Analysis of needs for development of the internet of things virtual laboratory

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Abstract. Industrial Era 4.0 and Society Era 5.0 are eras in which educational institutions are required to prepare graduates who are ready to enter a more competitive world of work, but the facilities and infrastructure for practicum learning in Indonesian educational institutions are not optimal, including virtual practicum facilities, as can be seen from the availability of virtual laboratories, which is still minimal, especially in higher education institutions compared to educational institutions abroad. A survey on the implementation of practicum learning in the pandemic era at Halu Oleo University showed that 37% of the practicum was implemented and 63% of the practicum was not implemented because there were no supporting facilities for virtual practicum learning during the pandemic. This study aims to analyze the students' needs for the implementation of the internet of things (IoT) virtual laboratory at Halu Oleo University. The analysis instruments include (1) IoT laboratory facilities; (2) IoT courses; and (3) learning processes and practica in IoT courses. This type of research is quantitative research with descriptive statistical analysis techniques. The results showed that 80.58% of the students strongly agreed with development of the IoT virtual laboratory as a means to support practical learning at Halu Oleo University.

1 Introductions

The Industry 4.0 Era and Society The 5.0 Era is an era in which educational institutions are required to prepare graduates who are ready to enter a more competitive world of work. Graduates who are ready to enter the world of work need laboratory facilities and infrastructure at educational institutions in accordance with the requirements of higher education national standards. [1]. Facilities and infrastructure include the provision of a virtual practicum learning system or a virtual laboratory to support learning. [2] [3]. The facilities and infrastructure for virtual practicum learning in Indonesian educational institutions have not been maximized, and it can be seen from the availability of virtual laboratories which are still minimal, especially vocational education institutions compared to educational institutions abroad.

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Virtual laboratories are available not only for educational institutions with complete laboratory facilities. Still, it can also be designated for educational institutions that do not yet have complete laboratories to achieve competence. Virtual laboratories can be used in practicum processes in distance or online education and can complement the limitations of equipment in laboratories. [4] [5] [6]. Virtual laboratories can help provide experience and competency skills, especially abstract skill competencies. Virtual laboratories have advantages in terms of ease of use, lower costs, safer and more flexible [7][8]

Advances in information and communication technology have made it possible to develop virtual laboratories, which provide opportunities for students to access various places in participating in virtual practicums to overcome physical laboratories' limitations. [9][6]. Practical implementation with a virtual laboratory supports the *Merdeka Belajar Kampus Merdeka* (MBKM) program such as practical learning on student exchanges from other campuses.

Practicums should be carried out directly in the laboratory; in certain conditions and situations, practicum activities cannot be carried out directly, so online practicum learning is an alternative so that practicums can continue to be carried out according to the provisions stipulated by the Ministry of Research, Technology, and Higher Education, so that practicums at vocational education institutions remain must be implemented. [10][8]
The Covid-19 pandemic has provided educational institutions with experience limiting face-to-face meetings, resulting in a limited learning process, theory, and practice, or online [11][12]. Implementing online theoretical learning during the Covid-19 pandemic could be done well. Still, online practicum learning needed to be carried out optimally due to the lack of preparation of facilities and infrastructure for online practicum or virtual laboratories.

To overcome the problem of limited laboratory equipment, wastage of expensive hardware, and potential dangers during computer hardware assembly experiments that often occur in laboratory practicums, such as in Internet of Things (IoT) practicums that use Arduino devices, microcontrollers, sensors, and components otherwise, a virtual laboratory solution is needed by designing a software interface that suits the physical laboratory conditions [13][14] . A virtual laboratory designed with the same interface as a physical device will allow students to carry out practicums even though the limitations of laboratory equipment constrain them.

Today's human life is directly connected to the internet in fields such as industry, agriculture, fisheries and maritime affairs, health, the economy, to education. Hence, understanding and competence related to IoT is very important. In another study, it was revealed that there are at least 3 (three) of knowledge that is needed for the industry today. In the future, including Artificial Intelligence (AI), the Internet of Things (IoT), and Edge Computing (EC) [15], then the current and future implementation of IoT is something that is needed due to the rapid and rapid development of technology and information.

Many educational institutions are currently making IoT a compulsory subject, so the need for IoT laboratories will be increasingly needed and will indirectly increase. At this time, educational institutions should prepare IoT curricula, training and courses, and learning platforms in virtual environments [16] [15]. Using IoT-based technology can support practical learning with more innovative learning models using simulators and virtual laboratories [17][18]. Therefore, topics in the field of IoT-related development education at present and in the future are urgently needed.

2 Methode

This quantitative descriptive research will describe the conditions of learning and practicum in the Internet of Things course at Halu Oleo University and analyze the need for laboratory use for practicum implementation. The sample in this study were students who were

temporarily taking the Internet of Things courses in the Electrical Engineering and D3 Electronic Engineering study programs; the research stages can be seen in Figure 1.

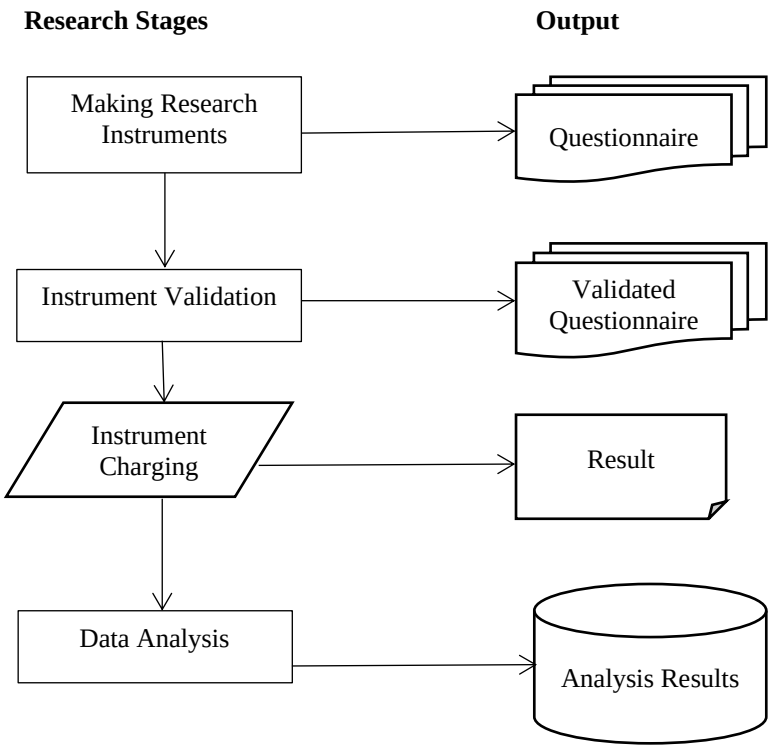

Fig. 1. Research Stages At the research stage, it will be followed by making research instruments.

Based on the information shown in Figure 1, the first stage is making research instruments in questionnaire form.. Research instruments were created to gather information about tertiary institutions' learning process and practicum. Instrument Using three measurement criteria, namely (1) IoT Laboratory Facilities, (2) Internet of Things Course, (3) Learning Process and Practicum, the following are the results of the instrument that have been validated carried out by material expert validation and language expert validation the next step is to validate the instrument, and after it is declared valid, the next process is data collection through filling out instruments by students, the results of filling in will be followed by data analysis which can then be concluded the need for implementing an IoT virtual laboratory.

Table 1. Criteria A Instrument: IoT Laboratory FacilitiesInternet

ID	Question
A1	Are IoT lab facilities physically available on your campus?
A2	Have you ever accessed a physical IoT lab?
A3	Are virtual IoT lab facilities available on your campus?
A4	Have you ever accessed a virtual IoT lab?
A5	Is there an internet network facility on campus to support the virtual laboratory?

Table 2. Instrument Criterion B: Internet of Things Course

ID	Question
B1	Have you ever learned about the Internet of Things?
B2	Have you ever taken or are currently taking IoT courses?
B3	Are IoT learning materials easy to understand?
B4	Do lecturers present the material in modules, job sheets, and teaching materials that are easy to understand?
B5	Have you ever done a practicum during your IoT course?

Table 3. Instrument Criterion C: Learning Process and Practicum

ID	Question
C1	Is practicum needed in IoT learning?
C2	Do you agree that IoT practicum skills can be carried out through a Virtual Laboratory?
C3	Would you like it if IoT learning was virtually presented in interactive multimedia?
C4	Would you like it if practical IoT learning could be done through a simulator?
C5	Would you be happy if virtual IoT practical learning could be integrated with video conferencing?
C6	Would you be happy if practical IoT learning could be virtually integrated with the Learning Management System (LMS)?
C7	Do you agree that an IoT virtual laboratory is developed for your practicum facilities?

The formula used is a descriptive analysis technique with an average scoring answer for each item assessed. According to Sugiyono (2016)[19] the average percentage of each component is calculated using the formula: As follows

$$P = \frac{\Sigma x}{N} \text{ x } 100\% \quad (1)$$

Description :
P = percentage gain
Σx = Total score for each selected criterion
N = Total ideal score

Table 4. Criteria for Choice of Answers and percentage of achievement

Options	Description	Percentage
4	Strongly agree / Very good / Very available / Strongly agree	76 – 100%
3	Agree / OK / Available / Yes	51 – 75%
2	Disagree / Not good / Less Available / Less Ever	36 – 50%
1	Disagree / Not Good / Not Available / Never	< 35%

The formula used is descriptive analysis technique with an average scoring answer for each item assessed (Arikunto, 2006). As follows:

$$P = \frac{\Sigma x}{n} \quad (2)$$

Description :
P = average score
$\sum$ x = number of answers for each respondent for each item assessed
n = number of respondents

Table 5. Average score criteria

Score	Description
3,26-4,00	Strongly agree / Very good / Very available / Strongly agree
2,51-3,25	Agree / OK / Available / Yes
1,76-2,50	Disagree / Not good / Less Available / Less Ever
1,00-1,75	Disagree / Not Good / Not Available / Never

3 Results and Discussion

Research conducted at Halu Oleo University to find out and analyze the needs of implementing IoT virtual laboratories study uses three instruments, namely:

1. IoT Laboratory Facilities.
2. Internet of Things Courses.
3. The Learning Process and Practicum based on 3rd expert validation of the instrument is valid for use with the following results.

Table 6. Validation results

CONCLUSION OF ASSESSMENT (VALIDATION)	Average scoring $P = \frac{\Sigma x}{n}$			
	A	B	C	D
General assessment of the research instrument sheets for the Internet of Things Virtual Laboratory Development in Educational Institutions	3,4	0,6	0	0

Description :

A. Can be used without revision

B. Can be used with little revision

C. Can be used with multiple revisions

D. Not yet usable

From the validation results, 3.4 scores were obtained for variable A so that the instrument could be used without revision, and there were 0.6 for variable B which was used with slight modification, then the validated instruments results were used for data collection; respondents consisted of 55 students of the S1 Electrical Engineering study program and D3 Electronics Engineering who programmed the Internet of things course.

Equations should be centred and should be numbered with the number on the right-hand side.

3.1 Conditions of IoT Laboratory Facilities

The results of the first questionnaire and data analysis are to find out student perceptions of the condition of the facilities that support the learning process and practicum at Halu Oleo University, questions regarding IoT laboratory facilities available physically and virtually, for example, on the question Are IoT laboratory facilities physically available on campus you, it can be shown in table 6 that there is an average score of 1.36 which means it is not available and is in line with other facility questions which are in the range of 1.00-1.75 and 1.76-2.50. Still, other things are shown related to the availability of the internet network; this indicates an average score of 2.96 which means the internet network is available. And overall, the facility obtained a percentage of 47.73%, which means that physical and virtual laboratory facilities still need to be available at Halu Oleo University.

Table 7. Results of Criterion A Instrument Analysis: IoT Laboratory Facilities

Category	Criteria A: IoT Laboratory Facilities					Score	Avearge Score
	A1	A2	A3	A4	A5		
Mean	1	1	2	2	3	9	45
Std.deviation	0,78	0,55	1,05	1,06	1,00	2,66	13,29
Average	1,36	1,18	2,02	2,02	2,96	9,55	47,73
Percentage Gain P = (Σx / N) x 100%							47,73

3.2. IoT Course Conditions

For criterion B related to IoT courses, question items Have you ever studied the Internet of Things? Have you ever taken or are currently taking IoT courses? Is IoT learning material easy to understand, Is the material presented by lecturers in modules, job sheets, and teaching materials easy to understand? It is in the range of an average score of 2.51-3.25, meaning the learning material is sufficiently available. Still, in the questions related to whether you have a practicum during the study of the IoT course, the average score is relatively low at 1.55, which means that students carry out practicum.

Table 8. Results of Criterion B Instrument Analysis: Internet of Things Course

Category	Criterion B: Internet of Things Course					Score	Avearge Score
	B1	B2	B3	B4	B5		
Mean	3	4	3	3	1	14	70
Std.deviation	0,49	0,56	0,39	0,47	0,90	1,46	7,31
Average	3,36	3,62	2,82	2,82	1,55	14,16	70,82
Percentage Gain P = (Σx / N) x 100%							70,82

3.3. The Learning Process and Practicum for IoT Courses

For criterion C, the learning process and practicum consist of 7 questions; in the first question, the average score is 3.75, which means it is necessary to carry out an IoT practicum; on the question, Do you agree if IoT practicum skills can be done through a Virtual Laboratory, an average score of 3.20 which shows students agree to carry out practicum through a virtual laboratory and on the last question Do you agree if an IoT virtual laboratory is developed? For your practicum facilities? Most students, with an average score of 3.47, agree that a virtual laboratory is designed to support IoT learning. And in general, the score value is 80.58, which means that it is very agreeable to the availability of this facility.

Table 9. Results of Instrument Analysis Criterion C: Learning Process and Practicum

Category	Kriteria C: The Learning Process and Practicum for IoT Courses							Score	Avearge Score
	B1	B2	B3	B4	B5	B6	B7		
Mean	4	3	3	3	3	3	4	22	78,57
Std.deviation	0,44	0,73	0,56	0,66	0,82	0,86	0,72	3,35	11,96
Average	3,75	3,20	3,40	3,11	2,82	2,82	3,47	22,56	80,58
Percentage Gain P = (Σx / N) x 100%									80,58

4 Conclusion

From the results of this study, an illustration was obtained that there has yet to be any availability of Internet of Things laboratory facilities at Halu Oleo University. Still, the Internet network has been available to support the use of the laboratory; from the results of criterion B related to IoT courses, a percentage value of 70.82% of IoT material is available. It will be easier to understand if carried out with practicum. The last criterion shows that 80.58% of students consider it necessary to develop a laboratory Virtual IoT to support the learning process at Halu Oleo University.

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