International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 3, May-June-2020, ISSN (Online): 2395-566X

Innovative Multi-Power Source Device: Product Evaluation and Cost Analysis

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***Abstract* – This study is focused on Overall Acceptability in terms of Product Evaluation (functionality, safety, reliability, efficiency) and Cost Analysis, of the Innovative Multi-Power Source Device. The study made of use of descriptive research design, descriptive statistics (means, percentages and standard deviations). The result showed that the developed Innovative Multi-Power Source Device performs successfully according to its design specification. It can be used as phase converter to operate three-phase motor from a single-phase power supply, change the direction of an electric motor in forward/reverse and be controlled the device manually or by using remote, and time switch and On-delay functions adequately. Aside from it residential and industrial application, it can also be used as a training material for technician teacher educator in teaching electrical motor control and phase converter. It is also worth an investment, as it has low production cost but higher possible profits. It is recommended therefore that this can be used to those end-users with low budget but needs a phase converter both residentials and industrial application. Electrical establishments should have mass production of this device to address the needs of the potential consumer of the device. Electrical instructor should also consider this device as training material in teaching electrical motor control and phase converter.**

***Keywords*– Acceptability, Product Evaluation, Cost Analysis, Innovative Multi-Power Source Device.**

I. INTRODUCTION

Industrialization is the priority of the government of the Philippines to catch up with its more industrialized neighbors in the region, and is a must in achieving economic growth. The Philippine government encourages local investors especially the small and medium-sized businesses (MSMEs) to invest in the country, particularly in the agricultural and manufacturing sector. This industry required a wide range of commercial and industrial electrical equipment running on a three-phase alternating current (AC).

In the energy sector, phase relates to the allocations of the load. Three phase power supply is typically needed for industrial or higher energy application because it offers a higher power density compared to a single-phase. Three-phase power makes it simpler to balance loads and optimizes the use of electrical ability to improve power effectiveness. This makes the supply of electricity more effective and economical.

This is a prevalent issue in the Philippines where electricity distribution companies/cooperatives do not install three-phase power supply, particularly in rural regions, because the transmission of three-phase supply is expensive and, owing to the high price distribution equipment. The cost is considerably more than single-phase power supply, so the villages are electrified using single phase distribution systems. Single-phase energy supplies are most frequently used when the typical loads are lighting or heating, rather than big electrical equipment's.

The alternative to this distinct problem is the use of a phase converter and a variable frequency drive (VFD) available on the market to operate a three-phase motor from a single-phase energy supply. Single phase to three phase converters is intended to handle most of the three phase loads used in rural regions in agriculture and small-scale sectors.

Apart from the phase converter and VFD, the home owner, with the cooperation of the utility company at its own expense, can install its own transformer at the utility pole, a transformer with a secondary winding that can supply 120 V AC. All of these alternative solutions involve comprehensive investment by the customer, and only well-established end-users can afford these alternatives.

Micro, small and medium-sized businesses (MSMEs), and normal end-users lack the working capital necessary to buy a phase converter, a VFD or even to install their own transformer or three-phase power supply. In order to address these issues, the researcher has decided to make an innovation that will help the needs of micro, small and medium-sized enterprises and the ordinary end-user who cannot afford to purchase the phase converter and VFD that are accessible in the market.

This paper proposes an alternative solution that meets the requirements in rural areas where only single-phase power supply is available. Another significant trend in this development is higher flexibility in applications. The concept of having one item with easy setup and that is the Multi Power Source Device. This innovative device can use both industrial and residential application. The concept of the Innovative Multi-Power Source Device is similar to the existing phase converter but is more versatile as it incorporated more features like, forward/reverse operation, remote control, time switch and On-delay timer in one Electrical Motor Controller.

II. REVIEW OF RELATED LITERATURE

Herman (2014) in his book titled Electric Motor Control 10th edition, he said that it is important to remember that the motor, machine, and motor controller are interrelated and need to be treated as a kit when selecting a specific device for a particular application. It is also designed to meet the provisions of the National Electric Code “(NEC) which the code sections applying to motors, motor circuits and controllers and industrial control devices are found in Article 430 on motors and motor controllers.

In the book titled Gas Well Deliquification 3rd edition (Lea. Jr & Rowlan, 2019), it mentioned that motor controllers are devices that control the operation of an electric motor. Motor controllers often include manual or automatic means for starting and stopping the electric motor, selecting forward or reverse rotation, accelerating or slowing down, and controlling other operating parameters.

Aside from manual and automatic operation, Herman (2016) in his book titled Understanding Motor Controls, mentioned about the semi-automatic control which is characterized by the use of push buttons. In this control system, the operator must still initiate certain actions such as starting and stopping, but she/he does not have to go the location of the motor or starter to perform the actions.

In another book titled Industrial Motor Control 7th, Herman (2013) said that the motor can be controlled by remote control using push button. When push button remote control does not have the capacity to start and run the motor, magnetic switches must be included. The operation of the magnetic switch is followed by electromagnetic means, the effort needed to actuate the electromagnet is supplied by electrical energy rather than by the individual.

Timer is used when the process is set on and off, or when the sequence of the next operation is set (Herman, 2013). Timers are a type of relay that has pneumatic or electronic contact time for different sequencing applications. They could be "stand alone" relays or attachments to standard relays. On-delay timers actuate contacts at a pre-set time after the coil has been energized and reset instantly with power off. Off-Delay timers actuate contacts instantly when energized, and reset to a pre-set time after de-energizing.

The forward-reverse control is another very common control circuit found in the industry. This control is used when the process involves forward and reverse or upward and downward movement. These phase motors can be reversed by changing any two stator leads. Forward-revers control employs interlocking to avoid simultaneous energization of both the forward and reverse coils (Herman, 2012).

Phase converters have been in use for decades to produce three-phase power from a single-phase source. National Electric Code (NEC) Article 455 defines a phase converter as an electrical device that converts single-phase to three-phase. Static phase converter has no moving parts other than switching relays that run during the start of the three-phase motor. Static Phase Converters work by charging and discharging capacitors to briefly generate a three phase of power for only a matter of seconds during the start-up of electric motors, after which the motor is forced to continue to run on only single phase and only part of its windings. According to their construction, the Static Phase Converters do not adequately control a class of three phase machines or facilities. They will not power in any way three phase welders, three phase battery chargers, three phase lasers or any sort of three phase circuitry system. Static Phase Converters will also not launch delta wound 3 phase motor (Radha Krishna, 2012).

In designing new method on running three-phase motor we need to consider the power factor. In AC circuits, the power factor is the ratio of the actual power used to perform the operation and the apparent power supplied to the circuit. Low power factor is a problem that can be addressed by adding power factor correction capacitors to the plant distribution scheme. Capacitors operate as reactive present generators supplying the required reactive power (KVAR) to the power supply. By providing its own source of reactive power, the industrial consumer releases the utility from having to supply it and therefore the complete quantity of apparent power provided by the utility will be less.

Power factor correction capacitors decrease the complete current generated by the distribution scheme and then boost the ability of the system by increasing the amount of the power factor. (Sapna Khanchi, 2013) in the study titled Power Factor Improvement of Induction Motor by Using Capacitors, it shows that the power factor is enhanced by the use of capacitors. Power factor is very small at no load and can be enhanced from 0.17 to 0.95 at complete load

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III. CONCEPTUAL FRAMEWORK

The methodology in this study shows the input, process and output that lead to the innovative design of Multi-Power Source Device. The input, process and output, Input-Output (IPO) model as defined by Schembri (2012) identifies the inputs, outputs and process presented by a functional graph that represents the flow of data and materials that go into a process in which transform the inputs into output. The inputs are the components of Innovative Multi Power Source Device. The process is the testing and evaluation between of the innovative product. The output is the Acceptability of the Innovative Multi Power Source Device.

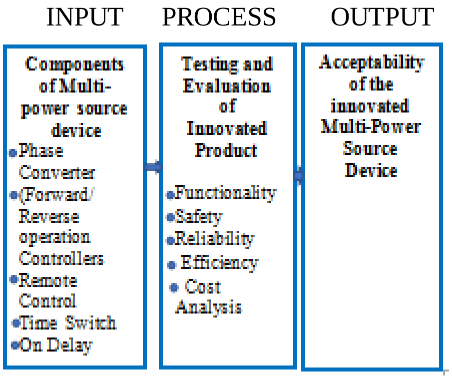

Fig.1. Diagram showing the interplay between variables of the study (Input, Process, Output format.

IV. METHODOLOGY

This study will utilize the use of developmental and descriptive method of research. It uses developmental method since this innovation aims to develop an advanced multi power source device and descriptive method to describe the evaluation criteria that the respondents will answer. First it will utilize a quantitative data as used in descriptive research. Creswell (2003) maintained that descriptive research is an approach which the inquirer often makes knowledge claims based primarily on constructivist perspectives are constructed with as intent of participatory perspectives in quantitative perspective and data analysis. The setting of this study was conducted in Tudela, Misamis Occidental. The study will make use of purposive sampling with strategic approach. In this study a total of twenty-five (25) respondents were chosen.

The first set of respondents were the expert – they are used to provide information about the product itself, not personal opinion or preference (Zoecklein et al. 2005). There were 10 experts who evaluated the device. The experts are from the academe and industry. One (1) TESDA trainer/assessor, two (2) from higher education teaching electrical technology, one (1) licensed electrical engineer working in power electric industry and one (1) registered Master Electrician with working experience as electric motor technician and five (5) industrial electrician. The other fifteen (15) respondents are the potential consumer of the product who will evaluate for consumer acceptability, and they are from different sector that needs of phase converter.

V. PRODUCT DEVELOPMENT

The design of the Innovative Multi-power Source Device (see figure 2) represents a typical motor controller used to control mechanical equipment. There are two modes through which this device control components can start or stop the motor, either manual or automatic. The key components are power circuit, control circuit, switches, terminal blocks, contactors, overcurrent protection devices and remote control, manual starters and other motor control accessories.

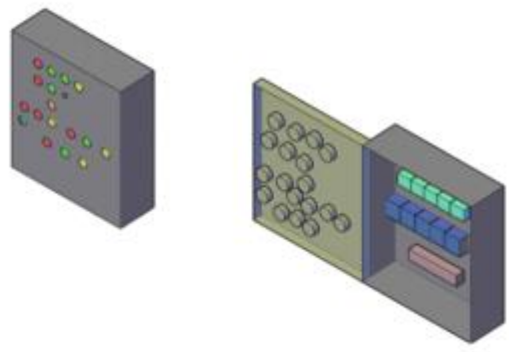

Fig.2. Project Design (Figure shows the design of the propose Innovative Multi-Power Source Device)

1. Phase Converter

The phase converter is the first component of the Innovative Multi-Power Source Device (see figure 3). In addition to converting electrical power from a single phase to a multiple phase or vice versa, the innovative device also has forward / reverse motor control. The connection is started from the power supply going to miniature circuit breaker and to magnetic contactor that is normally opened. The magnetic contactor is connected to the overload relay and the selector switch. The selector switch is used to select either the forward or reverse direction of the electric motor. The common terminal of the selector switch is connected to the normally open start button. The starting and running capacitor is connected parallel to the start button. The last connection is the terminal block, which is also connected to the capacitors.

Terminal blocks labelled T1, T2 and T3 is used if an innovative multi-power source device is connected in three-phase power supply, and this is where the three-phase motor will be connected. Then if an innovative multi-power

source device is connected in single phase power supply and the three-phase motor will connect to the terminal blocks labeled T1, T3 and T4. However, if an innovative multi-power source device is connected in three-phase power supply and the load is single phase motor, three-phase motor will connect to the terminal blocks labeled T1 and T2.

The number two (2) wire is connected from the emergency stop. The connection for the fuse is under the phase converter. The fuse connects to the overload contact normally closed going to the stop button, start button and to the holding coil. The connection needs to maintain contact, this is why it is connected to the contactor 1 (one) normally open. The red indicator lamp is attached to the terminal stop button and to the terminal A2 holding coil. There is a jumper connection in the fuse for the trip, where the overload contact normally open is connected to the fuse leading to the indicator lamp. Yellow indicator is for trip connection.

The forward and reverse indicator lamp is connected by a wire number five (5). As a result, the indicator lamp for the reverse direction is connected by wire number five (5) and wire number one (1). The forward direction indicator lamp is connected from wire number five (5) to wire number three (3).

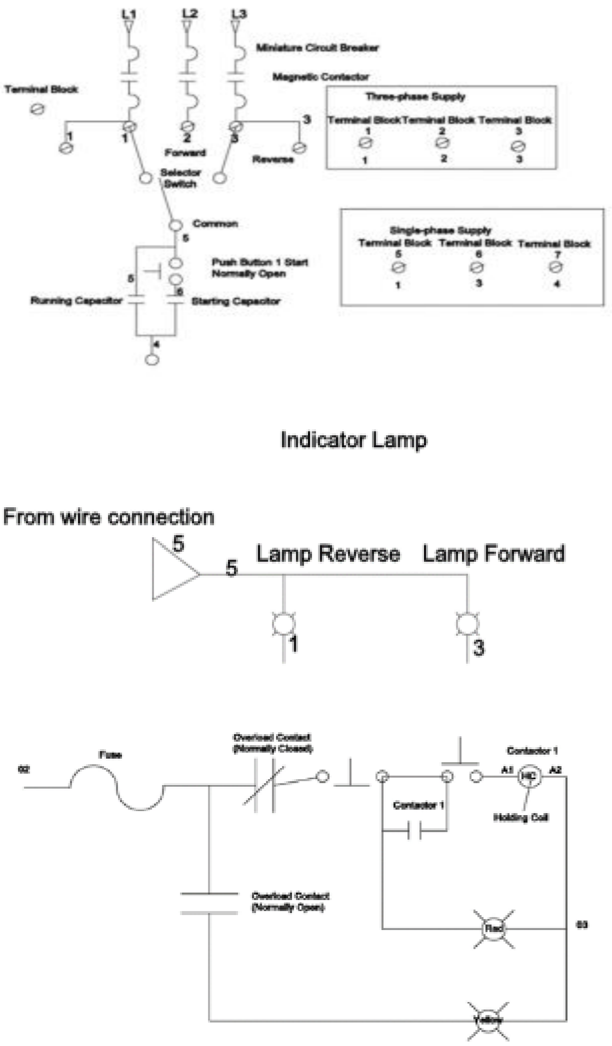

Fig.3. Schematic Diagram of Phase Converter.

2. Time Switch

The time switch connection will start from the wire number two (2) that is connected from the emergency stop (see figure 4). Number two (2) wire connects to the overload contactor normally closed and then to the selector switch. The selector switch is simply used for the On / Off application. The line one (1) of the timer switch is connected to the open selector switch terminal and the line two (2) is connected to the wire number (3). The indicator lamp (red) is connected together from selector switch and time switch to wire number (3). When the selector switch is turning on, there is a red light that indicates power in the circuit and timer is turning on. In order to energize the contactor (holding coil) three (3), the contact from the time switch must normally be opened so that when the timer reach it desired time it will contact timer will be close. The common terminal of the time switch is connected to the line one (1). If the normally open contact of the time switch will close the contactor (holding coil) three (3) will be energized. The indicator lamp (green) is connected under the time switch and holding coil. It will indicate that the load is turning On. The indicator lamp yellow (trip) is connected from the emergency stop wire number two (2) going to the overload contactor normally open then wire number three (3). If there is a yellow light, it means that the circuit is being trip.

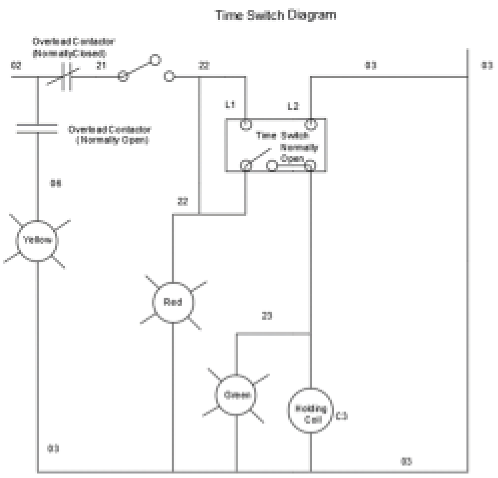

Fig.4. Schematic Diagram of Time Switch.

3. Remote Control

The remote-control connection will start from the wire number two (2) that is connected from the emergency stop (see figure 5). Number two (2) wire connects to the overload contactor normally closed and then to the selector switch. The selector switch is used if to select either to control the device manually or using the remote control. The selector switch has single stroke function, it means that one rotation is equivalent to one function. The stop button is connected from the selector switch going to the start button. The red indicator lamp is connected to the selector switch under manual operation. When the

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selector switch is in the manual position, there is a red-light. When the selector the switch is in the remote-control position, the connection for the manual operation will be cut off.

The connection of the remote control is started from the wire number twelve (12) going to the relay. The Line 1 for the remote-control is connected to the relay one (1) and line 2 for the remote-control is connected to relay one (1) going to wire number (3). The remote-control lamp is also connected to wire number 12 to wire number 3. This lamp indicates that the device is now in remote-control. The indicator lamp yellow (trip) is connected from the emergency stop wire number two (2) going to the overload contactor normally open then wire number three (3). If there is a yellow light, it means that the circuit is being trip.

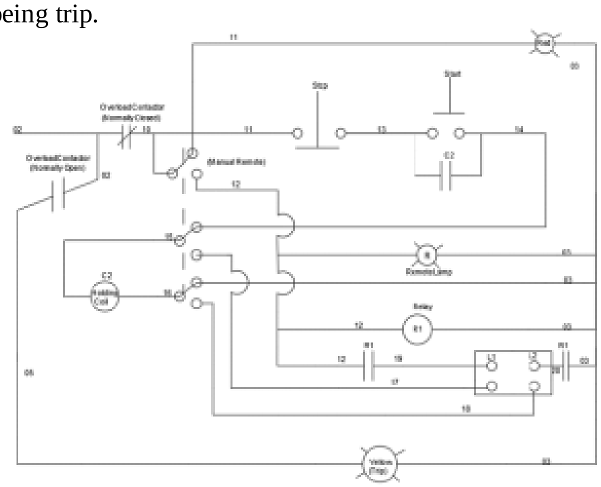

Fig.5. Schematic Diagram of Remote Control.

4. On-delay

The On-delay connection will also start from the wire number two (2) that is connected from the emergency stop (see figure 6). Number two (2) wire connects to the overload contactor normally closed and then to the selector switch normally open. The selector switch will connect to the timer one (1) then to wire number three (3). When the selector switch will be closed then the on-delay timer will be energized and starting to count. The contact timer is connected from the selector switch going to the contactor (holding coil) four (4) then to wire number (3). The connection for the maintaining contactor is parallel to the contact timer and contactor four (4). The red indicator lamp (power) is connected from the selector switch and to the wire number (3). If the selector switch will turn on, there is a red light that there is power in the on-delay circuit. The green indicator lamp (start) is connected timer contactor and to wire number (3). When the desired time is reaching, the contact timer will be closed and there will be a green light that indicates the load is turning on. For the trip connection, the overload contactor normally open is connected to the wire number (2) going to the yellow indicator lamp (trip) then wire number 3. If there is a yellow light, it means that the circuit is being trip.

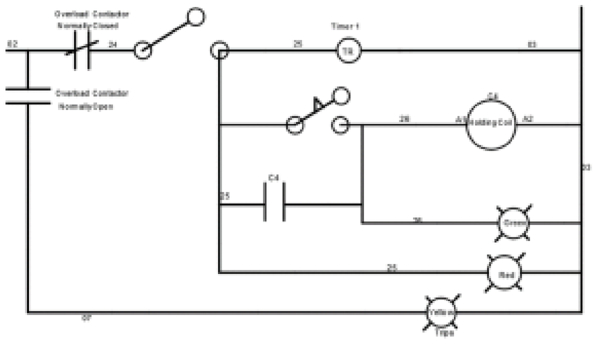

Fig.6. Schematic Diagram of On Delay.

4. Innovative Multi-Power Source Device

As shown. the figures are the designs and development of the completed Innovative Multi-Power Source device.

Fig.7.Motor Controller Panel (Figure shown the Control panel and Wiring Connection.

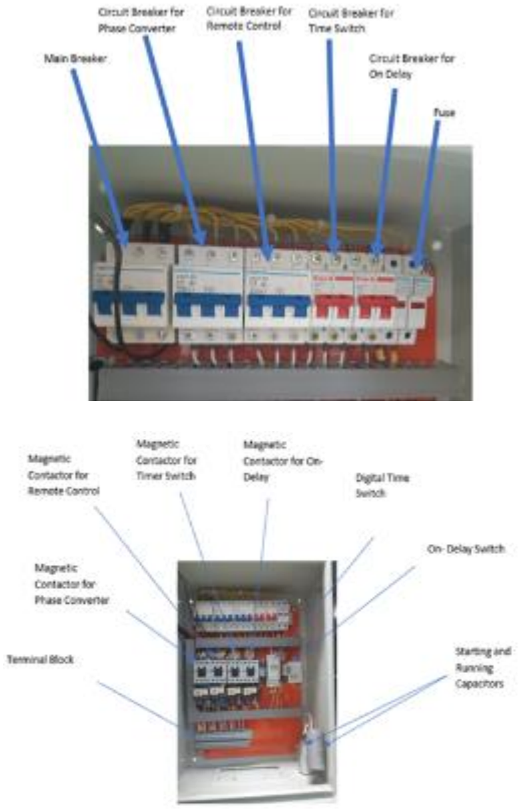

Fig.8.Branch Circuit Breakers and Motor Brach Circuits.

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V. DATA PRESENTATION AND ANALYSIS

Problem 1. What is the level of acceptability of the Innovative Multi-Power Source device in terms of;

- Functionality
- safety
- reliability
- efficiency

The data show that majority or sixty percent (60%) of the expert evaluated "Good" on the level of acceptability of the innovative Multipower source device in terms of functionality. The over-all rating is also "good" with a mean of 3.56. The standard deviation of 0.37 indicate that the evaluation of the experts on the level of acceptability of the innovative Multipower source device in terms of "Functionality" is similar to each other.

According to Albert and Thirupathi, (2004), the functionality of the product is a consequence of the combination of features desired by consumers and is usually used as a basis for the production of the product. In order to be successful, a new product must offer customers better functionality compared to another existing products (Albert and Thirupathi, 2009).

Table-I: Frequency, Percentage Distribution, Mean and Standard Deviation of level of acceptability of the Innovative Multi-Power Source device in terms of Functionality

Description	Range	Frequency	Percentage Distribution
Very Good	3.70-4.00	4	40.00%
Good	2.80-3.69	6	60.00%
Poor	1.90-2.79	0	0.00%
Very Poor	1.00-1.89	0	0.00%

Lozen et al. (2017), in their book titled "Electrical Product Compliance and Safety Engineering", they defined product safety as the application of engineering and management principles, criteria, and technique to optimize all aspects of safety within the constraints of functional effectiveness, time, and cost throughout all phases of the product life cycle.

The show that majority of the experts evaluated the Innovative Multipower Source device as "good" on the level of acceptability and in terms of safety. The over- all rating is also "good" with a mean of 3.32.

The standard deviation of zero point seventeen (0.17) indicates that the evaluation of the experts on level of acceptability of the innovative Multipower source device in terms of safety as similar to each other.

Table –II: Frequency, Percentage Distribution, Mean and Standard Deviation of level of acceptability of the Innovative Multipower Source device in terms Safety

Description	Range	Frequency	Percentage Distribution
Very Good	3.70-4.00	0	0.00%
Good	2.80-3.69	10	100.00%
Poor	1.90-2.79	0	0.00%
Very Poor	1.00-1.89	0	0.00%

In technical terms, reliability is characterized as the probability that a product will perform its intended function without failure under specified time-limit conditions as defined by the Institute of Electrical and Electronics Engineers (IEEE).

The data show that all of the experts evaluated the innovative Multipower source device "good" on the level of acceptability in terms of reliability. The over- all rating is also "good" with a mean of 3.06.

The standard deviation of 0.13 indicates that the evaluation of the experts on level of acceptability of the innovative Multipower source device in terms of reliability is similar to each other.

Table -III: Frequency, Percentage Distribution, Mean and Standard Deviation of Level of Acceptability of the Innovative Multipower Source device in terms of Reliability

Description	Range	Frequency	Percentage Distribution
Very Good	3.70-4.00	0	0.00%
Good	2.80-3.69	10	100.00%
Poor	1.90-2.79	0	0.00%
Very Poor	1.00-1.89	0	0.00%

Efficiency is the degree to which the device or components performs its specified functions with minimal resource consumption. It can also be defined as the relationship between the degree of effectiveness achieved and the quantity of resources spent, (Hughes, 2016).

The data show that majority or ninety (90%) percent of the expert evaluated "good" on the level of acceptability in terms of efficiency of the innovative Multipower source device. The over- all rating is also "good" with a mean of 3.20. The standard deviation of 0.23 indicates that the evaluation of the experts on level of acceptability of the innovation Multipower source device in terms of efficiency is similar to each other.

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Table-IV: Frequency, Percentage Distribution, Mean and Standard Deviation of the Level of Acceptability of the Innovative Multipower Source device in terms of Efficiency

Description	Range	Frequency	Percentage Distribution
Very Good	3.70-4.00	0	0.00%
Good	2.80-3.69	9	90.00%
Poor	1.90-2.79	1	10.00%
Very Poor	1.00 -1.89	0	0.00%

Problem 3. What is the over-all level of acceptability of the innovation Multipower source device?

The data show that all of the expert evaluated "good" with a mean of 3.29 on the over-all level of acceptability of the innovative Multipower source device. The standard deviation of 0.60 indicates that the evaluation of the experts on over-all level of acceptability of the innovation Multipower source device is similar to each other.

The data show that the Innovative multi-powers source device has good quality features in terms of; functionality, safety, reliability and efficiency. As what International Standards Organization (ISO,1986) defined the quality as the totality of features and chrematistic of a product or service that bear on its ability to satisfy specified needs. They expand this view in (IS09001:2008) as the totality of something can be determined by comparing a set of inherent characteristics with a set requirement. If those inherent characteristics meet all the requirements, high or excellent quality is achieved. If those characteristics do not meet all the requirements, a low or poor level of quality is achieved.

Table –V: Frequency, Percentage Distribution, Mean and Standard Deviation of level of Over-all acceptability of the innovation Multipower source device

Description	Range	Frequency	Percentage Distribution
Very Good	3.70-4.00	0	0.00%
Good	2.80-3.69	10	100.00%
Poor	1.90-2.79	0	0.00%
Very Poor	1.00 -1.89	0	0.00%

	Mean	Standard deviation	Description
Functionality	3.56	0.37	Good
Safety	3.32	0.17	Good
Reliability	3.06	0.13	Good
Efficiency	3.20	0.23	Good

Problem 4. What is cost analysis of the new innovation?

The results show that the highest possible price they are willing to spend to this product is about ₱45,800. The data also reveal that if the product will be sold at the highest price of ₱45,000 it is still competitive compared to the existing products available in the market.

The result of the cost analysis of the innovative multi-power source device is that the device is worth it to invest. The production cost of the innovative multi-power source device has a total of ₱24,907.08 and data show that it can be sold up to ₱45,800.

Table -VI: Consumer type response on the economic acceptability of the Innovation Multi-Power Source Device

Indicators	25kto 30k	31k -35 k	36k - 40k	41k -45 k	Mean	SD
How much money are you willing to spend on this product?	3	4	4	4	(2.60) 31k-35k	1.12

Indicators	No	Yes	Mean	SD
If you knew that the price of "product" was "P80,000", would you to buy it?	15	0	NO	0.0

What would be the highest price you would be willing to pay for this product?	Amount: average (? ?45,800)

Indicators	No	Yes	Mean	SD
Is the price of this product competitive compared to the existing product?	0	15	Yes	0.0

Problem 4. What is the implication towards technician education of the innovative product?

According to Ziefle & Jacobs (2009) technology education includes all types of intentional and systematic impact on the personality of the child, with the goal of imparting information and skills for the creation and use of technology as well as a technical interest. As to the implication of the innovative multi-power source device towards technician education, this device can be used as instructional material/visual aid in teaching electrical motor controls and phase converters. Visual aids are the best tools for making teaching effective and the best dissemination of knowledge (Shabiralyani et at.,2015).

As we enter to the 4TH Industrial Revolution and in education, 4.0 facilitators should use instructional material that helps the learner to be competent to work in the modern world. The device can be used in students experiential learning activities as the instructor facilitate learning via practical activities like trouble shooting where the learners solve common problem/situations they possibly encounter in the real world/industry while using electrical motor control. Giving activity that embodies authentic design problem-solving is believed to promote innovation.

VI. FINDINGS AND RECOMMENDATION

1. The Innovative Multi-Power Source Device was successfully developed as it fulfills the intended purpose.
2. The product evaluation of the device in terms of functionality, safety, reliability and efficiency got good over-all level of acceptability.
3. Aside from residential and industrial use, the device can be also used as training material for technician teacher education in teaching electric motor control,
4. The Innovative Multi-Power Source Device is worth investing.
5. On the basis of the findings the following recommendations are presented.

1. As recommended from the experts, it needs to make the timer relay display and controls be accessible without opening the panel to reduce safety risks while editing the timing. A password needs to be in place to protect the timer settings and additional energy saving features are needed. Remote control should be improved from simply on and off application to forward and reverse control. Additionally, it needs to increase the device's capacity to run multiple electric motor in simultaneous operation and digitized user and operating manuals with schematic diagram.
2. The industry-university collaboration should further improve to address the other needs of the end-user and further improvement of this product.
3. For instructional purposes, instructor teaching electric motor control and phase converter should use this device to assess students learning.
4. Farmers and other end-users should consider buying this device to save their money.
5. The researcher can make use of the results of this study for deeper analysis of issues and concerns in Innovative Multi-Power Source Device and use the results of the study as benchmark to increase its capacity and usability.

VII. CONCLUSION

The Innovative Multi-power source device is another example of a beneficial innovative product that successfully merges different applications in a single device at a lower cost. This product is almost the same as other existing products but more versatile in terms of functions. As a result of the financial crisis, consumer demand for a single product with multiple features is at a lower price. It also serves as another example of success in collaboration between industry and academe where the needs of the industry are addressed through research and innovation. The Innovative Multi-Power Source device will be a big help to the people in the rural areas who need phase converter in running their electrical motor, especially for the small and medium-sized enterprises that cannot afford to buy the other phase converter available in the market.

APPENDIX

Table-VII: Bill of Materials

Quantity	Materials	Unit Price in Peso	Total Amount
1 Piece	24 hours Manual /Auto Control Timer Digital Time Switches	997	997
1 Piece	600V 10A off switch Emergency switch Emergency Stop Switch Push Button	100	100
4 Pieces	Push Button Press Emergency Momentary Stop	100	400
4 Pieces	Magnetic Contactor 220VAC	600	2400
4 Pieces	Overload Relay	1462	5848
1 Piece	Relay Omron	913.60	913.60
13 Pieces	Pilot Light Indicator 220V	100	1300
4 Pieces	Selector Switch	172	688
2 Pieces	Miniature Circuit Breaker (2 Pole)	192	384
3 Pieces	Miniature Circuit Breaker (3 Pole)	365	1095
1 Piece	On Delay Timer	2,084.54	2,084.54
1 Piece	Remote Control On/ Off	189	189
2 Set	Terminal Block (Double Rows 12 Position)	114	228
1 Piece	Starting Capacitor	390	390
1 Piece	Running Capacitor	360	360
1 length	Din Rail	402.43	402.43
1 length	Cable duck	500	500
1 Piece	Control Panel (600mm X 500mmX 200mm	1700	1700
1 Roll	Control Wire # 18	250	250
1 Roll	Control Wire # 12	250	250
4 Pieces	Auxiliary Contact	913.67	3654.68
1pack	Wire Tagged	161	161
2 Pack	Cable Tie	84	168
10 Meters	Wire Wrap	182.83	182.83
1pack	Terminal Log	102	102
2 Pieces	Fuse Holder	69.5	139
2 Pieces	Fuse 2 Amperage	10	20
	Total Amount		**P 24,907.08**

VIII. ACKNOWLEDGMENT

The author thanks to Prof. Romeo M. De Asis, for giving him the opportunity to do this research and for providing valuable guidance throughout this study. Thanks to his dynamism, vision, sincerity, and motivation that have deeply inspired the researcher. To the authors family, colleagues and friends, for providing him with unfailing support and continuous encouragement. This accomplishment would not have been possible without them. Above all, praises and thanks to God, the Almighty, for his blessings throughout the completion of the study

REFERENCES

[1]. Aditya, T. Research to study Variable Frequency Drive and its Energy Savings. International Journal

of Science and Research (IJSR), India Online ISSN: 2319-7064. 2013.
[2]. Sapna Khanchi, V. K. Power Factor Improvement of Induction Motor by Using Capacitors. International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 7- 2013.
[3]. Rimbawat, A. A.Design of motor induction 3-Phase from waste industry to generator for microhydro at isolated village. 1st Nommensen International Conference on Technology and Engineering, 2017.
[4]. TEJAN, L. L. PROGRAMMABLE INDUSTRIAL MOTOR CONTROL TRAINER. International Research Journal of Engineering and Technology (IRJET (2018).
[5]. Shivanagouda.B. Pati, M. S. Operating Three Phase Induction Motor Connected to Single Phase Supply. International Journal of Emerging Technology and Advanced Engineering (2012).
[6]. Toshisuke OZAWA, K. T. Quantitative Evaluation of Social Acceptability of Products and Services. Nikkei Research, Inc. (2003).
[7]. Vishant Naik, S. K. Routine Test of Three Phase Induction Motor. International Research Journal of Engineering and Technology (IRJET. (2017).
[8]. Kim, H.-C. Acceptability Engineering: The Study of user Acceptance of Innovative Technologies. Journal of Applied Research and Technology 2(2). (2015).
[9]. Keltic, J. J. Electricity 4: AC/DC Motors, Controls, and Maintenance (2013).
[10]. Sumedh Tonap, P. C. Speed Control of AC Motor Using VFD. International Journal of Innovative and Emerging Research in Engineering. (2015).
[11]. Yogita Y. Garud, S. R. A Study on Variable Frequency Drive and It's Applications. International Journal of Innovative Research in Science, Engineering and Technology. (2016).

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