Development of Human Machine Interface (HMI) Training Kit as A Learning Media for Industrial Automation Engineering Practical Courses

T H T Maryadi¹, H S Pramono², Y I Hatmojo³, E Prianto⁴ and Sunomo⁵
¹,²,³,⁴,⁵ Electrical Engineering Education Study Program, Faculty of Engineering, Universitas Negeri Yogyakarta, Indonesia

E-mail: ¹totokheru@uny.ac.id

Abstract. Learning media is one of the learning tools that is needed so that the learning process can run smoothly and students can have competencies in accordance with the expected competency goals. This paper discusses: (1) developing a Human Machine Interface (HMI) training kit as a learning medium in the Industrial Automation Engineering Practical Course; (2) the performance of the HMI training kit; (3) the feasibility of the HMI training kit based on the assessment of media experts, material experts and student responses as training kit users. In developing this training kit using the ADDIE model which consists of Analysis, Design, Development, Implementation and Evaluation. Data collection was carried out by testing the performance of the media, and giving a questionnaire to media experts to assess the feasibility of the media aspect, a material expert questionnaire to assess the appropriateness of the material and a questionnaire to determine student responses as users. The data were analyzed by means of quantitative descriptive analysis which were then categorized. The result of this development is HMI practice learning media for industrial automation engineering practice courses which consist of HMI practice hardware, and jobsheets. The performance of the HMI training kit for input and output parameters, visualization of engine control in the form of buttons, sliders, output visualization, indicator lights, and overall graphics have a 100% correct performance. Based on media experts, design aspects, technical aspects and usefulness aspects were rated very well, so that overall the media aspect received an assessment in the very proper category. Based on material experts, technical aspects and aspects of usefulness received an assessment in the very good category, so that overall the material aspect received an assessment in the very proper category. Based on assessment of students as users, the average score student response falls into the very good category.

1. Introduction

Education is the most important gateway in creating new things, increasing creative and innovative thinking for the development of science and technology. The purpose of education is to lead students to make changes in behavior, intellectually, morally and socially, which are used to become individual and social beings. The achievement of the above objectives can be seen from the students who are able to interact in the learning environment at the place where the student is studying, which all activities are regulated by the teacher and school. The learning environment is a scope consisting of learning objectives, learning materials, learning media, learning methodologies and learning assessments. Learning assessment is one of the important factors in achieving the initial goals of a learning process in a learning environment.

As stated by Arsyad [1] and reinforced by Munadi [5], to achieve learning objectives, learning media are needed to convey material messages to students in a planned manner so that a
conducive learning environment is created where recipients can carry out the learning process efficiently and effectively.

Industrial automation covers a wide field from automation products to manufacturing. In everything that exists today, there are many challenges needed in reducing production time, reducing costs, increasing variety and improving quality. Industrial automation is usually developed in industry with the aim of increasing safety, comfort, communication and saving power without much human intervention. Industrial automation systems are needed to integrate machines in an effort to carry out the process of producing services or goods. In the development of industrial automation disciplines. The industrial automation system in its development has reached a higher level by using a system that has been integrated with computer networks and the internet. In an automation system all the analysis needed and control it and then display it in a number of screens or operator monitors, one of which is by using HMI [2].

The industrial revolution 4.0 gave rise to automated technology integrated with the internet network. HMI is used as an input device that bridges humans with machines and as an output device for communication from machines to humans. Education that spurs technological innovation in the current development is needed by the Indonesian nation to be able to compete in this global era. The application of good and adequate media is expected to stimulate students' thoughts, feelings, attention, and motivation to learn so that the learning process can run well, be energetic, and fun. "The use of learning media in learning activities can motivate students to learn and make it easier for them to get information" [4].

Increasing up to date practice facilities by connecting HMI and PLC as automatic control devices is a necessity in practical learning. In the industrial automation engineering practice course, there are competency objectives, one of which is that students have the ability to program PLC and HMI as the control base for the automation system. On the other hand, the lack of availability of equipment causes the ratio of tools and the number of students doing practice to be very small, therefore it is necessary to add practical equipment that is relevant to the industry. Provision of practical equipment certainly requires expensive costs, so to cover the shortage, creative ideas are needed that can develop similar equipment for practical activities.

Based on the description above, to meet the equipment needs for industrial automation engineering practice courses and to overcome the limited funds for the procurement of practical equipment, research is needed to develop practical equipment that is commensurate with the equipment used in industry. With this development, it is expected that an adequate HMI training kit can be used for practical activities in the industrial automation engineering practice course.

2. Method

Research conducted using the Research Development method. The development model carried out refers to the ADDIE model according to R M Branch [3]. There are five stages in the ADDIE development model, namely (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation.

The following is a description of the steps for developing the HMI training kit for practicing Industrial Automation Engineering courses.

2.1 Analysis

The analysis stage is the initial stage that needs to be done in product development. This stage aims to identify problems and gaps that occur in students. There are several procedures that need to be done at this stage, namely analyzing the performance gap analysis, determining learning objectives, analyzing learning and analyzing learning resources used in the learning process.

2.2 Design

After the analysis phase is carried out, the next stage is the design stage. The purpose of this stage is to design the product to be made using the appropriate testing method. The design is done by writing the concept or initial appearance of the product to be developed by paying
attention to the parameters associated with the product. Furthermore, designing the supporting tools of the training kit in the form of a manual, jobsheets and handouts.

2.3 Development

The purpose of the development stage is to produce a product in the form of an HMI training kit and its supporting tools in the form of a usage guide, jobsheets and handouts. Apart from product development, an instrument is also developed to measure its performance.

2.4 Implementation

The purpose of this stage is to test the use of products developed in an educational environment, involving teachers and students. This stage will generate responses from users, namely teachers and students.

The instrument used in this study was tested for validity. The validation of the instrument was carried out by two experts. In this validation, the content validity and form validity were tested. After the revision was made according to the suggestions given by the instrument, it was used to validate the media, material aspects and user responses.

2.5 Evaluation

The evaluation stage aims to measure the achievement of goals or assess the quality of the product being developed. The procedure that can be done is to determine evaluation criteria, choose the right evaluation to use and look for various information that can improve student learning outcomes.

The data analysis technique used is in the form of quantitative descriptive analysis in the form of product development performance testing results, due diligence results based on media experts and material experts as well as student responses.

3. Results and Discussion

3.1 Product and Performance Test

The results of this development are the HMI training kit in the form of HMI practice module hardware, and jobsheets for practical activities. The jobsheet consists of 8 topics with a practical time requirement of 8x2x50 minutes. The image of the results of this research can be seen in Figure 1 and Figure 2 below:

![Figure 1. Wienview HMI Training Kit](image1)
![Figure 2. Magelis HMI Training Kit](image2)

The product is tested for its performance using the black box testing approach. The functional test results from the development of the HMI training kit carried out are the display and input components such as buttons and sliders, displays and output components such as indicator lights, text data, and graphics, all of which get 100% correct results.
3.2 **Media Validation**

The feasibility test of the media aspect is carried out by asking for an assessment from 2 experts in the field of instructional media. Media validation assesses three aspects, namely: design, technical and usefulness. The validation results can be seen in Table 1.

| No | Assessment aspect | Max Score | Expert 1 | Expert 2 | Rerata per Aspek | % | Category      |
|----|-------------------|-----------|----------|----------|------------------|---|---------------|
| 1  | Design            | 32        | 24       | 29       | 26.5             | 83| Highly Feasible|
| 2  | Technical         | 32        | 27       | 29       | 29               | 91| Highly Feasible|
| 3  | Usefullness       | 32        | 28       | 27       | 27.5             | 86| Highly Feasible|
|    | Total             | 96        | 79       | 85       | 82               | 85| Highly Feasible|

Based on Table 1. The percentage of eligibility in terms of media validation can be described in the following diagram:

![Assessment of Media Expert](image)

**Figure 3. The Percentage of Each Aspect of the Media Validation**

Figure 3 is a graph of the results of the assessment of the two media experts. Based on this graph, it can be seen that the HMI training kit developed in all aspects has a very good rating. The highest score is in the technical aspect (91%), while other aspects, namely design and usability, get an average score percentage of 83% and 86%, both of which are in the very good category. Overall from the media side, it got a very decent assessment.

3.3 **Material Validation**

Assessment of training kits by material experts is carried out by looking at 2 aspects, namely technical aspects and aspects of benefit. The results of the assessment can be seen in Table 2.
Table 2. The Results of the Material Validation

| No | Assessment aspect | Max Score | Expert 1 | Expert 2 | Mean per Aspect | % | Category       |
|----|-------------------|-----------|----------|----------|-----------------|---|----------------|
| 1  | Technical         | 44        | 34       | 43       | 38.5            | 88 | Highly Feasible |
| 2  | Usefullness       | 28        | 25       | 28       | 26.5            | 95 | Highly Feasible |
|    | Total             | 72        | 59       | 71       | 65              | 90 | Highly Feasible |

Based on Table 2, the percentage of eligibility in terms of material validation can be described in the following diagram:

Figure 4. The Percentage of Each Aspect of the Material Validation

Figure 4 is a graph of the material expert's assessment with the results on the benefit aspect (US) having the highest mean score percentage (95%) which is in the very good category. While the technical aspects get an assessment with a mean score percentage of 88% which is included in the very good category. Overall, the mean score percentage is 90%, including in the very feasible category.

3.4 User Testing

After an assessment was carried out by media experts and material experts, the training kit assessment was continued with limited trials for students to see the responses of students as users. Students are given an explanation of practical equipment and then a demonstration of its use is carried out. After that students are asked to try the training kit and then given a questionnaire to provide an assessment of the training kit. In the questionnaire response of students as users contains four aspects, namely material aspects, design aspects, technical aspects and aspects of benefit. The results of the user ratings are as shown in Table 3.

Table 3. Users’ Assessment of the Developed HMI Training Kit

| No | Aspect    | Max Score | Mean Score | %  | Category|
|----|-----------|-----------|------------|---|---------|
| 1  | Material  | 32        | 28.2       | 88 | Very Good|
| 2  | Design    | 24        | 20.7       | 86 | Very Good|
| 3  | Technical | 32        | 27.6       | 86 | Very Good|
| 4  | Usefullness| 24        | 21.4       | 89 | Very Good|
|    | Total     | 112       | 97.0       | 87 | Very Good|
Based on Table 3, the percentage of eligibility for training kits in terms of users can be described in the following diagram.

![Percentage of Each Aspect of User Assessment](image)

**Figure 5. The Percentage of Each Aspect of User Assessment**

Figure 5 is a graph of the assessment of students as users with the results on the benefit aspect having the highest average score percentage, namely 89%, which is included in the very good category. Meanwhile, in the material, design and technical aspects, the scores were scored with the average percentage of 88%, 86% and 86%, all of which were included in the very good category. Overall the assessment of the training kit by students as users gets a mean score percentage of 90% which is included in the very good category.

4. **Conclusions**

4.1 The result of this development is a HMI practical learning media for industrial automation engineering practice courses consisting of HMI practice hardware, and jobsheets.

4.2 Test the performance of the development of the HMI training kit as a display and input components such as buttons and sliders, as well as the HMI as a display and output components such as indicator lights, text data, and graphics, all of which get 100% correct results.

4.3 Based on media experts, design aspects, technical aspects and usefulness aspects were rated very good, so that overall the media aspect received an assessment in the very feasible category.

4.4 Based on material experts, technical aspects and aspects of benefit get an assessment in the very good category, so that overall the material aspect gets an assessment in the very feasible category.

4.5 The response of students as users states that the material aspects, design aspects, technical aspects and usefulness aspects give very good scores, so that the overall user assessment has an average score in the very good category.

5. **References**

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