Educational Technology in Industrial Automation Applications Using Digital-Based Portable Boiler Machines

Mohamad Jajuli[1], Rahmat Hidayat[2], Adit Kurniawan[3], Enjang Ahmad Juanda[4]
{mohamad.jajuli@unsika.ac.id}

Universitas Singaperbangsa Karawang[12], Institut Teknologi Bandung[3], Universitas Pendidikan Bandung[4]

Abstract. Educational technology in the industrial era 4.0 requires education to use digital technology as a learning tool used in the teaching and learning process. In the boiler engine, there can be a decrease in boiler performance caused by poor combustion, dirty heat exchanger systems and poor operation and maintenance. With a decrease in boiler performance, it will have an impact on decreasing efficiency, so a monitoring system is needed to determine the efficiency value of the boiler. This research model uses the Research and Development model. The result indicates that there is an improvement of students' understanding toward industrial electronics subjects especially in utilizing industrial automation application technology by 85%. This improvement is supported by the increase of boiler performance by 90% from the performance trials carried out in the field. This is influenced by the increase of efficiency supported by a digital system on a portable boiler machine.

Keywords: Educational technology; Industrial automation applications; Digital

1 Introduction

The problem that occurs in vocational secondary students (SMK) is the lack of educational technology used as a media in teaching and learning. In addition, vocational students also find it difficult to study in industrial electronics. In the boiler machine, there can be a decrease in boiler performance caused by poor combustion, dirty heat exchanger systems and poor operation and maintenance. With a decrease in boiler performance, it will have an impact on decreasing efficiency, so a monitoring system is needed to determine the efficiency value of the boiler. This study uses the design method incorporated with classroom action research. In sequence, these methods are identifying needs, designing hardware and software, producing, testing and doing research to vocational high schools

A steam boiler is a device for generating steam by converting water into steam, which consists of two important parts, namely a heating furnace which produces heat obtained from burning fuel and a proper boiler, a device that converts water into steam (Hanzen, 2009, P12). Water is a medium used in high temperature processes or for partial conversion into mechanical energy in a turbine. Mechanical energy is used to drive a turbine generator which will then be converted into electrical energy.

In the boiler system, there can be a decrease in boiler performance, a decrease in boiler performance caused by poor combustion, dirty heat exchanger systems and poor operation and

ICES 2021, November 17-18, Jakarta, Indonesia
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DOI 10.4108/eai.17-11-2021.2318656

maintenance. The decrease in boiler performance will have an impact on decreasing efficiency, so a monitoring system is needed to determine the efficiency value of the boiler. This monitoring system aims to monitor the temperature at the steam output of the boiler engine where the temperature often changes in temperature this is due to the use of excess fuel so that it affects the steam temperature in the boiler engine. In addition, technically the purpose of this application is to monitor the temperature of the steam output against changes in temperature in the boiler combustion chamber so that the efficiency value of the boiler can be identified.

2 Research Methods

The research method used is the design method. The design is carried out to get the best design and performance of a portable boiler machine based on a digital monitoring system using some concepts in accordance with theory. The results of the design of the tool are expected to bring up the design of the device on the actual model. The device design of this research consists of mechanical, electronic, software and mechanical design. The electronic circuit works as a thermocouple, LCD and programming control system. The following is the design of the tool that will be made.

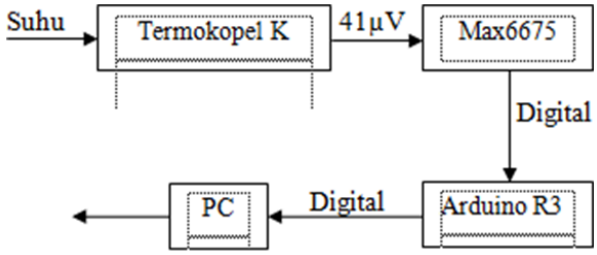

Fig. 1. Sensor block diagram

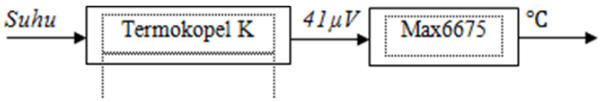

Fig.1. Sensor block diagram with max 6675 module

This study used the design method incorporated with classroom action research. In sequence, these methods are identifying needs, designing hardware and software, producing, testing and doing research to vocational high schools.

3 Results and Discussion

The technology model in this application is changing from a conventional (manual) model to a computer-based and microcontroller-based portable form (automation).

Fig.2. Portable boiler machines

Based on the picture above, the result of this study indicates that there is an increase in boiler performance by 90% from the performance trials carried out in the field. This is influenced by the increase of efficiency supported by a digital system on a portable boiler machine.

The pressure of portable boiler engine is controlled by providing combustion to the portable boiler engine. From the results of measurements using a barometer, there are three categories, namely 1) Low pressure boiler including 6.5 Bar, 8.2 Bar, 2) Medium pressure boiler category consisting of 13 Bar, 24 Br, 36 Bar, and 48 Bar, 3) High pressure boiler category which consists of 52 Bar, 54 Bar and 61 Bar. From testing industrial automation learning media tools using portable boiler machines, it is obtained that it can function properly, means the boiler machine can work as planned. Furthermore, the type K Thermocouple Sensor is installed on the output pipe of the boiler which functions to detect the temperature of the pressurized steam described in Figure 4.

Fig.3. LCD Display on Temperature

Figure 3 shows the measured steam temperature value in the output pipe displayed on the TM1637 LCD. The thermocouple sensor test is carried out by comparing the value of the measurement results of the standard AT1650 Infrared Thermometer with the reading value of the thermocouple sensor whose measurement results are in the form of digital numbers displayed on the display (LCD), both sensors measure the temperature of the heater which contains water and is placed at the measurement point. different, then the heater is heated, and the stopwatch is activated, for data retrieval / measurement results are carried out every 15 second increments with a measurement range of 28-47^{o} C, the data collection is carried out 12 times with the same point.

The following is data from the calibration of the K bolt thermocouple sensor with the AT1650 Infrared Thermometer sensor.

Table 1. Table of Sensor Testing

No	Standard (°C)	Tool (°C)	Error (°C)
1	28	28.245	-0,245
2	31.9	31.875	0,175
3	32	31.84	0,16
4	33.1	32.62	0,48
5	35.6	34.16	0,90
6	37	36.17	0,83
7	38	37.64	0,36
8	41	40,83	0,17
9	43	42,74	0,26
10	44	43,38	0,62
11	45	44,18	0,82
12	47	46,15	0,85

It is to find out the efficiency of the fuel by comparing the temperature data in the combustion chamber with the temperature data at the steam output every 20 second's increases. In this temperature monitoring system using a type K thermocouple sensor and MAX6675 module as signal conditioning, Arduino Uno R3 (MEGA328P) as a microcontroller, TM1637 as an LED display on the measurement results displayed. The results of this study indicate that there is an improvement of students' understanding toward industrial electronics subjects especially in utilizing industrial automation application technology by 85%.

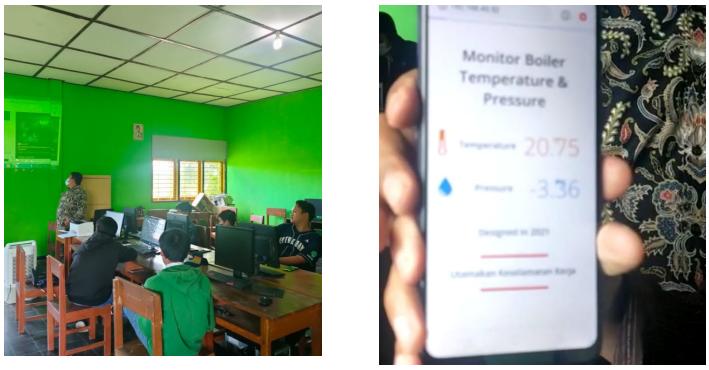

Fig. 5. Learning outcomes of portable boiler monitoring applications

This improvement is supported by the increase of boiler performance by 90% from the performance trials carried out in the field. This is influenced by the increase of efficiency supported by a digital system on a portable boiler machine.

Fig. 6. Implementation of learning outcomes for SMK students

The development of industrial automation learning media using a portable boiler machine based on a digital monitoring system is done at Vocational High Schools (SMK) in Karawang Regency. Then, data analysis in this study was carried out by means of scientific calculations, namely testing 1) testing power supply circuits or regulators, 2) Measurement portable boiler engine temperature, 3) Pressure measurement. on the learning media of this PCB solvent tool, as well as evaluating the system design using the AVR microcontroller software.

4 Conclusion

The result research indicates that there is an improvement of students' understanding toward industrial electronics subjects especially in utilizing industrial automation application technology by 85%. This improvement is supported by the increase of boiler performance by 90% from the performance trials carried out in the field. This is influenced by the increase of efficiency supported by a digital system on a portable boiler machine.

Acknowledgement

The researcher would like to thank the Ministry of Education, Culture, Research, and Technology for the grant funds provided in the 2021 Inter-University Cooperation (PKPT) scheme research.

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