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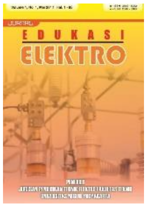

Development of an Industrial Electrical Installation Training Unit

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Abstract— The purpose of this study is to obtain a modular unit for training and instruction in industrial electrical installations as a suitable learning media. This study uses research and development (R&D) with ADDIE model, which consists of five phases: analysis, design, development, implementation, and evaluation. The research subject is Diploma 4 student in Department of Electrical Engineering Education, Faculty of Engineering, Universitas Negeri Yogyakarta. The research result as follows. (1) Manufacture of industrial electrical equipment training module products. (2) Application program feasibility for material-related assessment includes content aspects, learning aspects, and efficiency aspects. All aspects of the substantive feasibility study were rated as highly feasible with a score of 94.5 points. Application program feasibility for media professional evaluation includes visual, hardware, usability, and portability aspects. It has an average score of 109.5 on all aspects of the media feasibility test and is categorized as highly feasible. (3) Student user reactions, including learning, visual, hardware, usability, and portability. All aspects of student user response were rated as very good with an average score of 107.1.

Keywords: unit training, installation, electricity, industry.

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1 Background

The quality of the learning process is affected by the availability of the learning media used. The availability of learning media is a factor that can support quality and learning success. Limited learning media can lead to suboptimal learning outcomes. More affordable, practical, and efficient learning media units are needed for the learning outcomes achieved to be more effective and maximal. expected to have more optimal and economic performance.

Technical science products that can be developed as learning vehicles in vocational education of electrical installation skills are industrial electrical installation training devices and virtual simulators. These learning media act as a messenger technology or information from the sender (lecturer, lecturer, trainer) to the receiver (student) to stimulate the thoughts, feelings, concerns, and interests of the student and enhance understanding and learning outcomes. leads to This learning medium, Industrial Electrical Installation, is packaged in hardware and software form. The hardware form of this learning medium is designed as an industrial electrical equipment training device and the software form is designed as a virtual industrial electrical equipment simulator.

2 Literature Review

2.1 Efforts to Improve Learning Outcomes Through Training Units

Various new technological innovations were developed and introduced in learning, in this case multimedia-based media technology is an alternative solution to improve student learning achievement. According to [7], learning media is a teaching aid, namely supporting the use of teaching methods used by teachers. Meanwhile, according to [1], learning media is anything that can be used to convey messages or information in the teaching and learning process so that it can stimulate the attention and interest of students in learning. Based on the description of the experts', learning media is a tool that can help the teaching and learning process, the meaning of the message conveyed becomes clearer and the learning objectives can be achieved effectively and efficiently.

According to [9], in making a learning media one must pay attention to the visual and text aspects. So in research and development of this media is based on aspects of media design. According to [3] Educational technology involves the reasoned and effective use of technology to support or facilitate learning, performance, and instruction. It can be concluded that technology-based learning media is expected to be used in teaching and learning activities with the intention that the process of educational communication interaction between educators and students can take place effectively and efficiently.

2.2 Industrial Electrical Installation Training Unit

Media training on Industrial Electrical Installation is concepts that arise from increased understanding of components, tools and systems are studied according to the functions and real nuances of the original goods. This training media consists of industrial electrical installation training units in the form of hardware.

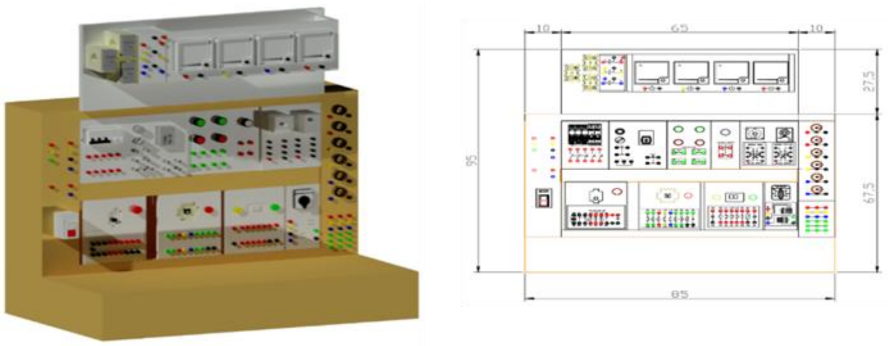

Figure 1. Design of an industrial electrical installation training unit

The industrial electrical installation training unit consists of learning activities: identification of 3-phase electrical components and observation of installation equipment, control of industrial lights and 3-phase motors on trainers, control of 3-phase induction motors using magnetic contactors, control of 3-phase induction motors using magnetic contactors [2]. Control of 3 phase induction motors using magnetic contactors, installation of industrial lighting controls using photocells, installation of 3 phase motor control box panels turning right-left [4], installation of automatic 3 phase star delta motor control box panels [10].

This training unit is packaged so that students can easily assemble and connect several components. Students only need to connect cables to the banana module units in assembling a system, so students do not need to unscrew each component. While the software unit is in the form of digital replication in the form of a virtual simulator of industrial electrical installations [8]. That this virtual simulator is a replication of a real model into a digital model using computer software.

3 Method

Research on the design of training units and virtual simulators of industrial electrical installations using the ADDIE and waterfall model research and development methods. The ADDIE development model is used to develop hardware training unit materials, while the waterfall model is used to develop virtual simulator software. The ADDIE model used refers to the ADDIE development model according to [6]. The concept of developing the ADDIE model as can be seen at Figure 2.

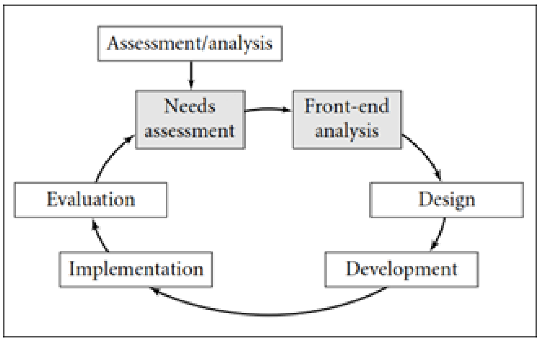

Figure 2. The ADDIE instructional design cycle

4 Data Collection Technique

Evaluation data is collected in two stages: black box testing and feasibility testing. Black box testing was initially performed as a functional test of training units tested with 5 users. The feasibility study is based on data from questionnaires completed by students after their internships in industrial electrical installations.

4.1 Blackbox test

The black box testing is used to test the use function of the training unit being developed, the black box test is carried out by filling out a questionnaire in the form of whether the training unit is functioning from its proper state. Testing based on the functional aspects of the equipment or equipment used in the training unit.

4.2 Training unit feasibility instrument

The assessment instrument used as a measuring tool to determine the feasibility level of the training unit is in the form of a questionnaire with a Likert scale. The questionnaire used consists of questions and/or statements adapted to the data to be collected. Filling in the questionnaire used is based on the actual situation and the needs seen by users, namely students in industrial electrical installation practical learning. Aspects assessed based on the theoretical basis used are four aspects used for the development of training units.

5 Instrument Testing

5.1 Instrument Validity

The instrument validity using content validity. Content validity was determined using the agreement of the field of study experts in accordance with the research material. The instrument validity are conducted using expert judgment. The results of the instrument trials were then measured for the agreement index using the Aiken-V formula. The agreement index V is then matched with the instrument validity criteria in Table 2.

$$V = \frac{\sum s}{n(c-1)}$$

Remarks:
V= agreement index,
s = assessment score minus the lowest score (s = r-lo),
r = rating score,
lo = lowest score,
n = the number of assessors,
c = the number of categories of the appraiser's choice.

Table 2. Category validity index-V

	Index	Validity Category
Validity of Aiken-V	0.81-1	High
	0.41-0.8	Medium
	0-0.4	Low

The results of the instrument validity test by experts stated that the instrument was valid with several improvements according to the suggestions. Suggestions for improvement from experts can be seen in the attachment to the validation statement sheet. The validity test using the Aiken-V formula is summarized in Table 3.

Table 3. Summary of instrument validity test

Instrument	Number of Appraisers	Index V	Validity Criteria
Material Expert	5	0.80-0.93	Medium- High
Media Expert	5	0.73-1.00	Medium- High
User Feedback	94	0.74-0.88	Medium- High

5.2 Instrument Reliability

Research instruments that are classified as reliable are instruments that can be used several times to measure similar research objects and can produce the same data. The reliability used in the development of Industrial Electrical Installation training units is carried out by taking data from instruments on students with practical learning of Industrial Electrical Installation. The data obtained is processed and analyzed to predict the level of reliability of the instrument. Data processing on the development of Industrial Electrical Installation training units to determine the level of reliability using the Cronbach's Alpha formula.

6 Data Analysis Technique

6.1 Feasibility Data Analysis

Data analysis techniques obtained from research instruments in the form of questionnaires. Questionnaires on the development of Industrial Electrical Installation training units are given to students in practical learning of Industrial Electrical Installation. The questionnaire will show. The questionnaire instrument used in the development of Industrial Electrical Installation training units uses a Likert scale with four choices, namely: very feasible (4), feasible (3), less feasible (2) and not feasible (1). The analysis technique used uses descriptive analysis techniques that are adjusted to the results of the questionnaire obtained.

7 Research Result

The product produced is the Industrial Electrical Installation Hardware training unit. The resulting training units are used for Industrial Electrical Installation learning activities, especially

Industrial Electrical Installation in learning organized by the Bachelor Degree Electrical Engineering Education Study Program and Diploma 4 Electrical Engineering Study Program. The training unit product development research applies the ADDIE development model.

7.1 Analysis

The analysis carried out in this development research consisted of two stages, namely needs analysis and front-end analysis. There are six activity processes in the needs analysis stage to be able to find out what needs are needed. The six activities include: 1) describing current conditions, 2) describing ideal conditions, 3) making a sequence of problems to be solved, 4) identifying differences, 5) determining positive areas, and 6) deciding what actions to take. should be done.

1) Needs Analysis

Conditions that support the development process of the Industrial Electrical Installation training unit include 1) all students can be sure to have a Smartphone device, 2) the operating system used is in accordance with the application operating system being developed, 3) hardware-based multimedia so that it can be used more freely. Thus, the above conditions are very supportive in the development of Industrial Electrical Installation training units.

Based on the description of the analysis above, several solutions can be offered, including 1) dividing the class into small classes with a total of 3-4 students, 2) adding practical training units, 3) giving students the opportunity to study outside class hours accompanied by laboratory technicians, 4) developing units Industrial Electrical Installation training. The solution for making classes into small classes makes class queues for laboratory use longer and the teaching time for supporting lecturers and technician assistance becomes longer. Adding practical training units will have a financial impact and will require reorganization of the laboratory. Giving students the opportunity to study outside class hours has implications for the availability of laboratory technicians because Industrial Electrical Installation practical activities must be accompanied by lecturers or technicians who are competent in the field of Industrial Electrical Installation.

The development of an Industrial Electrical Installation training unit has never existed before. the Industrial Electrical Installation training unit is a medium that can help students prove theories related to lower hazard potential and relatively cheaper costs and easy to apply. With the Industrial Electrical Installation training unit, students can prove several training units such as direct on line motor starting, star-delta, soft starter. The development of an Industrial Electrical Installation training unit has never existed before. the Industrial Electrical Installation training unit is a medium that can help students prove theories related to lower hazard potential and relatively cheaper costs and easy to apply. With the Industrial Electrical Installation training unit, students can prove several training units such as direct online motor starting, star-delta, soft starter. The development of an Industrial Electrical Installation training unit has never existed before. the Industrial Electrical Installation training unit is a medium that can help students prove theories related to lower hazard potential and relatively cheaper costs and easy to apply. With the Industrial Electrical Installation training unit, students can prove several training units such as direct online motor starting, star-delta, soft starter.

2) Front-End Analysis

Analysis of students carried out included identifying the background, identifying learning characteristics, and the prerequisite skills of students. Students in industrial electrical installation practical learning activities have heterogeneous educational backgrounds, namely senior secondary education, and vocational secondary education. The characteristics of learning in the Bachelor of Electrical Engineering Education Study Program and Diploma 4 Electrical Engineering Study Program are education with a portion of 30% theory and 70% practicum, so that practical learning is more dominant than theory. The pre-requisite competencies for Industrial Electrical Installation practicum include students who have taken Industrial Electrical Installation theory courses, theoretical and practical electricity basic courses.

Situation analysis on Industrial Electrical Installation practical activities in the form of practicum environmental constraints in the laboratory. current conditions practical activities are carried out using limited training units and using technology that is less relevant to current technological developments. The development of Industrial Electrical Installation training units is relevant to current technological developments. Apart from being relevant to current technological developments, these training units can be used flexibly without being limited by space and time. Thus, the development of training units according to the current situation.

Analysis of existing data includes identification of learning materials, references, and syllabus. Learning materials include material regarding Industrial Electrical Installation in buildings. Industrial Electrical Installation practicum is carried out according to certain procedures that require students to master the topic of Industrial Electrical Installation material. Thus, the theoretical study of Industrial Electrical Installation must be included in the Industrial Electrical Installation practical training unit.

Cost and benefit analysis includes identification of costs and benefits as well as return on investment. The development of Industrial Electrical Installation training units is easier than the procurement of actual equipment. The investment obtained is in the form of learning so that it is expected to be able to overcome the gap in knowledge and practicum skills for Industrial Electrical Installation.

Based on the description of the front-end analysis above, it is very possible to develop an Industrial Electrical Installation training unit. The results of media development are expected to support the practical activities of Industrial Electrical Installation. The Industrial Electrical Installation practical training unit was developed complete with several training unit simulations contained in a building. Thus, the development of Industrial Electrical Installation practical training units can be carried out without problems because all aspects can be contained in the media.

7.2 Design

The design stage is the planning and development stage of the media. The elements of the design stage include (1) Schedule preparation, (2) project team, (3) training unit specifications, (4) learning structure, (5) control circuit and installation scheme design, (6) training unit design, (7) review.

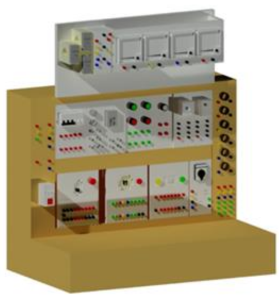

Figure 3. 3D models

1) 2D design

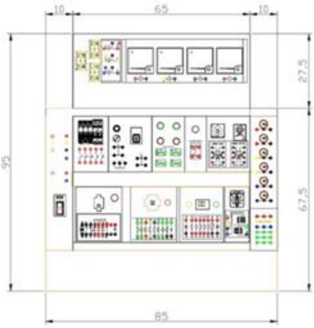

Figure 4. Front view

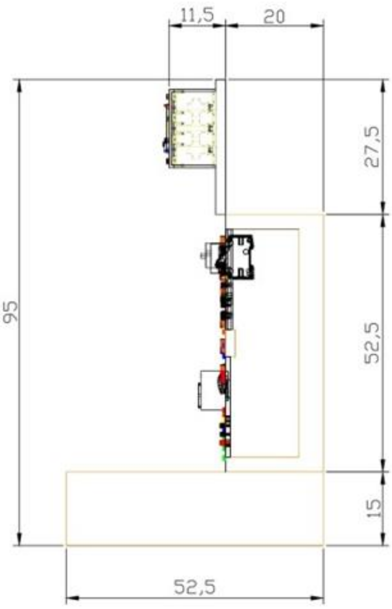

Figure 5. Side view

7.3 Development

The development stage includes the development of the training unit hardware, and the development of learning materials. The development results are described as follows.

1) User Requirement Specifications

User requirement specifications include interface requirements, data requirements, and functional requirements. Interface requirements are the content needed in the interaction between the user and the application program. The need for data needed during device testing. functional requirements are the functioning of the training unit to be used as a practicum medium.

2) Integration Testing

Integration testing is carried out using the black box testing method (black box test). The black box test is a test by looking at the performance of the functions that have been created. The performance of the Industrial Electrical Installation training unit was tested on two respondents.

7.4 Implementation

The Industrial Electrical Installation training unit before being applied to learning activities must be validated by experts. Expert validation is carried out to ensure that the training units developed can ensure the correctness of the material and meet the training unit standards. The material developed is applied to Industrial Electrical Installation learning activities. The application is carried out for Industrial Electrical Installation practices. The application was carried out at the Department of Electrical Engineering Education Study Program of Electrical Engineering and Electrical Engineering, Faculty of Engineering, Universitas Negeri Yogyakarta.

7.5 Evaluation

The evaluation phase includes formative evaluation. Formative evaluation is used to determine the feasibility of the product being developed and evaluate the use of the product. Formative evaluation is carried out by examining the due diligence questionnaire which consists of a material expert eligibility questionnaire, a media expert eligibility questionnaire, and a respondent questionnaire. Suggestions and input from experts and respondents to the questionnaire items are very useful for product improvement.

8 Product Trial Result

The Industrial Electrical Installation training unit has carried out various trials, including black box tests, material expert tests, media expert tests, and limited response tests.

8.1 Media Performance Test

Performance test is done by black box test. Black box testing is done by giving questionnaires to respondents. Respondents amounted to two students of the Department of Electrical Engineering Education who had passed the Industrial Electrical Installation course. Black box testing was carried out using a questionnaire with a total of 38 items. The assessment questionnaire is divided into two indicators, namely functioning as many as 34 items and performance as many as 4 items. The rating score is a dichotomous score, with the lowest value being 0 and the highest being 38. The black box rating score can be seen in Table 4.

Table 4. Black box test score

Respondents	**Indicator**	
	Function	**Performa**
1	34	4
2	34	4
Average	34	4

1) Function Aspect

Based on the black box test assessment table in the appendix, the functional aspect consists of 34 statement items, so that the lowest score is 0, the highest score is 34, the ideal mean is 17, and the ideal standard deviation is 5.67. The conversion of the black box test score is shown in Table 5.

Table 5. Conversion of function aspect black box test scores

Aspect	**Intervals**	**Category**
Function	$25.5 \le x \le 34$	Very Feasible
	$17 \le x < 25.5$	Feasible
	$8.5 \le x < 17$	Less Feasible
	$0.0 \le x < 8.5$	Not Feasible

Based on Table 4. The rating score by the respondents obtained an assessment score of 34. The mean rating score was then matched to Table 5 to find out the qualitative data. The test results obtained the category "Very Feasible" on the aspect of function.

2) Performance Aspect

Based on the black box test assessment table in the appendix, there are 4 statement items on the functional aspect, so that the lowest score is 0, the highest score is 4, the ideal mean is 2, and the ideal standard deviation is 0.67. The conversion of the black box test score is shown in Table 6.

Table 6. Conversion of performance aspect black box test scores

Aspect	Intervals	Category
performance	$3.0 \le x \le 4.0$	Very Feasible
	$2.0 \le x < 3.0$	Feasible
	$1.0 \le x < 2.0$	Less Feasible
	$0.0 \le x < 1.0$	Not Feasible

Based on Table 4, the score of the assessment by the respondents obtained an assessment score of 4. The mean rating score was then matched to Table 6 to find out the qualitative data. The test results obtained the category "Very Feasible" on the performance aspect.

Based on the description the results of black box testing, the feasibility category for each aspect has been identified. The assessment scores by respondents were then converted in percentage form, then the assessment results were summarized as shown in Table 7.

Table 7. Summary of black box test assessment

Respondents	Aspect			
	Function		Performance	
	(%)	Category	(%)	Category
Respondent 1	100	Very Feasible	100	Very Feasible
Respondent 2	100	Very Feasible	100	Very Feasible
Average	100	Very Feasible	100	Very Feasible

8.2 Material and Media Validation Test

Material and media validation tests were carried out to determine the feasibility of Industrial Electrical Installation training unit products as Industrial Electrical Installation practical training units. The product being developed must meet eligibility in terms of the feasibility of Industrial Electrical Installation materials and media. The test was carried out by four Postgraduate Lecturers at Feasible, including two Lecturers assessing the feasibility of the material and two Lecturers assessing the feasibility of the media.

1) Material Test

In the validation test by material experts, there are three aspects of assessment, namely related to the content of the material, learning, and efficiency. The material expert validation test used an instrument in the form of a questionnaire with a total of 24 items, covering 13 items on the content aspect, 5 on the learning aspect, and 6 on the efficiency aspect. The rating score uses a Likert scale of 1-4. The assessment scores by material experts are shown in Table 8.

Table 8. Material Assessment Score

Respondents	Aspect		
	Content material	Learning	Content material
Material Expert 1	51	Material Expert 1	51
Material Expert 2	52	Material Expert 2	52
Average	51.5	Average	51.5

a) Material Content Aspect

Based on the material expert assessment table in the Appendix, there are 13 statement items on the material content aspect, so that the lowest score is 13, the highest score is 52, the ideal mean is 32.5, and the ideal standard deviation is 6.5. The conversion score for the assessment of the content aspect of the material is shown in Table 9.

Table 9. Material assessment score

Aspect	intervals	Category
Content Material	$42.25 \leq x \leq 52$	Very Feasible
	$32.5 \leq x < 42.25$	Feasible
	$22.75 \leq x < 32.5$	Less Feasible
	$13 \leq x < 22.75$	Not Feasible

Based on Table 8, the score of the assessment by the material expert 1 was 51 and the material expert 2 was obtained by 52, so that the average rating score was 51.5. The test results obtained the category "Very Feasible" on the aspect of the material content.

b) Learning Aspect

Based on the material expert assessment table in the Appendix, the learning aspect contains 5 statement items, so that the lowest score is 5, the highest nominal score is 20, the ideal average is 12.5, and the ideal standard deviation is 2.5. The conversion of the learning aspect assessment score is shown in Table 10.

Table 10. Learning assessment scores

Aspect	Intervals	Category
Learning	$16.25 \leq x \leq 20$	Very Feasible
	$12.5 \leq x < 16.25$	Feasible
	$8.75 \leq x < 12.5$	Less Feasible
	$5 \leq x < 8.75$	Not Feasible

Based on Table 8, the score of the assessment by the material expert 1 was 19 and the material expert 2 was obtained by 20, so that the average rating score was 19.5. The test results obtained the category "Very Feasible " on the Learning aspect.

c) Efficiency Aspect

Based on the material expert assessment table in the Appendix, there are 6 statements on the efficiency aspect, so that the lowest nominal score is 6, the highest nominal score is 24, the ideal average is 15, and the ideal standard deviation is 3. The conversion of the efficiency aspect assessment score is shown in Table 11.

Table 11. Learning assessment scores

Aspect	intervals	Category
Efficiency	$19.5 \leq x \leq 24$	Very Feasible
	$15 \leq x < 19.5$	Feasible
	$10.5 \leq x < 15$	Less Feasible
	$6 \leq x < 10.5$	Not Feasible

Based on Table 8, the score of the assessment by the material expert 1 was 23 and the material expert 2 was obtained by 24, so that the average rating score was 23.5. The test results obtained the category "Very Feasible " on the aspect of efficiency.

2) Media Test

There are four aspects to the validation test by media experts, including visuals, hardware, usability, and portability. The media expert validation test used an instrument in the form of a questionnaire with a total of 28 items covering 10 visual aspects, 7 hardware aspects, 7 usability aspects, and 4 portability aspects. The rating score uses a Likert scale of 1-4. The assessment score can be seen in Table 12.

Table 12. Media expert assessment score

Respondents	Aspect			
	Visual	Hardware	Usability	Portability
Media Expert 1	38	27	28	15
Media Expert 2	40	27	28	16
Average	39	27	28	15,5

a) Visual Aspect

Based on the media expert's assessment table in the attachment, the visual aspect contains 10 statement items, so the ideal lowest score is 10, the ideal highest score is 40, the ideal mean is 25, and the ideal standard deviation is 5. The visual aspect score conversion is shown in Table 13.

Table 13. Visual aspect assessment score

Aspect	Intervals	Category
Visual	$32.5 \leq x \leq 40$	Very Feasible
	$25 \leq x < 32.5$	Feasible
	$17.5 \leq x < 25$	Less Feasible
	$10 \leq x < 17.5$	Not Feasible

Based on Table 12, the rating score by media expert 1 obtained a value of 38 and media expert 2 obtained 40, so that the average assessment score was 39. The average rating score was then matched with Table 13 to find out the qualitative data. The test results obtained the category "Very Feasible" on the visual aspect.

b) Hardware Aspect

Based on the media expert's assessment table in the attachment, there are 7 statements on the hardware aspect, so that the lowest ideal score is 7, the ideal highest score is 28, the ideal average is 17.5, and the ideal standard deviation is 3.5. The conversion of the hardware aspect assessment score is shown in Table 14.

Table 14. Hardware aspect rating score

Aspect	Intervals	Category
Hardware	$22.75 \leq x \leq 28$	Very Feasible
	$17.5 \leq x < 22.75$	Feasible
	$12.25 \leq x < 17.5$	Less Feasible
	$7 \leq x < 12.25$	Not Feasible

Based on Table 12, the rating score by media expert 1 obtained a value of 27 and media expert 2 obtained 27, so that the average rating score was 27. The average rating score was then matched with Table 14 to find out the qualitative data. The test results obtained the category "Very Feasible" on the hardware aspect.

c) Usability Aspect

Based on the media expert's assessment table in the appendix, there are 7 statements on the usability aspect, so that the lowest ideal score is 7, the ideal highest score is 28, the ideal average is 17.5, and the ideal standard deviation is 3.5. The usability aspect assessment score conversion is shown in Table 15.

Table 15. Usability rating score

Aspect	Intervals	Category
Usability	$22.75 \leq x \leq 28$	Very Feasible
	$17.5 \leq x < 22.75$	Feasible
	$12.25 \leq x < 17.5$	Less Feasible
	$7 \leq x < 12.25$	Not Feasible

Based on Table 12, the rating score by media expert 1 obtained a value of 28 and media expert 2 obtained 28, so that the average assessment score was 28. The average rating score was then matched with Table 15 to find out the qualitative data. The test results obtained the category "Very Feasible" on the usability aspect.

d) Portability Aspect

Based on the media expert assessment table in the appendix, there are 4 statements on the portability aspect, so that the lowest ideal score is 4, the ideal highest score is 16, the ideal mean is 10, and the ideal standard deviation is 2. Conversion of portability aspect assessment scores is shown in Table 16.

Table 16. Rating score portability

Aspect	Intervals	Category
Portability	$13 \leq x \leq 16$	Very Feasible
	$10 \leq x < 13$	Feasible
	$7 \leq x < 10$	Less Feasible
	$4 \leq x < 7$	Not Feasible

Based on Table 12, the media expert 1 scored a score of 15 and media expert 2 scored 16, so that the average rating score was 15.5. The mean rating score is then matched with Table 16 to find out the qualitative data. The test results obtained the category "Very Feasible" on the aspect of portability.

8.3 Test User Response

The user response test was conducted to find out the responses of student users of Industrial Electrical Installation training unit products as Industrial Electrical Installation practical training units. Products developed must get a good response from users. The implementation of the user response test was carried out by ninety-four people including 31 students of D4 Electrical Engineering and 63 student of Bachelor of Electrical Engineering Education, Faculty of Engineering, Universitas Negeri Yogyakarta who had taken the Industrial Electrical Installation course.

There are five aspects to the user response test, including learning, visual, hardware, usability, and portability aspects. responses by users using instruments in the form of a questionnaire with a total of 31 items covering, 3 learning aspects, 10 visual aspects, 7 hardware aspects, 7 usability aspects, and 4 portability aspects. The rating score uses a Likert scale of 1-4. The assessment score can be seen in Table 17.

Table 17. User rating score

Respondents	Aspect				
	Learning	Visual	Hardware	Usability	Portability
Average	11,2	33,7	23,8	24,6	13,8
Deviation raw	1.5	5	3,5	3,5	2
Minimum Score	3	10	7	7	4
Maximum Score	12	40	28	28	16

1) Learning Aspect

Based on the user rating table in the appendix, there are 3 statements on the learning aspect, so that the lowest ideal score is 3, the ideal highest score is 12, the ideal average is 7.5, and the ideal standard deviation is 1.5. The conversion of the visual aspect assessment score is shown in Table 18.

Table 18. Learning aspect assessment score

Aspect	Intervals	Category
Learning	$9.75 \leq x \leq 12$	Very Good
	$7.5 \leq x < 9.75$	Good
	$5.25 \leq x < 7.5$	Less Good
	$3 \leq x < 5.25$	Not Good

Based on Table 17, the average user rating score is 11.2. The mean rating score is then matched with Table 18 to find out the qualitative data. The test results obtained the category "Very Good" on the learning aspect.

2) Visual Aspect

Based on the user rating table in the appendix, the visual aspect contains 10 statement items, so that the lowest ideal score is 10, the ideal highest score is 40, the ideal mean is 25, and the ideal standard deviation is 5. Conversion of the visual aspect assessment score is shown in Table 19.

Table 19. Visual aspect assessment score

Aspect	Intervals	Category
Visual	$32.5 \leq x \leq 40$	Very Good
	$25 \leq x < 32.5$	Good
	$17.5 \leq x < 25$	Less Good
	$10 \leq x < 17.5$	Not Good

Based on Table 17, the average user rating score is 33.7. The average rating score is then matched with Table 19 to find out the qualitative data. The test results obtained the category "Very Good" on the visual aspect.

3) Hardware Aspect

Based on the media expert's assessment table in the attachment, there are 7 statements on the hardware aspect, so that the lowest ideal score is 7, the ideal highest score is 28, the ideal average is 17.5, and the ideal standard deviation is 3.5. The conversion of the hardware aspect score is shown in Table 20.

Table 20. Hardware aspect rating score

Aspect	Intervals	Category
Hardware	$22.75 \leq x \leq 28$	Very Good
	$17.5 \leq x < 22.75$	Good
	$12.25 \leq x < 17.5$	Less Good
	$7 \leq x < 12.25$	Not Good

Based on Table 17, the average user rating score is 23.8. The average rating score is then matched with Table 20 to find out the qualitative data. The test results obtained the category "Very Good" on the hardware aspect.

4) Usability Aspect

Based on the media expert's assessment table in the appendix, there are 7 statements on the usability aspect, so that the lowest ideal score is 7, the ideal highest score is 28, the ideal average is 17.5, and the ideal standard deviation is 3.5. The usability aspect assessment score conversion is shown in Table 21.

Table 21. Usability rating score

Aspect	Intervals	Category
Usability	$22.75 \leq x \leq 28$	Very Good
	$17.5 \leq x < 22.75$	Good
	$12.25 \leq x < 17.5$	Less Good
	$7 \leq x < 12.25$	Not Good

Based on Table 17, the average user rating score is 24.6. The average rating score is then matched with Table 21 to find out the qualitative data. The test results obtained the category "Very Good" on the usability aspect.

5) Portability Aspect

Based on the media expert assessment table in the appendix, there are 4 statements on the portability aspect, so that the lowest ideal score is 4, the ideal highest score is 16, the ideal mean is 10, and the ideal standard deviation is 2. Conversion of the portability aspect score is shown in Table 22.

Table 22. Rating score portability

Aspect	Intervals	Category
Portability	$13 \le x \le 16$	Very Good
	$10 \le x < 13$	Good
	$7 \le x < 10$	Less Good
	$4 \le x < 7$	Not Good

Based on Table 17, the average user rating score is 13.8. The mean rating score is then matched with Table 22 to find out the qualitative data. The test results obtained the category "Very Good" on the aspect of portability.

9 Product Revision

The product developed in this research is the Industrial Electrical Installation training unit. The product developed has been validated by four experts consisting of two material experts and two media experts. Four experts are Lecturers in Electrical Engineering Education, Faculty of Engineering, UNY.

9.1 Revision of Material Aspect

Material experts have assessed the product being developed. Material experts provide an assessment of the questionnaire items and suggestions and input for improvements to products developed from material aspects.

9.2 User Feedback

The user has assessed the product being developed. Users provide ratings on questionnaire items and responses to products developed from the user's point of view.

10 Final Product Review

This development research produced the final product in the form of an Industrial Electrical Installation training unit. Products are used to support practical learning of Industrial Electrical Installation. The developed media has gone through several stages of testing, including black box testing, expert validation, and responses by users.

10.1 Performance Test

The performance test of the Industrial Electrical Installation training unit was obtained through a black box test. The black box test is carried out by looking at the results of each given function or event without looking at the given program code. Based on the results of the black box test, a score of 34 was obtained on the function aspect, with the "Very Feasible" category and a score of 4 on the performance aspect, with the "Very Feasible" category.

Based on the results of the performance tests that have been carried out, the learning performance of Industrial Electrical Installation from the functional aspect gets a percentage of 100%, the performance aspect gets a percentage of 100%. Thus, the total score of the black box test gets a percentage of 100% and are categorized very good.

10.2 Feasibility Test

The feasibility test for the Industrial Electrical Installation training unit was obtained through the validation of material experts, media experts and users. The feasibility test is reviewed from the material aspect, the media aspect, and the user aspect. The material and media aspects were assessed by four lecturers from the Department of Electrical Engineering Education, Faculty of Engineering, Universitas Negeri Yogyakarta, while the user aspects were assessed by 94 students from the Department of Electrical Engineering Education, Faculty of Engineering, Universitas Negeri Yogyakarta.

1) Material Eligibility

The material feasibility of the Industrial Electrical Installation training unit includes three aspects, namely content, learning, and efficiency. Aspects of the content of the material include several indicators, namely learning outcomes, learning materials, depth of material, and contemporary. The learning aspect includes several indicators, namely learning strategies, learning motivation, and opportunities to learn. The efficiency aspect includes several indicators, namely time and resources. The items in the material expert questionnaire instrument are the application of several indicators on the aspects of material content, learning, and efficiency. The material expert questionnaire that has been prepared is then assessed by the material expert and all indicators have been met.

The results of the assessment by material experts, the content aspect of the material obtained an average score of 51 and are categorized “Very Feasible”. The learning aspect obtained an average score of 19.5 and are categorized “Very Feasible”. The efficiency aspect obtained an average score of 23 and are categorized “Very Feasible”. Based on the results of validation by material experts, the overall application program is stated to contain Industrial Electrical Installation material on the learning outcomes of testing direct current electric motors with various connections with the correct procedures. The results of the feasibility assessment of the material for the Industrial Electrical Installation training unit by material experts are in Figure 6.

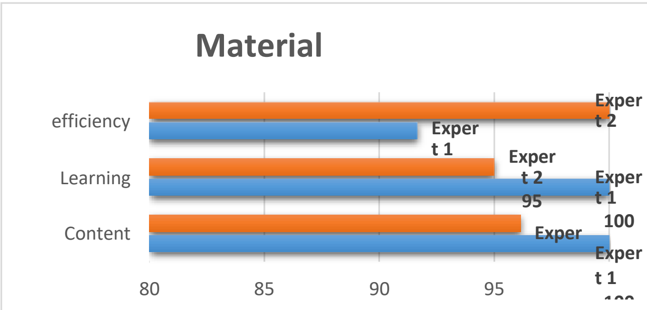

Figure 6. Material expert assessment

2) Media Feasibility

The feasibility of Industrial Electrical Installation media includes four aspects, namely visual, hardware, usability, and portability.

The results of the assessment by media experts, the visual aspect obtained an average score of 38.5 and are categorized very feasible. The hardware aspect obtained an average score of 26.5 and are categorized “Very Feasible”. The usability aspect gets an average score of 28 and are categorized “Very Feasible”. The portability aspect gets an average score of 15.5 and are categorized “Very Feasible”. Based on the results of validation by media experts, the overall application program is declared to have met the unit criteria for testing the electrical training unit with the correct procedures. The results of the feasibility assessment of Industrial Electrical Installation media by media experts can be seen in Figure 9.

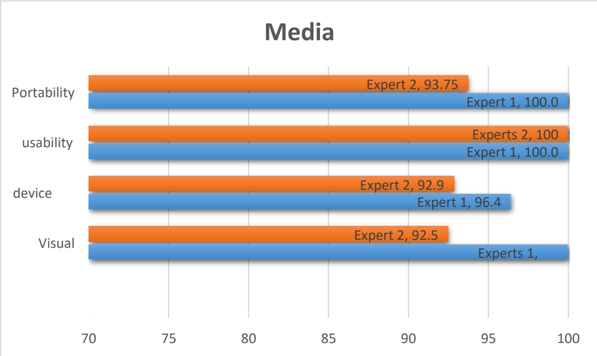

Figure 7. Media expert assessment

3) User Feedback

User testing was carried out on students of the Department of Electrical Engineering Education, Faculty of Engineering, Universitas Negeri Yogyakarta, with a total of 94 students as respondents. The user rating score uses a Likert scale of 1-4. The results of the assessment by the user, the learning aspect obtained an average score of 10.9 and are categorized “Very Good”.

The visual aspect gets an average score of 33, is categorized “Very Good”. The hardware aspect obtained an average score of 23.8 and are categorized “Very Good”. The usability aspect gets an average score of 24, is categorized “Very Good”. The portability aspect obtained an average score of 13.8 and are categorized “Very Good”.

Based on the results of the assessment by the user, overall, the application program is stated to have been well received by the user for testing the electrical training unit on the user or building side. User feasibility assessment results can be seen in Figure 8.

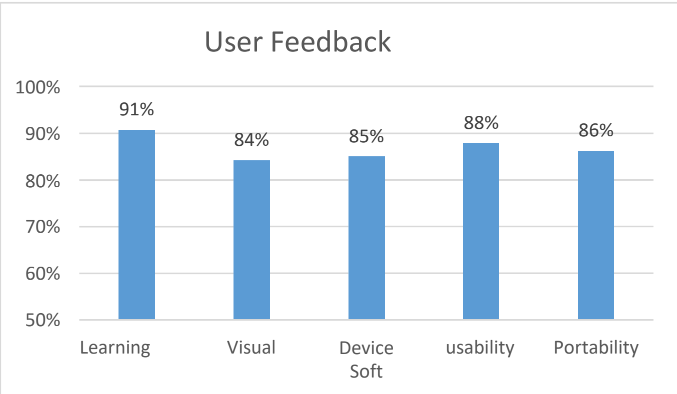

Figure 8. User responses

11 Conclusion

An Industrial Electrical Installation training unit has been developed that can simulate testing an electrical training unit with the correct procedures. The performance of the Industrial Electrical Installation training unit is known through the black box test, a score of 38 is obtained so that it can be categorized as "Very Good".

The feasibility of the application program in terms of the assessment by material experts includes aspects of material content, learning aspects, and efficiency aspects. All aspects of the material feasibility assessment got a score of 94.5 and were categorized as "Very Feasible". The feasibility of application programs in terms of assessment by media experts includes visual aspects, hardware aspects, usability aspects, and portability aspects. All aspects of the media feasibility assessment get an average score of 109.5 and are categorized as "Very Feasible".

User responses by students include learning aspects, visual aspects, hardware aspects, usability aspects, and portability aspects. All aspects of user response by students get an average score of 107.1 and are categorized as "Very Good".

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