikan bahawa pendekatan berasaskan praktikal ini dianggap berkesan, mudah

difahami, serta mampu meningkatkan kefahaman pelajar dalam melaksanakan ibadah haji secara lebih menyeluruh.

Item 8

8. Kaedah tunjuk ajar dan simulasi meningkatkan kefahaman saya tentang praktikal haji.

38 responses



Rajah 8. Kaedah tunjuk ajar dan simulasi meningkatkan kefahaman tentang praktikal haji

Bahagian C: Kepuasan Keseluruhan

Analisis data bahagian ini bertujuan untuk mengenal pasti tahap kepuasan keseluruhan pelajar yang mengambil aliran Diploma Pengurusan Haji & Umrah di KPMAIWP.

Item 9

9. Secara keseluruhan, saya berpuas hati dengan Modul KAH sebagai bahan rujukan pembelajaran.

38 responses



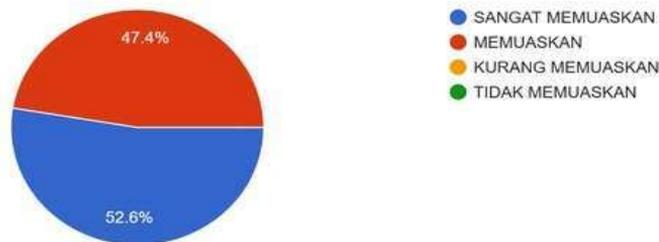
Rajah 9. Kepuasan keseluruhan terhadap Modul KAH sebagai bahan rujukan pembelajaran

Berdasarkan Rajah 9, sebanyak 47.4% responden menyatakan respon “sangat memuaskan” terhadap Modul KAH sebagai rujukan pembelajaran, manakala 52.6%

responden menyatakan “memuaskan”. Tiada responden yang memilih kategori “kurang memuaskan” (0.0%) atau “tidak memuaskan” (0.0%). Dapatan ini menunjukkan bahawa kesemua responden memberikan penilaian positif terhadap penggunaan Modul KAH sebagai sumber rujukan. Hal ini membuktikan bahawa modul tersebut dianggap sesuai, bermanfaat, serta mampu membantu pelajar memperkukuh pemahaman dan pembelajaran mereka.

Item 10

10. Saya akan mencadangkan Modul KAH digunakan secara meluas di program Diploma Haji dan Umrah.
38 responses



Rajah 10. Cadangan penggunaan Modul KAH secara meluas di program Diploma Haji dan Umrah

Berdasarkan Rajah 10, sebanyak 52.6% responden menyatakan respon “sangat memuaskan” terhadap cadangan agar Modul KAH digunakan secara meluas dalam program Diploma Haji dan Umrah, manakala 47.4% responden menyatakan “memuaskan”. Tiada responden yang memilih kategori “kurang memuaskan” (0.0%) atau “tidak memuaskan” (0.0%). Dapatan ini menunjukkan bahawa kesemua responden memberikan penilaian positif terhadap cadangan peluasan penggunaan Modul KAH. Hal ini membuktikan bahawa modul tersebut mempunyai potensi tinggi untuk dijadikan bahan rujukan utama dalam program Diploma Haji dan Umrah kerana keberkesannya dalam menyokong proses pengajaran dan pembelajaran.

Bahagian D: Aplikasi AI dalam PdP

Analisis data bahagian ini bertujuan untuk memaparkan aplikasi AI dalam sesi Pengajaran dan Pembelajaran (PdP) subjek Pengenalan kepada Haji dan Umrah (PPM 2113) yang menjadi subjek wajib kepada semua pelajar Diploma Haji dan Umrah.

Aplikasi 1: Penggunaan Bahan Visual



Visual 1: Tatacara ringkas Haji Tamattu' berdasarkan Modul KAH minggu 7 janaan *ChatGPT*

Visual 2: Perbezaan jenis-jenis Haji berdasarkan Modul KAH minggu 7 janaan *ChatGPT*

Aplikasi 2: Video Simulasi Haji



Visual 3: Petikan Video Aliran Perlaksanaan Haji berdasarkan Modul KAH minggu 1 hingga 10 dengan bantuan AI

Aplikasi 4: Nota Ringkas

Jadual 13. Nota Ringkas berdasarkan Modul KAH minggu 3 janaan *DeepSeek*

Rukun Haji	Formula Hafalan	Perincian Utama
Niat Ihram Haji	N.I.A.T	<p>N – Niat di Miqat • Miqat Zamani: Bulan Haji (Syawal, Zulkaedah, 1–10 Zulhijjah) • Miqat Makani: Lokasi (Bi’r Ali, Yalamlam, dll.)</p> <p>I – Ihram (Pakaian khas) • Lelaki: 2 kain tanpa jahitan, idtiba’ ketika tawaf • Wanita: Tutup aurat (kecuali muka & tapak tangan)</p> <p>A – Amalan sunat ihram: mandi, wuduk, solat sunat ihram, talbiah</p> <p>T – Tertib: Wajib dilakukan di miqat</p>
Wuquf di ‘Arafah	W.A.K.T.U	<p>W – Wajib (rukun terpenting, tanpa wuquf haji batal)</p> <p>A – Arafah (lokasi sah)</p> <p>K – Ketetapan masa: 9 Zulhijjah (zuhur) – 10 Zulhijjah (subuh) • Afdhal: siang + malam</p> <p>T – Tumpuan ibadat: doa, zikir, Quran, tidak berpuasa</p> <p>U – Utamakan hadir walau seketika</p>
Tawaf	T.A.W.A.F 7	<p>T – 7 pusingan (mula & tamat di Hajarul Aswad)</p> <p>A – Aurat ditutup • Lelaki: pusat – lutut • Wanita: seluruh tubuh kecuali muka & tapak tangan</p> <p>W – Wuduk & suci (badan, pakaian, tempat)</p> <p>A – Arah kiri Kaabah, berjalan ke hadapan</p> <p>F – Fokus niat (Tawaf Wada’, Sunat, Nazar, Qudum, Haji, Umrah)</p> <p>7 (Sunat) – Idtiba’, Ramal, Istilam, doa & solat sunat tawaf</p>

Kecerdasan Buatan (AI) mempunyai potensi dalam perkembangan pendidikan dunia, juga Malaysia [9]. Rentetatan itu, bahagian ini menumpukan analisis terhadap integrasi kecerdasan buatan (AI) dalam sesi Pengajaran dan Pembelajaran (PdP) subjek Pengenalan kepada Haji dan Umrah (PPM 2113), yang merupakan kursus teras bagi pelajar Diploma Haji dan Umrah di KPMAIWP. Aplikasi AI dimanfaatkan untuk memperkukuh penyampaian kandungan modul Kursus Asas Haji melalui pendekatan PdP yang lebih interaktif, visual dan berpusatkan pelajar. Penggunaan bahan visual yang dijana oleh AI seperti infografik banyak membantu pelajar memahami konsep

Haji serta Umrah secara lebih jelas dan tersusun, sekaligus meningkatkan tahap kefahaman dan pengekalan maklumat.

Selain itu, integrasi AI turut diaplikasikan melalui penggunaan video simulasi haji yang memaparkan perjalanan ibadah Haji secara holistik dan realistik. Video ini berfungsi sebagai alat pembelajaran visual yang mensimulasikan suasana sebenar di Tanah Suci, membolehkan pelajar mendapatkan gambaran menyeluruh tentang pelaksanaan rukun dan wajib haji sebelum situasi sebenar. Di samping itu, set soalan kuiz yang dianjurkan dengan bantuan AI digunakan bagi menguji tahap pemahaman pelajar secara segera. Pendekatan ini bukan sahaja menggalakkan pembelajaran sendiri setiap pelajar, malah membantu pensyarah mengenal pasti kelemahan pelajar untuk penambahbaikan PdP secara berterusan.

Penyediaan nota ringkas secara berstruktur melalui janaan AI juga menjadi wasilah kepada wujudnya teknik hafalan kreatif oleh para pelajar, misalnya dengan penggunaan formula akronim bagi rukun Haji. Rukun Niat Ihram Haji dihuraikan melalui formula “N.I.A.T”, Wuquf di ‘Arafah melalui “W.A.K.T.U”, dan Tawaf melalui “T.A.W.A.F 7”, lengkap dengan perincian utama yang relevan. Pendekatan ini memudahkan pelajar untuk mengingat fakta penting secara sistematik, selaras dengan keperluan pembelajaran berorientasikan kefahaman praktikal. Secara keseluruhannya, integrasi AI dalam modul Kursus Asas Haji telah menyumbang kepada PdP yang lebih efektif, menarik dan sejajar dengan keperluan pendidikan kontemporari dalam bidang pengajian Haji dan Umrah, selaras dengan peningkatan penggunaan teknologi simulasi bagi pelajaran Manasik Haji di IPT serata Malaysia [10].

4. RUMUSAN KESELURUHAN

Data kajian diperoleh melalui soal selidik atas talian menggunakan Google Form melibatkan 38 pelajar Diploma Haji dan Umrah di KPMAIWP. Soal selidik terbahagi kepada empat bahagian iaitu kandungan Modul Kursus Asas Haji (KAH), kaedah penyampaian modul, kepuasan keseluruhan, dan aplikasi AI dalam pengajaran.

Responden menilai aspek seperti kefahaman terhadap rukun dan larangan ihram, susunan topik, gaya penyampaian pensyarah, penggunaan bahan visual, serta kesesuaian modul sebagai rujukan akademik. Skala Likert empat mata digunakan bagi mengukur tahap kepuasan pelajar sepanjang tempoh PdP 14 minggu. Hasil dapatan bagi kandungan Modul KAH menunjukkan majoriti pelajar berpuas hati dan

menganggap modul ini jelas serta mudah difahami. Sebagai contoh, 74% hingga 100% responden menyatakan modul membantu mereka memahami rukun haji, susunan topik, dan larangan ihram. Tiada respon negatif direkodkan, menandakan isi kandungan modul benar-benar relevan sebagai sumber pembelajaran di peringkat diploma. Modul ini juga dinilai sesuai sebagai bahan akademik kerana berjaya memenuhi keperluan teori dan praktikal ibadah haji serta umrah.

Bagi kaedah penyampaian, semua responden memberi maklum balas positif. Kaedah pengajaran pensyarah, penggunaan bahan visual, serta simulasi dianggap berkesan dan menarik. Lebih 90% responden menyatakan pendekatan ini sangat memuaskan atau memuaskan. Sebagai contoh, simulasi praktikal haji membantu meningkatkan kefahaman pelajar terhadap ibadah secara menyeluruh. Hal ini menunjukkan gabungan tunjuk ajar tradisional dengan pendekatan interaktif berjaya mengekalkan minat serta meningkatkan pemahaman pelajar.

Dari segi kepuasan keseluruhan, modul ini mendapat penilaian amat tinggi. Semua responden bersetuju bahawa modul sesuai dijadikan bahan rujukan, malah lebih daripada 50% mencadangkan penggunaannya diperluaskan dalam program Diploma Haji dan Umrah. Keputusan ini membuktikan Modul KAH mempunyai nilai akademik dan praktikal yang tinggi serta wajar dijadikan modul asas dalam kurikulum rasmi. Kesepakatan positif ini menunjukkan tahap keberkesanan modul bukan sahaja pada isi kandungan, tetapi juga dari aspek kesesuaian penggunaannya secara lebih meluas.

Selain itu, integrasi AI dalam PdP turut memberi impak positif. Antara aplikasi yang digunakan termasuk bahan visual, video simulasi, set kuiz dan nota ringkas berbentuk formula hafalan. Inisiatif ini membantu pelajar memahami teori serta menguasai amalan praktikal ibadah dengan lebih efektif. Nota ringkas berformula seperti N.I.A.T, W.A.K.T.U, dan T.A.W.A.F memudahkan hafalan rukun-rukun haji. Penggunaan AI ini menunjukkan pendekatan moden dapat melengkapkan pembelajaran tradisional, sekali gus meningkatkan keberkesanan pengajaran dan pembelajaran dalam program Diploma Haji dan Umrah.

5. PENUTUP

Kajian ini membuktikan bahawa Modul Kursus Asas Haji (KAH) berkesan dan sesuai dijadikan rujukan pembelajaran utama bagi pelajar Diploma Haji dan Umrah di Kolej Profesional MAIWP berdasarkan penilaian positif daripada 38 responden. Modul ini

bukan sahaja membantu pemahaman teori dan amali ibadah haji melalui kandungan yang sistematik serta kaedah pengajaran yang menarik, malah turut diperkukuh dengan penggunaan bahan visual, simulasi dan tunjuk ajar. Integrasi teknologi seperti aplikasi AI juga memberi nilai tambah yang signifikan serta meningkatkan tahap kepuasan pelajar. Oleh itu, penambahbaikan berterusan melalui inovasi teknologi dan pedagogi moden dicadangkan bagi memastikan Modul KAH kekal relevan dan berkesan.

RUJUKAN

- [1] Amran M.A., & Che Noh, M. A. (2021). Penilaian kefahaman peserta Kursus Asas Haji berpandukan Modul Kursus Asas Haji. In *Proceedings of the International Conference on Social Science and Humanities (ICSSH 2021)*, 454–465.
- [2] Amran, M. A., Hamzah, M. I., & Che Noh, M. A. (n.d.). Kaedah pengajaran ibadat haji kepada orang awam. Kolej Matrikulasi Negeri Sembilan & Universiti Kebangsaan Malaysia. Diakses dari <https://www.nama-laman-web-anda.com/kajian-haji>.
- [3] An-Nawawi, Y.S. (2022). *Minhaj al-Talibin*. Saudi: Dar al-Minhaj.
- [4] Khan, E. A., & Shambour, M. K. (2025). AI Applications in Mega Events: Hajj and Umrah as a Case Study. *Global Journal of Economics and Business*, 15(3), 375-382.
- [5] Modul Kursus Asas Haji (KAH) <https://www.tabunghaji.gov.my/ms/haji/bimbingan/nota-modul-kursus-asas-haji-kah>.
- [6] Mohd Khairul Anuar, M. A., & Ahmad Sanusi, A. A. (2019). Keberkesanan Kursus Asas Haji dalam Meningkatkan Kefahaman Ibadah Haji di Kalangan Bakal Jemaah. *Jurnal Usuluddin*, 49(1), 73–94.
- [7] Mohd, H., Hashim, J., Wan Khairuddin, W. M. K. F., Engku Alwi, E. A. Z., & Reshad, H. F. M. (2020). Metode Bimbingan Lembaga Tabung Haji Terhadap Jemaah Haji Malaysia: Satu Penilaian. *Tamaddun*, 21(2), 231–246.
- [8] Mustofa, A., Mustofa, A. & Ali, A. (2023). *Al-Fiqh al-Manhaji ‘ala Mazhab al-Imam as-Syafie*. Putrajaya: Jabatan Kemajuan Islam Malaysia.
- [9] Tumiran, M. A., Baharuddin, B. H. & Mohammad, N. (2025). Potensi Kecerdasan Buatan (AI) Dalam Sistem Pendidikan Di Malaysia: Analisis Kandungan. *Quantum Journal of Social Sciences and Humanities*, 6(2): 237-250.
- [10] Wan Roslili A.R. et al. (2020). Penerapan Teknologi Simulasi dalam Pengajaran Manasik Haji di IPT Malaysia. *Jurnal Sains Sosial dan Kemanusiaan*, 15(3), 224–239.

- [11] Zulkifli, H. & Che Noh, M.A. (2015). Penggunaan Modul Interaktif dalam Bimbingan Ibadah Haji: Satu Kajian Awal. *Jurnal Pengajian Islam*, 8(2), 55–66.

PREDICTING STUDENT PERFORMANCE USING LSTM MODEL AT VOCATIONAL HIGH SCHOOL TELKOM, BANDUNG, INDONESIA

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ABSTRACT - Classroom learning evaluation plays a vital role in assessing student performance and ensuring structured learning development, particularly in programming education. However, traditional assessment methods often fail to identify struggling students early enough for effective intervention. This study aims to develop and evaluate a predictive model for early identification of at-risk students in programming courses at SMK Telkom Bandung, utilizing Moodle Learning Management System (LMS) data. The research objectives were to: (1) develop a Long Short-Term Memory (LSTM) based predictive model using LMS data, and (2) compare its performance against traditional methods for identifying at-risk students. The methodology involved analyzing 317 student records from Computer and Network Engineering (TKJ) and Software Engineering (RPL) classes across two academic semesters (2023-2024). The study utilized various data points including test scores, attendance records, and student activity logs. The LSTM model achieved 92% accuracy, 89% precision, and 85% recall, significantly outperforming the Decision Tree classifier in capturing learning patterns. Although the dataset lacked continuous time-series logs, each student's activities were organized in pseudo-sequences following the learning order (quizzes, assignments, and attendance records), allowing the model to simulate temporal dependencies across tasks. Analysis revealed remedial quiz performance and attendance patterns as key predictors of student outcomes. This study also explicitly considers ethical aspects by ensuring that student data were anonymized, participants' consent was obtained, and institutional approval was granted. The findings demonstrate the effectiveness of deep learning approaches in educational analytics, particularly for early intervention in vocational programming education. For practitioners, the study recommends implementing automated early warning systems based on declining quiz performance patterns and establishing structured remedial programs informed by attendance and assessment data. This research contributes by demonstrating the feasibility of using LSTM with pseudo-sequential LMS data in vocational schools, providing both methodological and practical insights.

Keywords: Learning Management System (LMS); Long Short Term-Memory (LSTM); Predictive Model for Student Performance; Vocational High School (SMK); Programming Education.

1. INTRODUCTION

Academic evaluation is essential in education for understanding student performance and guiding targeted interventions to provide timely support for struggling students. However, traditional assessment methods in school, such as periodic grading and teacher observations, are often reactive and fail to identify at-risk students early. In Indonesia Vocational High Schools (SMK), this challenge is particularly pronounced, as the adoption of Learning Management Systems (LMS) for predictive analytics remains limited. As a result, students at risk of academic difficulties are often identified only after their performance has significantly declined, reducing the opportunity for timely intervention [1].

While extensively used in higher education for course management and monitoring student engagement, their potential in vocational education remains largely untapped. For instance, SMK Telkom Bandung, a leading vocational school specializing in Information and Technology (IT) education, has implemented Moodle as its LMS platform for programming courses. However, identifying students struggling with programming concepts remains a challenge due to the lack of predictive tools. This highlights the need for data-driven predictive models that can analyze student engagement and performance to provide timely support.

Existing predictive models in education, such as Decision Trees, have limitations in capturing temporal learning patterns, which are crucial for understanding student progress over time. Traditional models rely on static data points rather than analyzing sequential data, leading to gaps in accurately identifying at-risk students. Additionally, the lack of available LMS datasets tailored for vocational education presents another challenge, making it difficult to develop effective machine learning models that reflect the unique learning environments of SMK students.

Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) have enabled predictive modeling in education by leveraging LMS data including student grades, attendance records, and interaction logs. Among various ML techniques, Long Short-Term Memory (LSTM) has proven effective due to their ability to analyze sequential data and identify temporal learning patterns [2]. Although the dataset is not a continuous time series, the ordered sequence of quizzes, assignments, and attendance across the semester can be organized into pseudo-sequences. LSTM models are effective for this structure because they capture long-term dependencies that static approaches such as Decision Trees cannot. Prior studies have shown that recurrent models improve the prediction of student performance using LMS activity data [3]. By modelling the progression of learning over time, LSTM provides a more suitable

framework for educational analytics. In contrast, Decision Tree models, despite their interpretability, are unable to account for sequential patterns, which limits their ability to track long-term student development [4].

Despite these advancements, most predictive modeling studies focus on higher education, while vocational schools remain largely unexplored. Traditional machine learning models such as Decision Trees remain widely used in educational research but are limited in capturing the dynamic progression of student learning. In Indonesian vocational schools, the adoption of AI-based predictive tools is still minimal, highlighting a clear gap that this study aims to address. Prior studies show that LMS adoption in Indonesian universities has significantly enhanced structured and interactive learning experiences, improving student comprehension of course materials [5]. Moreover, LMS use has been positively correlated with academic performance, with significant differences observed between students taught through LMS and those taught using traditional methods [6]. The effectiveness of LMS in supporting student learning also depends on factors such as instructional design, the specific LMS platform, and the level of student engagement [7]. However, similar advancements in vocational education, particularly within Indonesian SMK, remain limited. To address this gap, this study proposes:

- 1) Developing an LSTM-based predictive model using LMS data to identify students at risk of falling behind in vocational programming courses.
- 2) Comparing LSTM performance with Decision Tree models to assess the effectiveness of deep learning in educational analytics.

In this study, the LSTM model was used not for pure time-series forecasting, but to capture structured-sequential dependencies that reflect learning progression throughout the semester.

2. MATERIALS AND METHODS

This study follows four main phases: (1) Data Collection, (2) Preprocessing, (3) Model Development, and (4) Evaluation. Each phase is detailed in the following sections as illustrated in Figure 1.

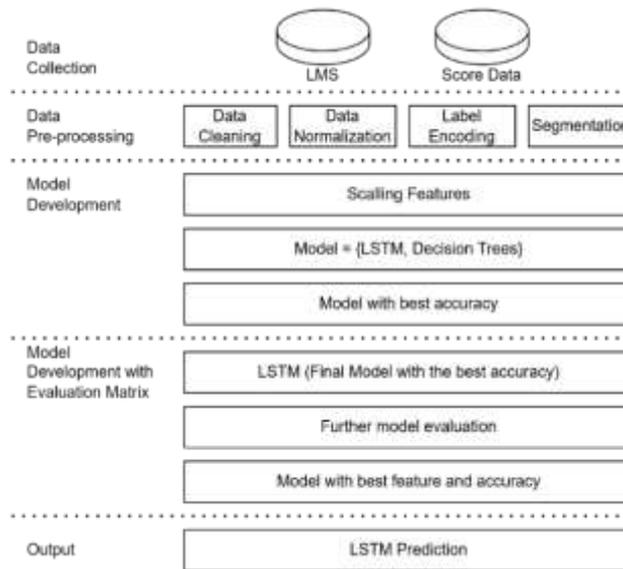


Figure 1. The proposed methodology for predicting at-risk students.

2.1. Data Collection and Preprocessing

2.1.1. Dataset

The dataset was collected from SMK Telkom Bandung’s Moodle LMS, covering two academic semesters (2023-2024) and including 317 student records from programming courses in Computer and Network Engineering (TKJ) and Software Engineering (RPL) programs. Features were engineered from LMS data to capture key aspects of student learning, including quiz attempts, assignment performance, and attendance frequency. Engagement indicators such as logins and material access were also examined, but only the most relevant predictors were retained after correlation and redundancy checks. The target variable (Status) was derived from the final course grade (Course_total): students scoring below 60% were labeled as at-risk (0), and those scoring 60% or higher as not at-risk (1). To avoid label leakage, no variable used to compute Course_total was included as a predictor, only features recorded before the final aggregation were retained.

2.1.2. Data Preprocessing

Several preprocessing steps were applied to ensure data consistency. Missing quiz and assignment scores were replaced with zero, numerical features were normalized using

Min–Max scaling, and categorical outputs were label-encoded. These procedures prepared the data for model training and ensured comparability across variables.

The target variable (Status) was label-encoded into binary categories (0 = at-risk, 1 = not at-risk). For evaluation, the dataset was split into 80% training data (253 samples) and 20% testing data (64 samples) using stratified sampling to preserve class distribution. Given the dataset imbalance (98 students classified as not at-risk and 219 as at-risk), Focal Loss was employed during LSTM training to mitigate bias toward the majority class [10]. Feature correlation analysis confirmed no overlap between target and input features; Course_total was dropped entirely before model training.

2.2. Model Development

Two machine learning models, Long Short-Term Memory (LSTM) and Decision Tree (DT), were implemented and compared to predict at-risk students.

2.2.1. Long Short-Term Memory (LSTM)

LSTM was selected for its ability to analyze sequential data and capture temporal dependencies [9]. Although the dataset did not contain continuous logs, aggregated features were arranged into ordered pseudo-sequences to reflect students' progression across quizzes, assignments, and attendance. This structure allowed the LSTM to model sequential dependencies and capture learning patterns more effectively than static approaches.

The implemented LSTM architecture consists of an input layer accepting preprocessed features in a three-dimensional format (samples, time steps, features), followed by an LSTM layer with 64 units utilizing tanh activation. A dropout layer (0.3) was implemented to mitigate overfitting, succeeded by a dense layer (32 units, ReLU activation) and a final dense layer with sigmoid activation for binary classification. The model was implemented using Python 3.8 and TensorFlow 2.8.0 with Adam optimizer (learning rate = 0.001) for 50 epochs and Focal Loss ($\gamma = 2.0$, $\alpha = 0.25$) [10]. Training was conducted with a batch size of 16 and early stopping mechanism (patience = 5, monitoring validation loss) to prevent overfitting.

2.2.2. Decision Tree (DT)

As a baseline model, Decision Tree Classifier was implemented for comparison. Decision Tree is an interpretable model that provides a transparent decision-making

process, illustrating how quiz, assignment, and attendance features contribute to identifying at-risk students. The model was implemented using scikit-learn with Gini Impurity criterion, maximum depth of 5 to prevent overfitting, and minimum samples split of 2. Decision Tree serves as a simpler alternative to LSTM, providing a structured analysis of how quiz, assignment, and attendance scores influence student performance.

2.3. Evaluation Metrics

To assess the performance of the predictive models, four standard classification metrics were used: Accuracy, Precision, Recall, and F1-Score. These metrics provide a comprehensive evaluation of the model's ability to classify students into "at-risk" and "not at-risk" categories:

- 1) Accuracy: Accuracy represents the overall correctness of the model and is defined as the proportion of correctly classified instances relative to the total number of instances, as shown in Equation (1) [8]:

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (1)$$

where:

- TP (True Positives) refers to correctly classified at-risk students.
- TN (True Negatives) refers to correctly classified not at-risk students.
- FP (False Positives) refers to students incorrectly classified as at-risk.
- FN (False Negatives) refers to students incorrectly classified as not at-risk.

- 2) Precision: Precision represents the proportion of correctly identified at-risk students among all students predicted as at-risk, as shown in Equation (2) [8]:

$$Precision = \frac{TP}{TP+FP} \quad (2)$$

- 3) Recall: Recall evaluates the model's effectiveness in identifying actual at-risk students and is defined in Equation (3) [8]:

$$Recall = \frac{TP}{TP+FN} \quad (3)$$

- 4) F1-Score: The F1-Score is the harmonic mean of Precision and Recall, providing a balanced measure of both, as shown in Equation (4) [8]:

$$F1 - Score = 2 \times \frac{Precision \times Recall}{Precision + Recall} \quad (4)$$

By evaluating both models using these metrics, a comparative analysis can determine which model more effectively identifies at-risk students, contributing to data-driven educational interventions. Although this study used an 80/20 split due to data limitations, future work will employ k-fold and semester-based validation to assess model stability and generalizability.

3. RESULTS AND DISCUSSION

This section presents the experimental results of the LSTM and Decision Tree models, along with a detailed discussion of their implications for identifying at-risk students in vocational high school programming courses. The analysis focuses on model performance, feature importance, practical applications, and limitations.

3.1. Model Performance Analysis

The LSTM model demonstrated superior performance compared to the Decision Tree baseline across all evaluation metrics, as summarized in Table 1. The LSTM achieved 92% accuracy with balanced precision of 89% and recall of 85%. In contrast, the Decision Tree yielded lower accuracy (87%) and recall (75%), indicating limitations in capturing temporal trends. The dataset comprised 219 ‘at-risk’ and 98 ‘not-at-risk’ students. Macro-average metrics were used to account for this imbalance. The use of Focal Loss during LSTM training helped mitigate bias toward the majority class, ensuring fairer performance across categories.

Table 1. Performance comparison of LSTM and Decision Tree models.

Model	Accuracy	Precision	Recall	F1-Score
LSTM	92%	89%	85%	87%
Decision Tree	87%	83%	75%	78%

While this study employed a single 80/20 stratified split for evaluation, additional cross-validation procedures are planned to confirm the consistency of model performance across different student groups and semesters. The confusion matrices as shown in Figure 2, provide detailed insights into the classification performance of both models. For the LSTM model, out of 64 test cases, it correctly identified 42 at-risk students (true positives) and 17 not-at-risk students (true negatives). The model produced only 2 false negatives (at-risk students incorrectly classified as not-at-risk)

and 3 false positives (not-at-risk students incorrectly classified as at-risk). This demonstrates the LSTM's strong capability in minimizing misclassifications, particularly in identifying students who genuinely need support.

In comparison, the Decision Tree model showed slightly lower performance, correctly identifying 41 at-risk students and 15 not-at-risk students. However, it generated more misclassifications with 3 false negatives and 5 false positives. The higher number of false positives in the Decision Tree model (5 versus 3 in LSTM) indicates that the LSTM better precision in identifying truly at-risk students, thereby minimizing unnecessary interventions. This improvement can be attributed to LSTM's ability to process sequential features as interconnected data points rather than isolated values, allowing it to better capture the progression of student performance throughout the semester. The model's strength in temporal pattern recognition is particularly valuable for early intervention strategies in programming education, where concepts build upon previous knowledge.

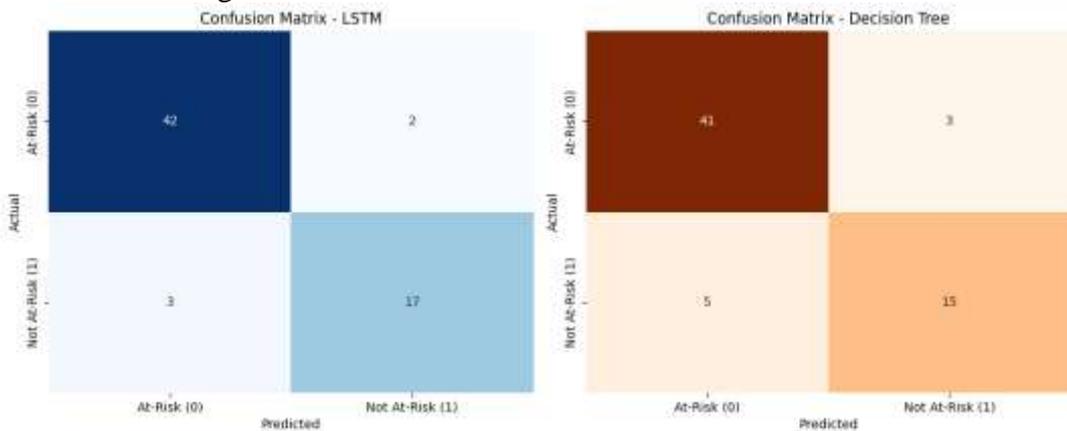


Figure 2. Confusion matrices of LSTM (left) and Decision Tree (right).

The model's learning progression is visualized in Figure 3, which displays the training and validation metrics over 50 epochs. The accuracy curves demonstrate stable learning behaviour, with both training and validation accuracy converging around the 30th epoch. The loss curves show consistent decrease and stabilization, indicating effective model learning without significant overfitting. This convergence pattern suggests that the model successfully captured the underlying patterns in the student performance data while maintaining generalization capability. These findings align with Aljaloud et al. [2], who showed LSTM's advantage in modeling temporal dependencies. However, our model achieved higher precision (92% vs. 89%), likely due to Focal Loss addressing class imbalance.

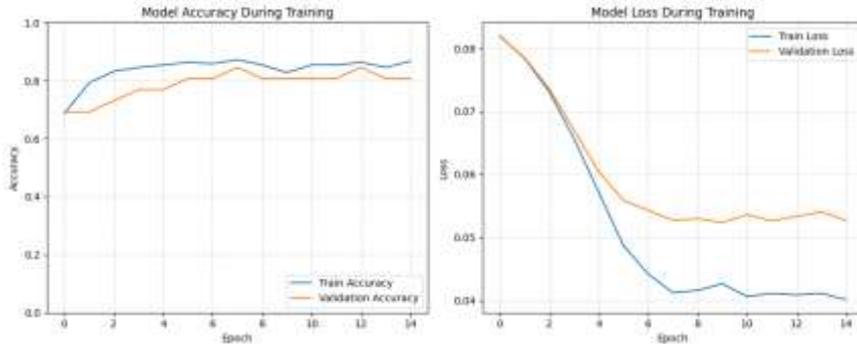


Figure 3. Training and validation accuracy/loss for the LSTM model.

3.2. Feature Importance Analysis

The feature importance analysis from the Decision Tree model identified Quiz_Remedial (85.8%) and Attendance_Kehadiran (10.9%) as the strongest predictors of student performance, as shown in Figure 4. In contrast, the LSTM captured temporal patterns such as gradual declines in quiz scores and the cumulative impact of repeated low performances that the Decision Tree could not detect. This temporal sensitivity enables earlier identification of at-risk students.

At SMK Telkom, remedial quizzes occur mid-module before final examinations, which explains their strong predictive contribution. These findings support the model's potential for proactive, rather than retrospective, performance monitoring.

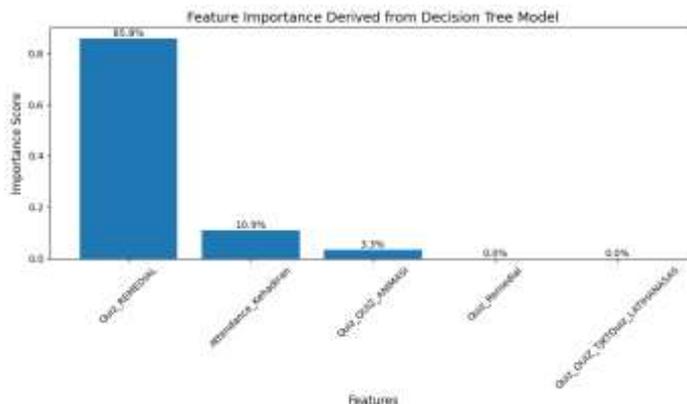


Figure 4. Feature importance derived from the Decision Tree model.

3.3 Ethical Considerations

This research adhered to ethical guidelines. Student data were anonymized before analysis, with no personally identifiable information stored. Consent was obtained from all participants and guardians. Institutional approval was granted by SMK Telkom Bandung's ethics committee and the university's academic board. Data were handled following data protection regulations to ensure privacy and confidentiality.

3.4 Practical Implications and Future Work

Although the LSTM model demonstrates strong predictive performance, its computational complexity poses challenges for real-time integration within LMS platforms. Future research will broaden the dataset to multiple institutions, evaluate additional baseline models such as Random Forest and Logistic Regression, and refine feature engineering to improve generalization. Ensuring compatibility with existing LMS frameworks remains essential for practical deployment in vocational education settings.

The study introduces two operational thresholds, namely a Recall of 0.80 for broad screening purposes and a Recall of 0.90 for high-sensitivity monitoring. Alerts generated at these thresholds can facilitate targeted interventions, including remedial instruction, adaptive assessments, and mentor consultations. Future simulation studies will further examine the impact of varying threshold levels on the effectiveness and efficiency of these intervention strategies.

4. CONCLUSION

This study demonstrates that the LSTM model effectively predicts at-risk students at SMK Telkom Bandung with 92% accuracy, where remedial quiz scores and attendance emerged as key predictors. The model outperformed Decision Tree by capturing sequential learning patterns and integrating ethical safeguards in data use. Future work will expand datasets across multiple schools, optimize real-time LMS integration, and explore additional baseline models to enhance generalizability.

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REFERENCES

- [1]. Furqon, M., Sinaga, P., Liliyasi, L., & Riza, L. S. (2023). The impact of Learning Management System (LMS) usage on students. *TEM Journal*, 1082–1089.
- [2]. A. S. Aljaloud, D. M. Uliyan, A. Alkhalil, M. Abd Elrhman, A. F. M. Alogali, Y. M. Altameemi, M. Altamimi, and P. Kwan, “A deep learning model to predict student learning outcomes in lms using cnn and lstm,” *IEEE Access*, vol. 10, pp. 85 255–85 265, 2022.
- [3]. A. Ghazvini, N. Mohd Sharef and F. B. Sidi, "Prediction of Course Grades in Computer Science Higher Education Program via a Combination of Loss Functions in LSTM Model," in *IEEE Access*, vol. 12, pp. 30220-30241, 2024.
- [4]. Al-Sulami, A., Al-Masre, M., & Al-Malki, N. (2023). Predicting At-Risk Students' Performance Based on LMS Activity using Deep Learning. *International Journal of Advanced Computer Science and Applications*, 14(6).
- [5]. Fibriasari, H., Andayani, W., Putri, T. T. A., & Harianja, N. (2023). Learning Management System Now and in The Future: Study Case from the Indonesian University Students. *International Journal of Information and Education Technology*, 13(1), 158–165.
- [6]. Ojo, M. B. (2024). Examination of the impact of learning management system on university undergraduate students' academic performance. *International Journal of Education Learning and Development*, 12(5), 67–82.
- [7]. P, R. A. (2024). The Learning Management System (LMS) and Student Learning Effectiveness: A Systematic Literature review. *International Journal of Research Publication and Reviews*, 5(6), 1857–1861.
- [8]. Alhassan, A., Zafar, B., & Mueen, A. (2020). Predict Students' Academic Performance based on their Assessment Grades and Online Activity Data. *International Journal of Advanced Computer Science and Applications*, 11(4).
- [9]. Shou, Z., Xie, M., Mo, J., & Zhang, H. (2024). Predicting Student Performance in Online Learning: A Multidimensional Time-Series Data Analysis approach. *Applied Sciences*, 14(6), 2522.
- [10]. Lin, T., Goyal, P., Girshick, R., He, K., & Dollar, P. (2018). Focal loss for dense object detection. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 42(2), 318–327

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