PLC- CONTROLLED ELEVATOR SYSTEM

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Abstract

The main purpose of this study was to design, assemble, and assess the functionality of the PLC-Controlled Elevator System and determine the level of acceptability of the prototype. It was done to test the functionality and acceptability of the elevator using a programmable logic controller. This was conducted at Bohol Island State University Main Campus, Tagbilaran City during the Academic Year 2017-2018. The study employed the experimental methods of research and descriptive design in developing the PLC- Controlled Elevator System. The descriptive design was used to determine the functionality and acceptability of the PLC- Controlled Elevator System in terms of performance, convenience, safety, durability, and cost. The respondents were the experts from the academe and industry. Results revealed that acceptability level and functionality of the PLC- Controlled Elevator System was rated very high by the experts from the academe and in the industry. The results proved that the programmable logic controller is suitable to interface in the elevator system. Since the elevator was rated very high, the researcher recommends provisions for various types of PLC and programming language and conducting trainings for teachers and instructors on PLC-based technology to broaden their competencies in control automation.

Keywords: System, PLC-Based, Elevator, Functionality, Acceptability.

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1. INTRODUCTION

The use of technology in our community nowadays, is a necessity since makes all work easier and let then live more conveniently than the past years. One of the examples where technology can help people to continuously grow and improve their lifestyles is to have or to use elevator. Elevator is a type of technology that provides people an easier and faster way in transportation going up/down in a building.

With such idea, the researcher will apply the PLC or Programmable Logic Computer in making a prototype elevator, the programmable logic controller (PLC) is an industrial computer in which control devices such as limit switches, push buttons, proximity or photo electric sensors, provide incoming control signals into the unit. It is a digitally- operated electric system designed for use in an industrial environment which uses a programmable memory for the internal storage user- oriented instructions for implementing specific functions such as logic, sequencing, timing, counting, and arithmetic to control, through digital or analog inputs and outputs, various types of machines or processes.

Further, Bryan (2014) stated that the operation of the programmable logic controller is relatively simple. The input/output (I/O) systems physically connected to the field devices are encountered in the machine or the are used in the control of a process. The (I/O) interfaces provide the connection between the CPU/laptop and the information providers (inputs) and controllable devices (outputs). The input/output system is a part of the PLC- Controlled Elevator System; however, it needs a motor which is run by magnetism and electromagnetism to make it work.

The operation of the elevator would not be possible without the aid of an electric motor. An electric motor is an electrical device that converts electrical energy to a rotating mechanical energy (Gibilisco, 2000). Through the aid of the electric motors, the elevator is given power to go up and down from one floor to another. Small motors like wiper motor and indicator devices such as the

seven segments are used in the gadget. In using a relay for a particular application, the (coil) control voltage at which the relay will operate should be determined. It is used in the instructional apparatus because the motor has only 12V supply.

2. METHOD/S

The study utilized the experimental method in assembling and designing the gadget. It was developed at Bohol Island State University Main Campus, Tagbilaran City for Academic Year 2017-2018. In doing this, the researcher determines what may occur during the process. Descriptive method was also utilized to gather information in a form of a survey questionnaire. The study was conducted in different learning institutions and private industries in the province of Bohol, specifically in the Bohol Island State University, Main Campus, Coca-cola Bottlers Incorporated, Alturas Group of Company and Gerisonic Electronics and Communication System.

The researcher selected forty (40) respondents. Five (5) technology experts coming from the selected learning institutions and ten (10) experts from different private industries tested and validated the level of performance and assessed the effectiveness level of the PLC- Controlled Elevator System. Five (5) instructors who are experts in the field corrected the questionnaires used. Twenty (20) respondents from the electrical engineering third (3rd) year students validated the level of acceptability in terms of performance, convenience, safety, durability and cost.

3. RESULTS AND DISCUSSION

This chapter presents the findings, analysis, interpretation and holistic project design of the study. It also presents the data gathered, collated, and tabulated data in accordance to the appropriate statistical treatment.
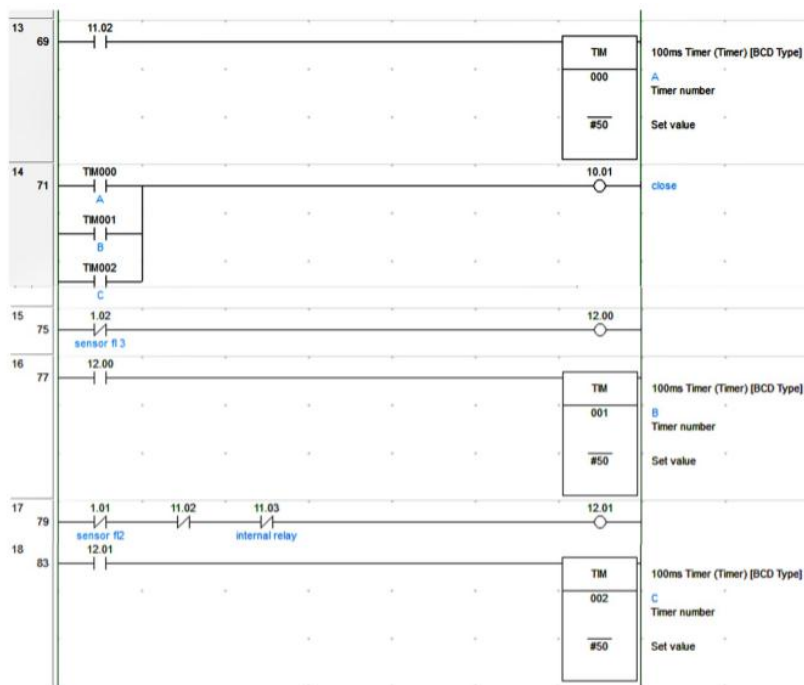
Design
The construction of the PLC- Controlled Elevator System was based accordingly to its specified

design. This design was the basis of the assembly of the model. The ladder diagram of the PLC- Controlled Elevator System is using plc ladder logic program.
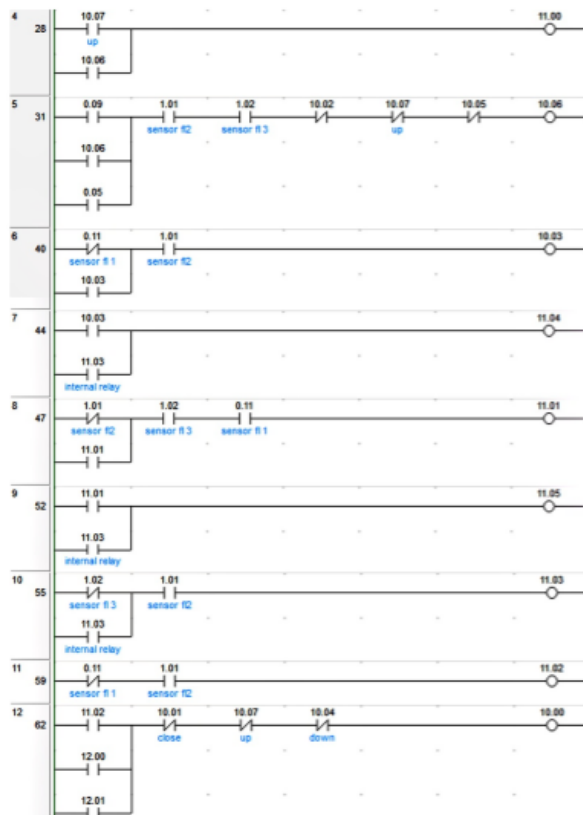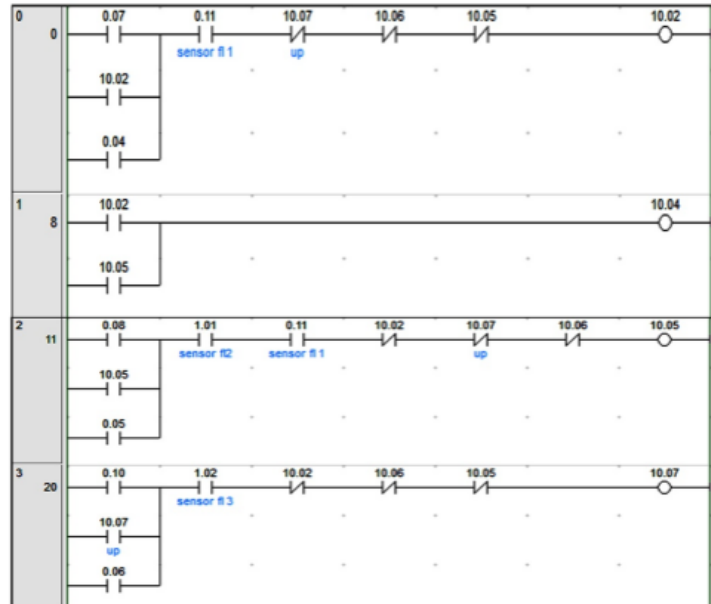
The pictorial diagram (Figure 3) of the PLC- Controlled Elevator System is an actual illustration of image using graphical symbols.

Table 1 The Functionality Level of the PLC- Controlled Elevator System Time in ascending/descending of the Elevator Car

Elevator Car Movement	Floor level	Trial	Time Travel	Accuracy of Floor Level Indicator	Efficiency of Proximity Sensor
Time Ascending	First to Second	1	4 sec.	Operative	Functional
		2	4 sec.	Operative	Functional
		3	4 sec.	Operative	Functional
	Second to Third	1	5 sec.	Operative	Functional
		2	5 sec.	Operative	Functional
		3	5 sec.	Operative	Functional
	First to Third	1	9 sec.	Operative	Functional
		2	9 sec.	Operative	Functional
		3	9 sec.	Operative	Functional
Time Descending	Third to Second	1	4 sec.	Operative	Functional
		2	4 sec.	Operative	Functional
		3	4 sec.	Operative	Functional
	Second to First	1	4 sec.	Operative	Functional
		2	4 sec.	Operative	Functional
		3	4 sec.	Operative	Functional
	Third to First	1	8 sec.	Operative	Functional
		2	8 sec.	Operative	Functional
		3	8 sec.	Operative	Functional

Table 1 showed the result of the Elevator car in ascending and descending movement as to time it traveled and the functionality of the floor level indicator as well as the proximity sensor. The first observation presented the movement of car elevator in ascending order. From first floor to second floor at three trials, it took 4 seconds for the elevator car to accelerate. Thus, the elevator car took 5 seconds to travel from the second floor to third floor with no technical error at three trials. The last aspect of testing of the elevator car from the first floor to third floor at three trials, it took 9 seconds for the gadget to move up without any problem in terms of the proximity sensor which performed its function as to stop the elevator car whenever it reached the desired operation in three floors. However, the elevator car in descending differed from the first observation due to the downward motion performed by the elevator car. The elevator car from the third floor to second floor and also second floor to first took 4 seconds to travel without any error regarding the proximity sensor and the functionality of the floor level indicator in the three trials performed. Thus, at the three final trials of the elevator car from the third floor to first floor, it took 8 seconds to accelerate without any trouble of the proximity sensor and so with the floor level indicator.

Table 2 The functionality level of the PLC- Controlled Elevator System Efficiency of Closing/Opening the Door

Door movement	Floor Level	Trial	Double Slide Door (Time Consumed)	Efficiency of Limit Switch
Opening	First Floor	1	1.43 sec.	100 % Functional
		2	1.43 sec.	100 % Functional
		3	1.43 sec.	100 % Functional
	Second Floor	1	1.43 sec.	100 % Functional
		2	1.43 sec.	100 % Functional
		3	1.43 sec.	100 % Functional
	Third Floor	1	1.43 sec.	100 % Functional
		2	1.43 sec.	100 % Functional
		3	1.43 sec.	100 % Functional
Closing	First Floor	1	1.43 sec.	100 % Functional
		2	1.43 sec.	100 % Functional
		3	1.43 sec.	100 % Functional
	Second Floor	1	1.43 sec.	100 % Functional
		2	1.43 sec.	100 % Functional
		3	1.43 sec.	100 % Functional
	Third Floor	1	1.43 sec.	100 % Functional
		2	1.43 sec.	100 % Functional
		3	1.43 sec.	100 % Functional

Table 2 showed the result on the functionality level of the PLC- Controlled Elevator System regarding the efficiency of opening the door and closing the door. During the trials that were performed in the different floors, the limit switch performed functionally as it reached the desired floor. Thus, the time consumed in opening the door at the specific floor desired was only 1.43 seconds. The same time was consumed during the closing of the door. Yet, after the door opens, it will take 5 seconds before it will automatically close again since it was programmed using the Programmer Logic Controller.

Table 3 Acceptability Level of the PLC- Controlled Elevator System

Acceptability Level	WM	D	R
3.1 Performance of the PLC- Controlled Elevator System			

1. Replicates the behavior of electronic device and circuits used in ladder logic programming for simulator.	3.90	VH	
2. Scalable application program that works on different windows environment	3.85	VH	
3. Provides users with the ability to write edit and debug programs written using a ladder logic format	3.85	VH	
4. Compact input and output modules for connections of lights, sensors and switches	3.65	VH	
5. Ladder logic programs can be downloaded and uploaded from computer to PLC and vice versa	3.75	VH	
6. Can simulate programs in Computers before downloading to PLC	3.8	VH	
7. Can be interfaced to a desktop, laptop and tablet computers via USB (universal serial bus) port.	3.7	VH	
8. Provide identical function with regards to traffic light, BCD counter and light sequence.	3.75	VH	
9. Can access information through internet.	3.95	VH	
Average	**3.80**	**VH**	**1**
3.2 Convenience			
1. Ports and terminals for input and output module is readily accessible	3.75	VH	
2. Programming language is user friendly with tutorials	3.7	VH	
3. The input language can be reprogrammed.	3.95	VH	
4. Movable from one place to another.	4.00	VH	
5. The parts are replaceable when damage.	3.55	VH	
6. Less hard wiring is use.	3.8	VH	
Average	**3.79**	**VH**	**2**
3.3 Safety			
1. Fuse was used as over-current and short circuit protection for the gadget.	3.9	VH	
2. A rectified 12-24VDC was supplied to the simulator for operation.	3.7	VH	
3. The casing is non-conductor and the components were properly fitted.	3.95	VH	
4. Electrical and electronics components are properly rated according to voltage and current.	3.6	VH	
5. Terminal connections and joints have adequate mechanical and electrical supports.	3.6	VH	
Average	**3.75**	**VH**	**3**
3.4 Durability			
1. The gadget can stand through vibration.	**3.9**		
2. Designed to same level of tolerance to temperature.	**3.55**		
3. Longevity to its process control.	**3.7**		
Average	**3.72**	**VH**	**4**
3.5 Cost			
1. The PLC- Controlled Elevator System has a total cost of ₱ **41, 871.00**	3.65	VH	
Average	**3.65**	**VH**	**5**
Average WM	**3.74**	**VH**	

Table 3 shows the summary of acceptability levels of the PLC- Controlled Elevator System in terms of its performance, convenience, safety, durability and cost. Using the Weighted Arithmetic Mean test, the PLC- Controlled Elevator System under "performance" ranked the highest with the average weighted mean of 3.80 and interpreted as "Very High".

Convenience was rated very high with an average weighted mean of 3.79. This means that the PLC-Controlled Elevator System requires less effort to operate as evaluated by the experts.

Safety was given a rating of "very high" and obtained an average weighted mean of 3.75. This implies that the simulator is a good electrical insulator and is properly equipped with short circuit protection. Moreover, the materials used were designed and selected to provide safety to users.

Durability had an average weighted mean of 3.72 and interpreted as "very high". Although it ranked fourth, It was seen to have the characteristics of low density, ease of fabrication, low thermal conductivity, high resistance to wear, and good corrosion resistance.

Cost was described "very high" and was ranked the lowest. The PLC- Controlled Elevator System was rather expensive because the materials used were guaranteed to have quality to provide better performance during operation. Selecting the suitable material for a specific application is always considered in constructing instructional tools for imparting knowledge to students (Dym, et. al. 2004). The overall weighted mean of the PLC- Controlled Elevator System was 3.75 which was interpreted Very High.

The Results Of The Study Revealed The Following Findings:
1. It was a type of multi-operational simulator that manages functionality according to the design problem. The materials of the device were carefully selected with guaranteed high quality.
2. It was able to operate the ascending/descending, closing /opening of the elevator car and follows the order of timing precisely of the sensor.
3. It was found to be highly acceptable in the aspects of performance, convenience, safety, durability, and cost with a total average weighted mean of 3.74 and interpreted as "Very High". Performance was ranked highest with an average weighted mean of 3.80 and described as "Very High". Cost was

ranked lowest with an average weighted mean of 3.65, although ranked lowest; it was described as "Very High" by respondents.

2. CONCLUSION

The PLC- Controlled Elevator System is an efficient tool as a prototype model for bases and reference in assembling electrical technology gadgets and provides relevant insights among instructors in the modern world of automation given that the performance of the device.

Recommendations
Based on the findings, the following recommendations are given:
1. Researcher will introduce the PLC- Controlled Elevator System to electrical technology and allied engineering courses as a tool for instruction.
✖ The monitor and the Central Processing Unit (CPU) should be integrated within the interior body of the gadget, making the study more secure and guaranteed to use.
✖ The door of the PLC- Controlled Elevator System must be installed properly to guarantee the absolute presentation of the gadget.
✖ The designed program of PLC-Controlled Elevator System must be added further to have more function of the gadget itself.
✖ An additional sensor must also be installed in the elevator car that would enable to detect any object that is stagnated in the elevator door. The sensor will be used to open the door as it detects the object.
✖ Conduct trainings to teachers and instructors on PLC-based technology to broaden their competencies in control automation.
✖ Recommend the study to be patented for its protection
2. School administrator shall encourage their instructors to construct instructional materials that can replicate the actual functions of the machines or devices found in the industry.

3. REFERENCES

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