JURNAL EDUNITRO
JURNAL PENDIDIKAN TEKNIK ELEKTRO
HTTPS://EJURNAL.UNIMA.AC.ID/INDEX.PHP/EDUNITRO
E-ISSN 2776-284X
P-ISSN 2776-2920
Vol. 3, No. 1, April 2023

Application of Smart Relay Software in 3-Phase Motor Practice at SMKN 2 Bitung

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Received: January 8th, 2023. Revised: March 4th, 2023. Accepted: March 11th, 2023
Available online: April 2023. Published: April 2023.

Abstract— This study aims to detect practical errors to minimize circuit errors. This research was carried out at SMK Negeri 2 Bitung in the even semester of the 2021/2022 academic year. The research method used is descriptive analysis research using quantitative and qualitative approaches. The data collection technique consists of three stages: observation, statements based on Bloom's taxonomy, and documentation. The subjects of this research were 25 students from class XII. The research instrument used is a statement based on Bloom's taxonomy which has gone through the validation stage of the supervisor. The results of this study are to minimize the occurrence of 3-Phase Motor Practice errors with the application of Smart Relay software for 25 students. The results showed they dominated with friendly answers regarding students' understanding of using Smart Relay software. Based on students' attitudes in using Smart Relay software, they dominate with agreeing answers, and so on, aspects of students' skills in using Smart Relay software dominate with agreeing answers. It was also obtained from student learning outcomes that understanding the Smart Relay software got an average score of 84.2.

Keywords: smart relay software, learning outcomes

I. INTRODUCTION

Education in Indonesia has experienced a period of development which is quite interesting to study. It can be compared with education in Indonesia which used to be with the current one, which has entered the era of technological development 4.0. The development of information technology significantly influences changes in every area of life (Handarini & Wulandari, 2020). Various fields of life are developing towards complete renewal, for example, education.

Education is a provision to achieve national goals (Mudana, 2019). The national ideals of the Indonesian state are stated in the preamble to the 1945 Constitution, namely to educate the life of the nation and also our country has a vision of a golden generation in 2045 as a celebration of 100 years of independent Indonesia's independence (Sofiyana, M. S. et al., n.d.). Education is essential to human life today because education is central to creating quality human resources (Rifa Hanifa Mardhiyah et al., 2021).

Vocational education is secondary education that can prepare students, especially to work in specific fields (Kuntang Winangun, 2017). State Vocational High School 2 Bitung is an educational institution responsible for preparing a professional workforce that can compete in today's world of work and industry. Specifically, the competence of Electrical Installation Engineering expertise is to prepare students to understand and have exceptional skills in the field of electrical installation engineering (Fatkhurrokhman & Pardjono, 2016). Students are introduced to various tools and components of practice following technological developments to improve the results of better and maximum practice.

Along with the development of technology and time in increasing the need for electricity in the community, electrical installations have experienced more advanced technological developments, especially in the case of electrical power installations. For example, a vocational high school education system in Indonesia has implemented an electric power installation learning system using intelligent relays.

One happened at SMK Negeri 2 Bitung in the learning process of electric power installations that had used the intelligent relay system. However, students' knowledge about the Practice of Electrical Power Installation in operating 3-phase electric

motors using the intelligent relay system was still lacking. Based on the results of interviews with the supervising teacher for the operation of 3-phase electric motor installations and the practice of electric power installation at SMK Negeri 2 Bitung, learning the subject of Electrical Motor Installation at SMK Negeri 2 Bitung is still carried out, and the teacher is still more dominating in the learning process.

Electrical power installation is the most crucial circuit in an electrical control system that functions to operate an electric power system (Pattinasarany et al., 2022). In this case, this electric power system will run a 3-phase electric motor with left-hand and right-hand rotation (Honggowiyono et al., 2012). The left and right rotary circuit is a circuit that uses two contactors to exchange one phase at the induction motor terminal (Yenni Arnas et al., 2016). An interlock mechanism connects the left and right rotary circuit systems. An interlock is an internal locking mechanism between two switches that occurs mechanically, electromagnetically, electromechanically, or several software programs (Umam et al., 2017). This lock means that if one of the toggle keys is activated, the other keys are inactive simultaneously. Furthermore, a more advanced system will be used here to operate the left and right rotary power installation system, namely a smart relay system (Mamahit & Sanggola, 2021) (Sanggola et al., 2022).

A smart relay is a mini PLC, a logic-based automatic controller that is relatively small in size as a substitute for conventional control systems such as ordinary relays and contactors (Ahmed et al., 2012). A smart relay is also a microcontroller-based control device that is applied to manage logic processes. Like PLCs, Smart relays are also a type of programmable controller (Siahaan, 2019).

A smart relay is a control device that can be programmed repeatedly to execute logic instructions, timers, counters, scheduling with an internal real-time clock (RTC) and read analogue data for batch processing (HUDA & RIJANTO, 2018). In terms of functioning, smart relays are very similar to PLC systems, while the features contained in smart relays are simpler than PLCs (Shobirin, 2017).

Zelio is a smart relay model produced by Schneider Telemecanique (Bunga et al., 2015). Furthermore, in Zelio, smart relays are available in 2 types compact and modular models. If needed, additional I/O modules (expansion I/O modules) can be added, both discrete I/O and analogue I/O. There are 2 smart relay models based on their uses, namely the compact and modular models. If the application has several I/O 20 (12 inputs and 8 outputs), then the compact model is the most suitable choice because it does not require additional modules.

Furthermore, if the number of I/O is more than 20, then choosing the modular model is the right choice. Zeliosoft can also be used for monitoring and simulating a programmed circuit and can also be programmed with two methods, namely Ladder Diagram (LD) or Function Block Diagram (FBD). In addition, this software also provides 2 displays, namely the electric symbol and the ladder symbol (Irawan, 2021).

All installations must comply with the provisions set, namely the General Electrical Installation Requirements. General Requirements for Electrical Installations aim that at the time of installation of electrical installation circuits, it is carried out correctly to ensure human safety from the danger of electric shock, the safety of electrical installation circuits and their equipment, security of buildings and their contents from electrical fires, and environmental protection (Andu, 2019).

This study aims to apply the learning of the smart relay software system in producing the effectiveness of student learning outcomes after using the smart relay module to minimize 3 phase motor practice errors in the Electrical Power Installation Engineering department located at SMK Negeri 2 Bitung. Researchers are interested in helping students of SMK Negeri 2 Bitung majoring in Electrical Power Installation Engineering at SMK Negeri 2 Bitung to increase student interest in implementing a smart relay system to operate 3-phase electric motors in detecting and minimizing errors in a series of electrical power installations.

This study also aims to minimize 3-phase electric motor practicum errors using smart relay software and help students understand its working principle.

Learning outcomes are several experiences obtained by students covering the cognitive, affective and psychomotor domains (Rusman, 2017). Learning is mastering not only the theoretical concepts of subjects but also habits, perceptions, pleasures, interests, talents, social adjustments, skills, aspirations, desires and hopes. The learning outcomes can be seen from the changes in perception and behaviour, including behavioural improvements (P. D. O. Hamalik, 2012). For example, the satisfaction of community and personal needs as a whole. Learning is a complex process, and changes in behaviour during the learning process are observed in changes in student behaviour after the assessment (O. Hamalik, 2001).

The teacher must be able to observe the change in behaviour after the assessment. The measure of student success is usually in the form of the value they get. The value is obtained after students complete the learning process within a certain period and then take

the final test. Then, from the test, the teacher determines student achievement. Learning is acquiring, assimilating and internalizing cognitive, affective and psychomotor inputs for effective action when needed and increasing the ability for further self-monitored learning (Daryanto, 2010).

Based on the explanation above, it can be concluded that student learning outcomes are changes in behaviour that occur in individuals or groups after learning activities are much better.

A 3-phase forward reverse induction motor is an operation of a 3-phase induction motor control system intended to change the direction of a 3-phase induction motor (Nurfauziah et al., 2022). The direction of rotation of a 3-phase induction motor can be rotated in two directions, namely right (forward) and left (reverse). Forward reverse induction motors are widely used to open and close garage doors, elevators, cranes, conveyors, and others. Only two contactors are needed to make this left and right rotary motor circuit.

In order for a 3-phase induction motor to rotate left and right, what must be done is to exchange one of the phases. In assembling the right-left rotary circuit, locking must be carried out, meaning that the motor only rotates in one direction (the right and left turn circuits cannot be turned on simultaneously) (Evalina et al., 2018).

Smart Relay software is a relatively small logic-based automatic controller substitute for conventional control systems such as ordinary relays and contactors (Bunga et al., 2015). Smart relay software can also be defined as a control device programmed repeatedly to execute logical instructions, timers, counters, scheduling with internal RTC, and reading analogue data for batch processing. Smart relay software is a virtual relay designed from a microcontroller to replace the conventional relay function in sequential processes.

The working principle of smart relays is to regulate processes or machines (Bunga et al., 2015). Smart relays receive signals from inputs from machines or processes to proceed to outputs. Smart relays have 3 steps in operation, commonly called the scan process, namely:

1) Read: reads data from the input device connected to the smart relay input.
2) Program execute: executes instructions/ programs stored in memory.
3) Write: update and write the program to the PLC based on the desired output conditions.

Through circuit drawings, many materials can be learned in completing a circuit, including understanding the working principle of a 3-phase electric motor with a reverse forward circuit. Students can also understand the working principle of smart relay software on operating a 3-phase electric motor with the reverse forward operation.

II. METHOD

This research will be carried out at the Department of Electrical Power Installation Engineering at SMK Negeri 2 Bitung. The research will be carried out in the even semester of the 2022/2023 academic year, within 1 month. The type of research used is descriptive analysis research using quantitative and qualitative approaches.

Data collection techniques used in the study are as follows:

1. Observation is a way of conducting direct observations in schools or at the research location to be studied.
2. Statements based on Bloom's taxonomy are several written statements used to obtain information from respondents.
3. Documentation is used to obtain data on learning outcomes during research.

The main instrument in this study was the researcher himself, using other supporting instruments in the form of a statement sheet based on Bloom's taxonomy which was tested for validity through interviews with students regarding the series in the learning process. The procedures in this study are:

1. Provision of learning materials.
2. Recapitulating student learning outcomes.
3. Identify developments during the student learning process.
4. Provision of instruments or statements.
5. Make conclusions from the results of the statements given.

The data analysis technique used in this research is descriptive analysis. The data analysis process starts by reviewing all the data from the statement results. Furthermore, data analysis with steps, namely:

1. Data reduction,
2. Data presentation, and
3. Concluding.

III. RESULTS AND DISCUSSION

A. Description of Research Data

1. Characteristics of Respondents

In this study, researchers present data in the form of Bloom's taxonomy which consists of 25 students as respondents consisting of 23 males and 2 females, with each respondent receiving 16 questions. Bloom's Taxonomy is a data collection technique by submitting a written statement divided into three aspects of assessment ranging from knowledge, attitudes, and skills to be answered in writing by respondents or research subjects. This statement was distributed directly by the researcher with the assistance of the observer teacher at the TITL Department of SMK Negeri 2 Bitung.

The researcher's data collection was carried out by Bloom's taxonomy, which uses a Likert scale in the form of a checklist with 16 statements. This statement is given to determine the extent of students' understanding of smart relay software detecting errors in the practice of 3-phase motors turning left and right.

B. Research Result

1. Variable description

a. Cognitive variables or aspects of understanding

In this aspect, the most important thing to assess is student knowledge, where we can see the extent of students' knowledge, what they understand, and how they apply, analyze, evaluate and create.

b. Affective variable or attitude aspect

In this attitude aspect, what is assessed is how students are interested in learning smart relay software, student responses regarding smart relay software, and how to organize and assess student character.

Table 1. Data on student learning outcomes about understanding smart relay software.

NO.	NAME OF STUDENT	SCORE
1	Aditya Biluango	80
2	Adhitya Rachmadianto	85
3	Aldo Tumoka	80
4	Aldin Saputra Pahude	85
5	Alva Agog Gho	80
6	Christoper Manoy	80
7	Divan D.H Piter	85
8	Excel Ngantung	85
9	Fernando Pattiwael	75
10	Firmansyah Paramata	90
11	Gabriel Sumirat	90
12	Hatri Paulus	95
13	Josua Maeka	80
14	Julkifli Ibrahim	95
15	Julvian Safrudin	75
16	Junardi Pahude	85
17	Karel Iyanleba	85
18	Livia Mali	80
19	Marselino Tinggehe	85
20	Michael Torar	90
21	Mickey Nangaro	75
22	Muhrafli Hamza	75
23	Muhammad Arori	85
24	Pricilia Edwin	95
25	Steward Takasenggehang	90
	AVERAGE	**84.2**

Based on the table in the test scores regarding the smart relay software in the operation of a 3-phase electric motor, turning left and right, the average value is 84.2, where this value meets the achievement of the value to be achieved, namely 80-90 with Minimum Completeness Criteria (in Indonesian abbreviated as KKM) 75.

2. Steps to use Zelio smart relay software

a. The first step, in a display like an image below, shows that the selection of the module category corresponds to the existing module, as well as the selection of the Zelio type (see Figure 1).

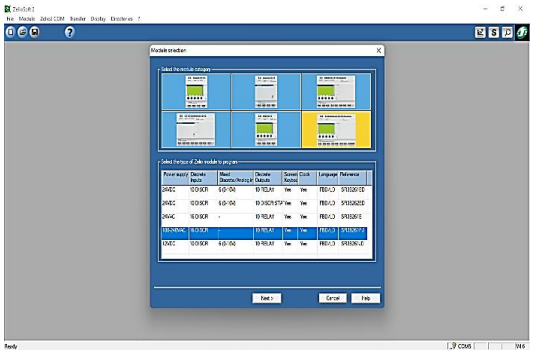

Figure 1. Selecting the smart relay module category

b. The selection of module selection is adjusted to the number of inputs and outputs to be used (see Figure 2).

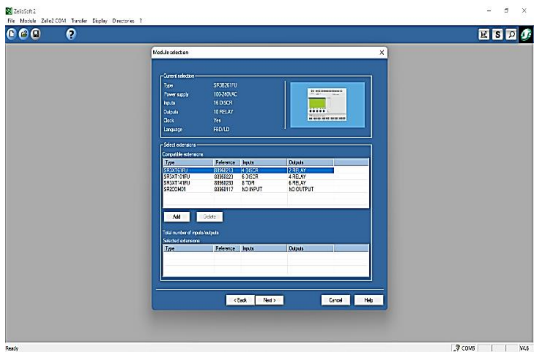

Figure 2. Selecting the type of smart relay software

c. Giving the input name for the ladder in the smart relay software (see Figure 3).

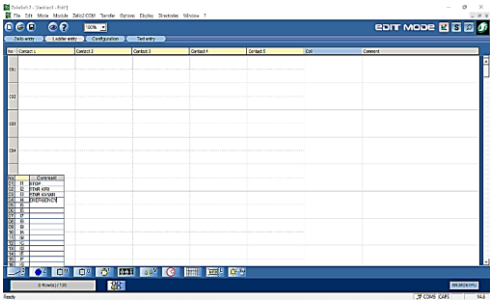

Figure 3. Input contacts

d. Giving a name to the output (see Figure 4).

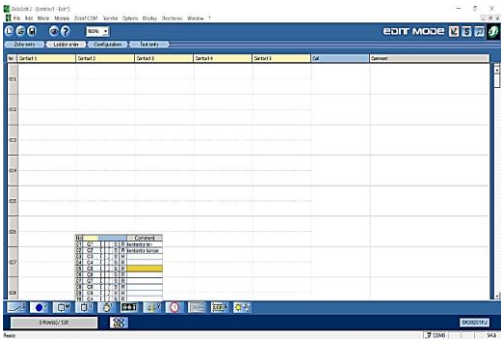

Figure 4. Output

e. The depiction of the left-turn circuit in the operation of a three-phase motor left-turn right-hand (see Figure 5).

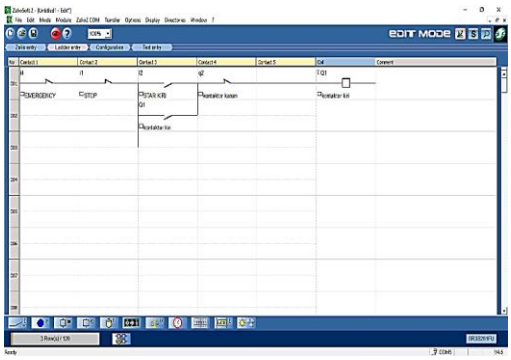

Figure 5. Left turn circuit

f. The depiction of the right-hand rotary circuit in the operation of a left-turned-right 3-phase motor (see Figure 6).

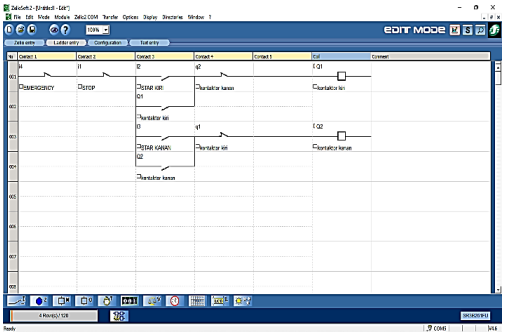

Figure 6. Right turn circuit

g. Perform simulation tests in simulator mode to detect faults in a circuit. After clicking simulations, click the green run button (see Figure 7).

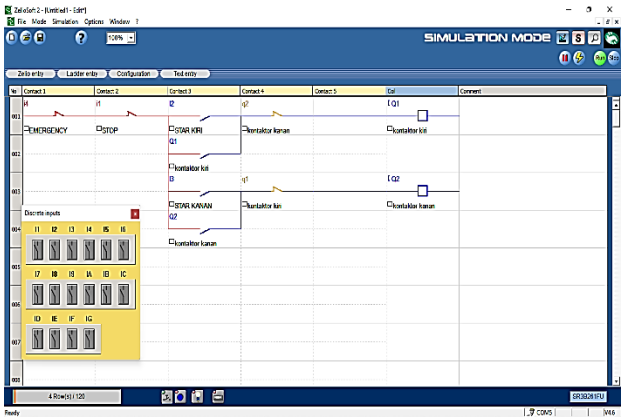

Figure 7. Circuit simulator test

Figure 8, where tests have been carried out on the simulator, shows that in the 3-phase electric motor circuit, turning left and right, there is no error in operation when it is simulated.

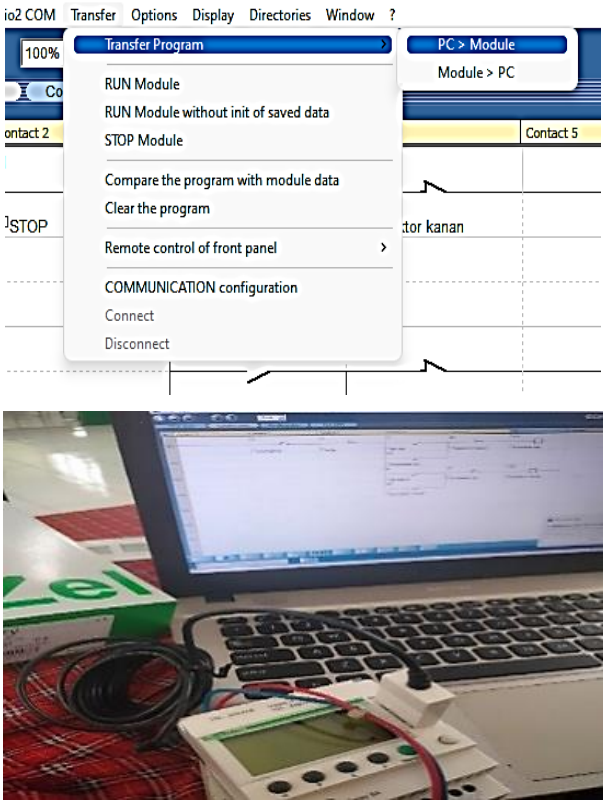

Figure 8. Transfer PC data to module

h. Perform transferring data from the PC to the Module (Figure 8).

C. Discussion

Data collection in this study is based on Bloom's taxonomy, where the measurement scale is based on the Likert scale. The frequency distribution table of the three indicators shows that in the first indicator (knowledge aspect), the highest frequency is in the agree with category, in the second indicator (attitude aspect), the highest frequency is in the agree with category, and so is the third indicator (skills aspect) the highest frequency is in the agree with category.

The application of smart relay software to detect 3-phase motor practicum errors was found with a description of the variables and the steps for using the Zelio smart relay software, namely:

1. Cognitive variables or aspects of understanding.

   C1 knowledge (96%) from most categories strongly agree and agree, C2 understanding (52%) from most categories strongly agree, C3 application (48%) from most categories agree, C4 analysis (72%) from most categories agree, C5 evaluation (48%) from the most agree category, C6 creates (68%) from the most agree category.

2. Affective variables or attitude aspect

   A1 acceptance (64%) from the most agree category, A2 respond (60%) from the most strongly disagree category, A3 appreciate (60%) from the most agree category, A4 organize (60%) from the most agree category, A5 characterization by score (56%) of the most agreed categories.

3. Psychomotor variables or aspects of skills

   P1 imitated (36%) from the most agree category, P2 manipulation (68%) from the category strongly disagreed, P3 precision (56%) from the most agree category, P4 articulation (52%) from the most agree category, P5 naturalized (56%) from the most agree category.

4. Steps to use Zelio smart relay software.

   By applying the steps for using the software correctly and based on the provision of sufficient material, students can operate the smart relay software correctly and correctly. In the operation of the smart relay software, students can test the circuit in simulator mode to detect errors in the circuit.

IV. CONCLUSION

Based on the data processing provided to students, it can be concluded that students can understand how to minimize errors in operating a 3-phase electric motor turning left and right using smart relay software.

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