DESIGN AND DEVELOPMENT OF A SUPER CAPACITOR POWER BANK

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APPROVAL SHEET

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The Researcher

DEDICATION

To God,

for giving good health and wisdom from the start

until my last struggle...

To my Family,

for their deepest love and support

To my Mentors,

for sharing their expertise...

To the Respondents,

for their inspiration...

To the Teachers,

for their philanthropy

To all of you, the researcher humbly dedicate this

academic masterpiece.

-Richard

ABSTRACT

This Study focused on the design and development of a super capacitor power bank that was developed by the researcher and compared it to the available power bank in the local market. The study employed the experimental method of research in the sense that the developed super capacitor power bank by the researchers evaluated the different parameters being measured and tested. Based on the findings of the study, it was concluded that the super capacitor and power bank can charge 30 minutes to 1 hour as compared to the conventional power bank for it took 2 hours to 3 hours to fully charge the battery. Moreover, super capacitor power banks are more effective and efficient as compared to the commercially available conventional power banks in the local market. Furthermore, the super capacitor power bank has a high acceptability level as rated by the evaluators which means that it is comparable to the existing commercially available conventional power banks in the local market. Then, the material components in constructing the super capacitor power bank were readily available from the hardware stores in the locality that can be assembled easily. Moreover, the study showed the total cost of P1,307.00 only, which is cheaper as compared to some of the commercially bought power banks in the local market. Finally, researchers concluded that the super capacitor power bank is more effective, efficient, and convenient as well as environment-friendly as compared to the commercially available power bank in the local market.

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Chapter 1

THE PROBLEM AND ITS SETTING

Introduction

Technology plays a major role in an individual's life and in their daily living. The current trend of the society is continually adopting every change of communication technology. Apparently, mobile phone became an important communication tool and considered as integral part of the society as a communication device. Perhaps people are increasingly using mobile phones rather than the fixed telephones nowadays (Goswami & Singh, 2016).

As reported in the paper of Sundari (2015), mobile phones have become the most popular means of communication from one another across the locality, country and in the global village. Seemingly, cellular phones are commonly used for entertainment, information and social connectivity. It has been demonstrated that individuals with low self-esteem use cell phones to form and maintain social relationships.

Many of today's portable convenience devices aside from cellular phone are Public Display Appliance (PDA), and Ipad PSP are typically battery operated and contain a small, rechargeable battery housed within the portable device. The battery of such devices typically provide the power for about one day, or less. It is necessary to recharge the chargeable better during night hour, in readiness for use the next day. Recharging is performed either by coupling AC/DC converter to a conventional outlet such as a 220 volts AC outlet and to a DC input on the portable device. Such occasions may occur during camping or when traveling or otherwise out of doors or away from a convenient AC outlet. It is thus desirable to provide a device which is small, portable and preferably hand held and which is capable of providing reserve power to a portable device. Battery chargers for mobile communication charger devices are typically classified into two types, a battery charger design to charge a battery removed from the mobile communication device, and a battery designed to be directly connected a mobile communication device and charge a battery installed in the mobile device. Mobile power bank devices have been introduced and commonly use, demands on power banks are increased.

However, the conventional mobile power bank device is an electronic device equipped with an internal battery and has only one function, charging. A conventional mobile power bank usually has a certain volume and weight and only single function that can cause decrease in willingness of carrying. The battery inside of the power bank contained small power and still rich low voltage level.

Nevertheless, there arises a number of occasions and situation in which it is inconvenient and even impractical or impossible to obtain a local AC outlet. Such occasions may occur during camping or when traveling or otherwise out of doors or away from a convenient AC outlet. Due to the difficulty of meeting the demand between the large capacity and small quality of the portable power bank, the large capacity will inevitably lead to higher quality, which leads to the portability of the portable power bank will be numerously reduced (Minghao Chen, YangYang and Yuwen Hui , 2017).

Xie, Li, Cai and Li (2016) stated that portable electronics devices became popular and increasingly sold in the market and used by people. Therefore, mobile power banks are necessary to ensure that devices remain available when working outdoors for long period of time; for example a cell phone used on a trip could be recharged from a mobile power bank. Although a power bank can extend the electricity capacity of the devices to a certain degree, it still has a limited amount of electricity; thus, it needs to be recharged frequently. Therefore, it is necessary to find alternative methods to solve the power supply problem of devices.

Recent development in the field of portable equipment has been the main driven force behind the search with the high energy density and form flexibility. There are varieties of batteries available, the most well know is lithium batteries because of it has low discharge potential, high energy density and the highest theoretical charge capacity of all commercial rechargeable batteries (Gudi, 2017). Similarly, in the study of Joshi (2015) revealed that due to the increasing abilities and decreasing cost of smart phones, their utility has increased but their power consumption is high. Joshi also added that these smart phones have a very large storage capacity and loaded with various applications associated with them is increasing rapidly.

Running many applications at a time causes the phones to drain out quickly. Although increased charge consumption for a host of parallel and quick applications is a good bargain, this also calls for the phone being charged frequently. However, the power banks available in the market do not have the ability to extend beyond a fixed number of ports. The design is rigid to a high extent. The cost of these power banks is comparatively very high as well. Other than that, using the present day power banks, we cannot do much, other than charging phones.

Apparently, communication nowadays with the use of mobile phones became as necessities by people today thus a cheapest and efficient alternative power bank is needed. Thus, this study aimed to design and develop a super capacitor power bank that can be easily and efficiently used by the mobile phone users.

Statement of the Problem

The study aimed to design and develop a super capacitor power bank.

Specifically, it sought to answer the following questions:

1. What is the performance characteristics of the selected power banks available in the market?

2. What is the design of the super capacitor power bank in terms of:

2.1 block diagram;

2.2 schematic diagram; and

2.3 PCB Layout?

2. What are the components of the super capacitor power bank and their functions?

3. What are development procedures of the super capacitor power bank?

4. What is the effective and most efficient super capacitor power bank in terms of:

4.1 functionality;

4.2 charging time;

4.3 durability; and

4.4 cost?

5. What is the level of acceptability of the developed super capacitor power bank along:

5.1 functionality;

5.2 charging time; and

5.3 durability?

Theoretical Framework

The study of supercapacitor was conceived from the heuristic theoretical model and first-principles density functional theory (DFT). According to the paper of Huang, Sumpter, and Meunier (2008), carbon supercapacitors bridge the gap between batteries and conventional dielectric capacitors, and are ideal for the rapid storage and release of energy. Furthermore, Gogotsi, Chmiola, Yushin, Portet, Simon, and Taberna (2006) found that a reduced capacitance of microporous carbons at large discharging current densities. Such behavior of reduced capacitance also exists for mesoporous carbon materials probably because of the solute diffusion process, but it is more pronounced for microporous carbons. Then, Tamai, Kouzu, Morita and Yasuda (2003) found that, at smaller discharge current, the capacitances of mesoporous and microporous carbon materials are in one data group but are separated into two data groups at larger discharge current, with the capacitances of microporous carbons being reduced by a larger degree than those of mesoporous carbons.

As stressed in the paper of Gidwani, Bhegwani, and Rohra (2014), as they affirmed on the density functionality theory of supercapacitors. As they explained the supercapacitor differs from a regular capacitor in that it has a very high capacitance. A capacitor stores energy by means of a static charge as opposed to an electrochemical reaction. Applying a voltage differential on the positive and negative plates charges the capacitor. This is similar to the buildup of electrical charge when walking on a carpet.

Moreover, they also explained that the super-capacitor is ideal for energy storage that undergoes frequent charge and discharge cycles at high current and short duration. Rather than operating as a stand-alone energy storage device, supercapacitors work well as low-maintenance memory backup to bridge short power interruptions. Supercapacitors have also made critical inroads into electric power trains. The charge time of a supercapacitor is about 10 seconds. The self-discharge of a supercapacitor is substantially higher than that of an electrostatic capacitor and somewhat higher than the electrochemical battery.

Another theory which this study was anchored on the theory advanced by Brian Evans Conway. He conducted extensive fundamental and development work on ruthenium oxide electrochemical capacitors. In 1991 he described the difference between "supercapacitor" and "battery" behavior in electrochemical energy storage.

This idea underscores the need in development of charger and power bank device. The understanding and learning concepts and principles in super capacitor can be made effective to design the charging process with the application of super capacitor. The difference between super capacitor and battery is a way to determine the charging and discharging process.

Product Development

The flow of this study is followed the product development model as it is shown on its Product Development on Figure 1.

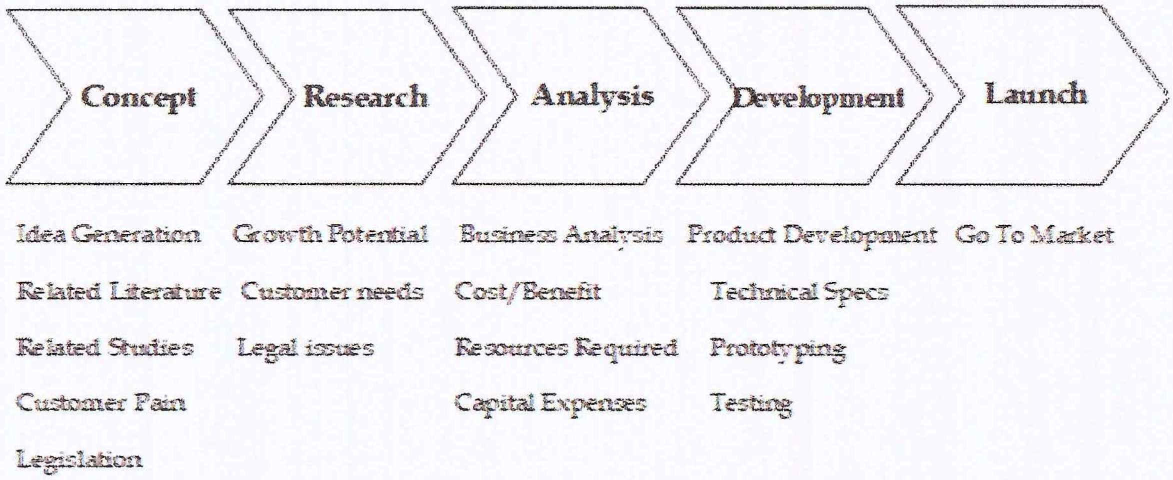

Figure 1. The Product Development of the Study

The paradigm shown has five major frames, which represent the flow of the study.

The first frames contain the initial step of product development which is the idea of the product. In this stage, are the concept, and ideas from books, publish and patented inventions, supplies and materials, tools and equipment and manpower are considered to conceptualized the development of the product of the present study.

Next, the second frame indicates the phase that consist of the process in developing the project, which include customer needs, legal issues, and growth potential of the power banks tested in this study.

While, the third frame served as the analysis of product in this study which the business analysis, cost/benefit, resources required and expenses in producing the super capacitor charger and power bank.

Then, the fourth frame is the development phase. In this phase product development, technical specifications, prototyping and testing are being undertaken to develop the product.

Lastly, the fifth frame is the launch phase in which the product is being sold and introduce to market.

Significance of the Study

The prime significance of this study is to provide community a super capacitor charger and power bank instead of commercially expensive power bank. The different groups that would benefit from this study are as follows:

Entrepreneurs. The output of this study would serve as investment to another venture by introducing into the market.

Business Owners. The result of the study would give insights to the business owners on the feasibility of the product developed by the researcher for commercialization.

Investors. The developed product of the researcher could be an eye-opener for the investors to finance for the manufacturing and enhancement of the product for commercialization purposes.

Community. This study would encourage the use of this power bank for communication specifically during emergency and as calamities come for it can recharge their phones for faster and longer use of gadgets.

Students. The result of the study would directly benefit students to clearly understand the principles behind the super capacitor as power bank.

Future researcher. The output of this study would serve as reference material for future researchers who intend to venture on super capacitor charger and power bank improvisation similar to the present study.

Scope and Delimitation of the Study

The researcher focused on the study on designing and developing a power bank using DC generator to super capacitor. DC generator create magnetic field upon movement of the motor, convert the mechanical rotation into electrical voltage reusable form of electricity. This study mainly focused in charging devices such as cellphones, and other portable gadgets with low voltages requirements. Electricity produce of this device is base in hand cranking through multiplying the speed of motor using gear box, and it can also plug into power supply adaptor ac/DC 5 volts direct current (DC).

The study was conducted in Northwest Samar State University-Main Campus, Calbayog City. Designing, canvassing, testing and fabricating the device took place for three (3) months. This was evaluated by the 30 evaluators that were oriented by the researcher before they have rated the devices in terms of functionality and charging time. Lastly, this study was conducted in the School Year 2017-2018.

Definition of Terms

The following terms are conceptually and operationally defined by the researcher that would help the readers to understand the study:

Charger. This refers to the device for charging a battery or battery powered appliance (Fundamental Electronics, 2010). As used in this study, it will charge the portable device so that the power from the storage will transfer to portable device using connectors.

Converter. This refers to the device for altering the nature of an electric current or signal, especially from AC to DC or vice versa, or from analog to digital or vice versa (Fundamental Electronics, 2010). As used in this study, this refers to the device that used to rectify from AC to DC source in alternating current outlet.

Cranking. This refers to the handle that turns the crankshaft of typically in order to start the engine (Fundamental Electronics, 2010). As used in this study to the DC generator it need to a make rotation through hand cranking.

Design. This is a plan or drawing produced to show the look and function or workings of a building, garment, or other object before it is built or made (Fundamental Electronics, 2010). As used in this study, this refers to the casing and mechanism of the device that makes the gadget presentable and comfortable to use.

Device. This refers to the thing made or adapted for a particular purpose especially a piece of mechanical or electronic equipment (Fundamental

Electronics, 2010). As used in this study, it refers to electronic device recognize its feature.

DC generator. This is the electrical machine which converts mechanical energy into direct current electricity; the energy conversion is based on the principle of production of dynamically induced electromechanical force electro motive force (Fundamental Electronics, 2010). As used in this study, it refers in producing electricity direct current.

Diode. A unidirectional device that allows current to flow through in one direction (Fundamental Electronics, 2010). In this study, it pertains to the component of the device that used to block the current and flow in one direction.

Design. This is a sketch or plan showing the main features of something to be executed (Webster New Students Dictionary, 1988). As used in this study, it refers to the derivation of data needed in the preparation of the project plan and the detailed plan of its parts.

Evaluation. This is the process of determining whether programs or certain aspects of programs are appropriate, adequate, effective, and efficient (Dictionary of Scientific and Technical Terms for Philippines School, 1988). As used in this study it refers to the evaluation in terms of effectiveness, efficiency, functionality of the improvised gadget.

Functionality. This is the capability of machine or device that can serve a purpose well (Grolier International Dictionary, 1998: 533). As used in this study, it refers to the functional effectiveness of the gadget as an aid of instruction in the lesson presented.

Gadget. This refers to the portable device used for demonstration of something (Dictionary of Scientific and Technical Terms for Philippines School, 1988). As used in this study, it refers to a small instruction device that could be used and installed in any place like the improvised oscilloscope.

Schematic Diagram. This is the electronic circuit showing electrical connections and identification of components (Webster New Students Dictionary, 1988). As used in this study, it refers to the schematic diagram of the improvised oscilloscope.

Supercapacitor power bank. This refers to the power bank developed by the researcher which is primarily used in charging electronic gadget. This was developed with the use of the supercapacitor which believed more efficient and comparable to the power bank available in the market.

Supplies/materials. This refers to the amount or quantity of goods available in the market to be purchased (Dictionary of Scientific and Technical Terms for Philippines School, 1988). As used in this study, these are the things that comprised the physical aspect of the improvised gadget.

Testing. This term applies to an examination intended to determine factual knowledge or acquired skill (Merriam-Webster Dictionary, 1999). As used in this study, it refers to subjecting the gadget to test various intended operations to ensure safety and accomplish correct functions.

Tools and Equipment. This refers to the necessary material that is used to implement in certain operation or activity (Webster New Students Dictionary, 1988). As used in this study, it refers to the electrically operated machines used to affect the construction process of the gadget.

LED. This refers to the diode that emits a certain color light when forward biased. The color of light emitted by the diode is determined by the type of materials used in the doping process (Glossary Grob's Basic Electronics, International Edition, 2008).

Performance Characteristics. This refers to the qualities and characteristics that are equipped for satisfactory performance in a particular role or function (Fundamental Electronics, 2010). As used in this study, it refers to the performance of the supercapacitor power bank as compared to the existing power banks in the market.

Portable. This refers to the part of a device that can be easily carried or moved, especially because of being a lighter and smaller version than usual (Fundamental Electronics 2010:199). As used in this study, it refers to the device that developed by the researcher.

Prototype. This refers to an early sample, model, or release of a product built to test a concept or process or to act as a thing to be replicated or learned from (Fundamental Electronics, 2010). As used in this study, it refers to the testing of the device on its function.

<u>Printed Circuit Board (PCB)</u>. This is the printed circuit board (PCB) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. Components (e.g. capacitors, resistors or active devices) are generally soldered on the PCB (Fundamental Electronics, 2010). As used in this study, it refers to the lay-out top view and bottom view of the circuit, wherein the current will flow.

<u>Super Capacitor</u>. This refers to the electric double layer capacitor is a high-capacity capacitor with capacitance value much higher than other capacitors but lower voltages limits that bridge the gap between electrolytic capacitors and rechargeable batteries (Fundamental Electronics, 2010).

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents a brief review of related studies and literature which are taken from both published and unpublished references and other reading materials that support the view in the development of this study.

Related Literature

In this digital era, technology development and breakthroughs are ongoing that makes individual living more comfortable. One of the advancement of technology is the improvement of communication technology such as internet, computers, and different models of cellular phones. Wherein, all these electronic device consumed electrical energy to recharge its power.

Obviously, the communication system plays a vital role in the present modern society. The size of the electronic devices has shrink from macro to micro and then transforming to nanometer scale with advancement of semiconductor technology. For example, the current mobile phones are designed compactly and operate with touch screen based technology. The unique features of these mobile phones includes data storage, audio and video, navigation system, conference calls, e-commerce, e-learning, and the likes which requires large capacity battery system (Allag & Liu, 2014).

With this, the mobile phones get easily drained its battery. And most of the batteries that used in the mobile phones are lithium ion batteries. According to Joshi (2015), the in-built lithium-ion battery is designed for compatibility and has limited energy storage to operate smart phones. Thus, these batteries are providing energy for hours and maximum a day subjected to usage pattern of the mobile phone. It means that the inbuilt battery is drained out and then need to plug-in for charging the battery. The charging can be done either through plug-in or by external portable energy sources such as power banks.

Notwithstanding, as the popularity of portable electronics increases, mobile power banks are necessary to ensure that devices remain available when working outdoors for long periods of time; for example, a cell phone used on a trip could be recharged from a mobile power bank (Xie, Li, Cai & Xiaodong Li, 2016).

As described by Hartono, Sunarno, and Sarwanto (2017) power bank is a device used to insert electrical energy to a rechargeable battery, without having to connect the device to electrical outlet. It can be used without having to connect it to an electrical device. It has electrical capacity so that when the energy contained in the power bank has been depleted, the power bank must be recharged by connecting it to an electrical outlet.

However, most of the power banks available in the market are the power banks have only capacities ranges from 2000 mAh to 20000 mAh or beyond are in a great demand for charging mobile phones. Then, it consists of three components such as lithium-ion battery, hardware protection circuit, and outer case. Among all, the battery serves as the heart of the power bank and hardware protection controls the current, voltage and temperature as well (Narayan, Venkateswarlu and Jagadish, 2018).

Apparently, there are several patented power banks that are available in the market. One of which is the work of Unger and Nuebauer (2015) with a patent number US9212794. It has a hand crank movable between a storage position and a cranking position. The base is rotatable coupled to the second end of the housing. The arm is translatable relative to the housing between a retracted position and an extended position such that when the arm is in the extended position, the arm is pivot-table relative to the base between a transaction position in which the arm is substantially parallel to the housing axis and a fixed position in which the arm is substantially perpendicular to the housing axis. It is related in this study to design the casing and mechanism of the crank in order to charge the super capacitor an apply force during charging period, and to change the specification of the DC generator in order to increase the output current so that can charges a mobile phones, with no limit of time use of cell phones. The present study limited time only on charging their phones I notice that it needs more development.

Another was the developed power bank by Bray with a patent number US8338979 that was registered in 2012. This power bank has a superconducting direct current (DC) generator driven by a wind turbine, the direct current (DC) generator including an annular armature, a stationary annular field winding coaxial to the armature and separated by a gap from the armature, a non-rotating support for the field winding; a fixed support, and a commutator assembly. The annular armature is connectable to rotate with a rotating component of a wind turbine. The stationary annular field winding is coaxial to the armature and separated by a gap from the armature. The field winding includes superconducting coil magnets. The fixed support couples the non-rotating support for the field winding to base fixed to an upper region of the wind turbine. The fixed support is connected at one end region to the non-rotating support as connected at an opposite end region to the base. The fixed support suspends the field winding over the base. The commutator assembly is configured to transfer DC current generated by the rotating armature to a power conversion system. It is related in this study in producing DC electricity replacing the wind as an input force by hand cranking to move the armature and create magnetic field, converting to electrical energy.

Dusan Veselic (2010) has a patent number US7701173 of a battery charging circuitry that received power from an external power source and supplying output power through an output node, to an electronic system of an electronic communication device and to battery, said switch-mode battery charging circuitry having an integrated circuit and an inductor, said integrated circuit arranges to cooperate with said inductor to provide current of said out-put power of greater magnitude battery isolation circuitry including a semiconductor switch connecting the output node to said battery, the battery isolation circuitry sensing voltage at said output node and variably restricting current to said battery when said voltage is below a minimum voltage value by operationally controlling said semiconductor switch as current passes through it. It is related in this study to make a power supply circuit to prevent the damage of the DC generator, then also to block the current from super capacitor to DC generator.

Kyung-sang Lee, Jung Woo Lee and Moon Young Chai (2007) patent number US7166987 of their portable charger for a mobile phone. The power bank composed of a field effect transistor that operates in such a way as to be switched on by application of low level voltage to a gate terminal through bias resistors and output the DC power, charged in the secondary battery, to the voltage converting means through protection means if the battery of the mobile phone is connected to positive and negative electrodes of the output terminal, and to be switched off by application of high level voltage to a gate terminal through bias resistors and charge the battery of the mobile terminal if the battery of the mobile phone is not connected to the positive and negative electrodes of the output terminal.

Liu Xinfang (2016) patent number US9506446 apparatus for providing power, the apparatus having a housing; a battery module positioned inside the housing, the battery module having; a battery , a battery circuit board coupled to the battery and ignition output port coupled to the battery circuit board, a circuit board positioned inside of the housing and coupled to the battery module, the circuit board having; a charge module, a discharge module, a lighting module and a control module coupled to the charge module, the discharge module and the lighting module; a light source coupled to the circuit board; and wherein the apparatus is configured to provide sufficient power to jump start a vehicle.

Yung-Shen Lin (2012) patent number EP2512002A2 solar energy portable power bank external devices, and includes a bank body, solar panel, a storage battery, a power converter, a fan , an input port and an output port. The solar panel placed on the surface of the bank body provides electrical energy to the storage battery in case of no external power to charge the storage battery. With the storage battery placed inside the bank body, it is very convenient for bringing about. The storage battery can be charged by any external power supply through the input port at night or on cloudy days for increasing the standby time of the solar energy portable power bank. The usage lifespan of the power converter can be extended because of the use of the fan. The power converter provides electrical energy for the output ports in order to adapt easily to various types of the external devices.

Fu-I Yang (2016) patent number US20160049816 a portable memory power bank comprises a charging loop, a battery, a discharging loop, a micro controller unit(MCU), a universal serial bus (USB) charging port and a USB discharging port inside a body of a power bank, and a built portable memory including a memory unit, a controller and a voltage source. The controller is coupled to the memory unit to have access to the data therein and also coupled to the USB charging port and USB discharging port separately. The voltage source is separately coupled to the discharging loop and the controller in order to supply electric power to the controller. The present invention therefore has functions of power storage, power supply; data storage, and data transmission for device such as cell phones and tablet PC. Moreover the connected device is being charged while transmitting the data.

Shih-Hui and Chin Tien Lin (2011) patent number US8013478 power bank apparatus includes a power storage unit, a first power output port and a first power input port. The power storage unit is connected to the first power input and output ports. The power bank apparatus is connected to a controller through the first power output port. The controller includes a control unit, a second power input port and a second power output port. The control unit is connected to the second power input and output ports, and the second power input port is connected to the first power output port, and the control unit is provide for controlling an output voltage value of the second power output port.

Another power bank was registered by Hao Dai (2010) with a patent number Us77232880. It has hand crank generator with a gear transmission and a generation motor driven by the gear transmission the crank and the gear transmission are coupled to each other. A clutch gear is coupled between the crank and the gear transmission. The crank is manually driven to further drive the gear transmission, and the generation motor is driven to generate electric current through the clutch gear. When the cranking stops, the clutch gear disengages from a motor gear disposed on the generation motor. A weighted wheel continues to revolve under inertia for a while to drive the generation motor to keep on generating electric current, so that the purpose of saving manual efforts can be achieved.

Moreover, Walter Hess (2007) in his power bank with a patent number US7239237 apparatus had comprised a housing a rechargeable battery source for providing a first source of direct current, a hand-crank dynamo configured to replenish the rechargeable battery source, and a direct current input receptacle configured for receiving a second source of direct current are disposed and held in the housing. An electric circuit is disposed and held in the housing and is in electrical communication with the rechargeable battery source and the direct current input receptacle to receive direct current from the first source of direct current or the second source of direct current. A cell phone charger output jack, in electrical communication with the electric circuit, is disposed and held in the housing. A radio receiver disposed and held in the housing and in electrical.

However, the present study developed a power bank that is made primarily with supercapacitors. It is believe by the researcher that supercapacitor power bank is comparable to the existing power banks in the market now and could recharge more power than the usual available power banks.

Supercapacitors as described by Kotz and Carle (2000) and Burke (2000) employed a thin dielectric layers and high surface area electrodes. Consequently, they exhibit capacitances that are several orders of magnitude higher than traditional capacitors.

According to Vangari and Jiang (2013), supercapacitor offers promising solutions to future energy storage requirements. A variety of methods and materials are available for the development of supercapacitors. Several supercapacitor electrode materials and relevant fabrication methodologies have been reviewed and several applications of supercapacitors have been experimented too.

Furthermore, with recent technical advances in electric-powered devices in terms of cycle life, charge time, and specific power, supercapacitors have become promising candidates in diverse fields that require high energy throughput (hybrid electric vehicles) and stable energy throughput such as sensitive automation, computer chips, and portable electronic devices. Moreover, the attractive characteristics of supercapacitors which have higher power densities and quick charge and discharge processes also impart reliable power throughputs (Divyashree and Hegde, 2015; Ke and Wang, 2016).

The cited literatures pave the way for the researcher to develop a power bank made from the supercapacitors. And it is believe by the researcher that can compensate to the usual power banks available at present in the market.

Related Studies

According to Mirhoseini (2011) hybrid battery-super capacitor can extend the power supply for a lifetime. Hypo energy combines high energy density and reliable workload supportability of an electrochemical battery with high power density and high number of recharge cycles of super capacitors. The lifetime optimizations consider nonlinear battery characteristics and super capacitors" charging overhead. Study the hybrid supply lifetime optimization for a preemptively known workload and for one ideal super capacitor. We show a mapping of Hypo energy-KI to the multiple-choice knapsack problem and use dynamic programming to address the problem. Hypo energy-KN considers the optimization for the known workload but in the case of having a non-ideal super capacitor bank that leaks energy. Evaluations on iPhone load measurements demonstrate the efficiency and applicability of the Hypo energy framework in extending the system's lifetime. It is related in this study by means of selecting the appropriate specification of super capacitor.

Based on the study of Chakma and Chawaphan (2017), the possible alternative energy source that can be used in emergency situations and finally wind up (hand crank) mechanism is the best option to generate voltage instantly and quite easily. The developed device has the gear box that allowed to generate short amount of power through cranking which is compact and rigid system, thus allows more portability. They used a small DC generator as a generator in reverse operation. Its operational efficiency about 80 percent of its input, but through more cranking can generate more sufficient voltage than required voltage. Then, they constructed a device than instantly generate power but the device, based on gear train system was quite bulky, less portable and performs poorly to charge up the latest smart phones. Expected that the output voltage would be enough to charge up a simple Li-ion battery which has less current rating used in usual cell phones, have succeeded in charging up such cell phone which has current rating less than the smart phones. Can achieve the success over the less current production by using motor (which is used as generator) of better current rating. The mechanical set up used in device is not made according to the requirement as the device to be made small but it is still efficient of giving a good output for charging up cell phone.

On the other hand, Venkatesh, Sairam, and Chappidi (2015) stressed that there are many alternative solutions for charging the phones. Out of which the first one is by using 9-V batteries and a 7805 (an extremely common linear 5V regulator: makes a solid 5V from 7-18V input). However, there is one thing about 9V's that we have learnt. One is that they don't have a lot of amp-hours, i.e., how much current (amps) they can provide and for how long hours. A Duracell 9V provides about 500 mAh over its lifetime. That's 500 mA for one hour or 100mA for 5 hours. That number is somewhat idealized but it is a good starting point. Another problem is that they don't like to supply lot of current because of their internal resistance which is approximately 2 ohms. But basically that just means that if you want a lot of current. The 9V was not able to provide all 500 mAh but more like 400 mAh (0.5V lost internal resistance). Another problem is that a 7805 is a linear regulator. That means if you want 100mA at 5V then you are taking 100mA at 9V and then losing the 400mW as heat. As the battery wears down to 7V the heat loss goes down to (7- 5V)*100mA=2W but we are still getting bad efficiency. At the best efficiency is 72% (5V/7V) and at the worst is 55% (5V/9V) that means it lost of about a third of a battery power as heat.

A human-powered wireless charger (HPWC) was proposed for low-power mobile electronic devices was studies by Dai and Liu (2012). As revoked in their study, HPWC is not only a wireless one but also powered by human can harvest energy, converted it into electricity, and then delivered to mobile electronics wirelessly. Theoretical analysis on the working principle of the HPWC has been performed. In addition, conceptual experiments have been carried out to demonstrate the feasibility of HPWS. The output characteristics of HPWC with two kinds of receiver coils have been tested when it works at different frequencies. It is shown that the maximum open-circuit voltage of this charger can reach 1280 mV, when the number of coil turns in receiver is 700 and the rotation frequency of hand crank is 1.5 Hz. Moreover, the output voltage of HPWC with a load has also been measured. The maximum output voltage of HPWC with a load of 75 ohms approximates to 400 Mv and an effective power of 1.1 Mw is gained when the 700 turns coil in receiver is available and the rotation frequency of hand crank is 1.5 Hz.

Likewise, Lee et al (2012) found out that axial flux permanent magnet (AFPM) generator which is a key element of a compact size portable and manual generator system composed of a gear system, a generator, a rectifier, and a battery charger. The design objects of the AFPM generator are its compact size, light weight, and high efficiency, and the three design objects are the main criteria to select the value of design variables. A soft magnetic composite core is used instead of a silicon steel core in the AFPM generator to achieve a compact size. In this paper, the overall design process to meet the design goals and the design results are presented with experimental results.

Linqiang et al (2010) developed a portable hand crank cell phone charger with an LED light that can be used anywhere. Results divulged that the device could conveniently use in any outdoor trips. This device would come in handy when there is a power outage and you need a flash light too, it always seems like the batteries are dead in flash lights. This devise is both practical and convenient. It is obvious that a device that could charge cell phone batteries just by the use of human harvesting energy is a very appealing and marketable product.

Similarly, Baek et al (2017) had developed a portable DC power supply based on electric double-layer capacitor (EDLC) bank which established for high power application. EDLC bank needs a DC-DC converter to maintain a constant output voltage and current. Especially a low impedance load makes the voltages capacitors discharge faster, and their discharging time is determined by RC time constant.

The operation of battery power bank with buck-boost type battery power module (BPMs) was studied by Moo et al (2014). As results of the study revealed all BPMs in the power bank are collaboratively to cope with the load requirements but substantially are operated individually. It schedules to discharge currents from batteries in accordance with their states of charges

(SOCs) and the operating modes of converters.

Moreso, Suen et al (2017) demonstrated an application in monitoring the capacity of portable power bank by developing a system with the arduino platform which allows the testing of the practitioners in the testing laboratories to test, record and analyze the portable bank under the test in remote manner. For standardizing the measurement, a testing standard for measuring capacity of portable power bank was drafted according to the circuit design in charging and discharging, environment and user's habit in Hong Kong. The developed system was implemented by analyzing numerous portable power bank existed in the market following the procedures listed in the drafted standard. The result showed that only the tested portable power bank labeled with rated capacity could deliver the capacity mentioned.

In addition, Narayan, Venkateswarlu and Jagadish (2018) conducted a studies on portable power banks for recharging electronic gadgets available in the market at present. They concluded that the performance of the lithium ion cell like capacities are found to be same within the studied cycles and the variation in the rated and actual capacities of the power bank are clarified. The laboratory results showed that the charging duration of the power banks from manufacturer to manufacturer are found to be different may be due to the protective circuit and also the practical deliverable capacity is comparatively lesser than the rated capacity of 5000 mAh power bank. Furthermore, they recommended that large capacity power banks with multi features such as torch, dual output ports, solar, wireless charging etc., are available commercially and user has to select the branded products for better life and safety of the device.

As can be read from the cited literatures, most of the power banks are developed from lithium-ion batteries and only few had used Super capacitors. With this, the researcher developed a super capacitor power bank that is comparable and somehow more efficient as compare to the existing ones.

Raza et al (2018) super capacitors (SCs) are attracting considerable research interest as high-performance energy storage devices that can contribute to the rapid growth of low-power electronics such as wearable, portable electronic devices and high-power military applications (e.g., guided missile techniques and highly sensitive naval warheads). The performance of SCs can be assessed in terms of the electrochemical properties determined through a combination between the electrode and the electrolyte materials.

The cited literatures gave the researcher to conduct a research with the use of super capacitor as power bank with his own design with the end-view of developing a gadget that can solved the problem of draining cell phones of the users; for today's time cellular phones are essential tool for our communication.

Chapter 3

METHODOLOGY

This chapter presents describe the methodology, which was applied in this study. It includes the research design, instrumentation, and validation of instrument, sampling procedure, data gathering, and statistical treatment of data.

Research Design

This study employed the developmental research design. Development research design is the systematic study of designing, developing, and evaluating programs, processes, and products that must meet criteria of internal consistency and effectiveness. Likewise, developmental research type involves situations in which the product-development process is analyzed and described, then, the final product is evaluated (Richey, 1994).

Since this study is concerned on the development of a gadget called super capacitor charger and power bank. Therefore, the study utilized the development research design. Initially, the researcher developed the product which is the super capacitor power bank. Then, its functionality and effectiveness is being evaluated. A questionnaire was used as the principal instrument in gathering the needed data.

This research used other data gathering technique such as actual observations. This method was used to describe, record, analyze, interpret, and ascertain some facts in order to come up with a more meaningful study.

In this particular study, the main objective is to determine the functionality, time rate, and durability of the developed super capacitor charger and power bank that would serve as basis for the improvement of the gadget.

Specifically, the respondents of this research study were composed of thirty (30) students from Northwest Samar State University which composed of fifteen (15) students under the BSIT 3rd year electronics and fifteen (15) students from the 5th year Electronics and Communication Engineering.

Accordingly, the responses and other information gathered out of a said instrument were analyzed and statistically interpreted. The researcher utilized statistical tools such as percentage, mean and standard deviation.

Instrumentation

The researcher measured the voltage and current generated by hand cranking and determined the variation of voltages when it comes to the speed of rotation using the **Volt Ohm Meter.**

The researcher used the **Oscilloscope** to visualize the peak voltage output during testing of the product and determined that consistent speed of rotation will provide stable voltages.

The researcher's developed questionnaire in used in data gathering. This is checklist type questionnaire which served as the primary tool to obtain the important data and suggestion relevant to the functionality, time rate, and durability of the gadget. Apparently, this instrument was utilized in the evaluating the developed super capacitor power bank on a 24/7 basis and rated by the selected evaluators.

Moreover, the questionnaire contained the indicators that measures the functionality, time rate and, durability of the gadget. Then, to ensure an objective ratings of the responses the questionnaire had indicators for each statement under functionality and time rate using the 5-point Likert's scale such as: 5 for Strongly Agree (SA), 4 for Agree (A), 3 for Undecided (U), 2 for Disagree (D), and 1 for Strongly Disagree (SD).

Validation of the Instrument

Initially, the researcher consulted BSIT Electronics and Electronic Communication Engineering Instructor preparing the questionnaire.

The draft of the questionnaire was presented to the researcher's adviser and instructor in the college of engineering technology under the BSIT Electronics and ECE for comments and suggestions. Their suggestions were considered in writing the questionnaire. Test and retest methods were employed by the researcher to determine the validity of the questionnaire. The researcher used the third year Bachelor of Science in Industrial Technology (BSIT) students for the test and re-test method of the questionnaire.

In the second week of March 2018 the first test was conducted and after two days the second test was also conducted with the same questionnaire and respondents. The result were analyzed, tallied and interpreted. It was found out by the researcher using appropriate statistical tool that there is no significant difference between the two test in terms of the different perceived statement in the questionnaire, inasmuch as the computed reliability coefficient were 0.85, 0.85, 0.85 respectively, signifying that the instrument was fairly high, adequate for individual measurements.

Generally, the researcher subjected the instrument of the study to expert validation. This was presented to the panel of examiners for refinement of the instrument for its content validation.

Sampling Procedure

Quota sampling was employed as the sampling procedure of the study. The researcher had selected evaluators from the BSIT major in Electronics and BS in ECE/Electronics Engineering under the College of Engineering and Technology wherein 15 students from BSIT and 15 also from ECE class that composed the sample of the study. They were selected or chosen as evaluators/respondents because they have the knowledge on electronics that could objectively evaluated the developed product of the researcher.

Data Gathering Procedure

The data was gathered with the used of questionnaire as described in the instrumentation. Before the distribution of the questionnaire to the target respondent, an approved recommended was requested by the researcher to the university president through formal letter from the Dean of the College of

Graduate Studies in order to gain support from the faculty and students of the college of industrial technology department in administering the questionnaire.

After the approval, the researcher through the permission of the CET dean were immediately make an schedule for the actual demonstration of the two groups of respondents relative to the operation and functions of the design and development of a Super Capacitor Power Bank. The actual demonstration to all respondents was done in the last week of December 2018. Then, after the actual demonstration the researcher personally distributed the questionnaire to the respondents to elicit needed data in the study. With the use of the questionnaire, the evaluators evaluated the supercapacitor power bank was rated on its acceptability, functionality and durability.

The respondent-evaluators were given ample time to indicate their responses. After such reasonable time given, retrieval of the questionnaire was done personally by the researcher to ensure a higher percentage of retrieval.

Statistical Treatment of Data

After gathering the data yielded by the questionnaire from the respondents or evaluators, the results were tallied, counted and tabulated carefully. Then, some statistical tools were used to analyze and interpret the treated with the use of Statistical Package for the Social Sciences (SPSS) version 21.

Percentage. This was used to describe the acceptability test of the super capacitor power bank in terms of functionality and time duration.

Weighted Mean. This was used to evaluate the performance of the design and development of super capacitor power bank in terms of functionality, charging rate, and durability of the gadget as observed by the respondent with the following scale and its descriptive analysis:

Scale	Weighted Mean	Descriptive Analysis
5	4.51-5.00	Strongly Agree (SA)
4	3.51-4.50	Agree (A)
3	2.51-3.50	Undecided (U)
2	1.51-2.50	Disagree (D)
1	1.00-1.50	Strongly Disagree (SD)

Standard Deviation. This was used to determine the variability on the responses or evaluations made by the evaluators on the performance characteristics of the super capacitor power and other power banks.

Chapter 4

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

This chapter presents presentation, analysis and interpretation of data that are graphically and textually presented along the statement of the problems of the study. It advances the interpretation and analyzes of the data that was treated with the aid of the appropriate statistical tools.

Performance Characteristics of the Selected Power Banks Available in the Market

Based on literatures as evaluated by the some researchers, most of the available power banks in the market are made up from lithium-ion batteries. It has a battery rating of 5000 mAh and has a charge duration and limited deliverable capacity. The deliverable capacity of the power bank is reasonably to charge the mobile phone with battery rating of 1500 mAh by two times which means that the operation of the mobile phone duration could be expected to enhance by two times approximately (Narayan, Venkateswarlu, & Jagadish, 2018). The charging duration of these power banks required 5 to 8 hours and its discharging duration was only 5 to 7 hours only.

In terms of the performance characteristics of the Super Capacitor power banks available in the market. These Super Capacitor power banks have a charging time of about 10 seconds. The self-discharge of a Super Capacitor is substantially higher than that of an electrostatic capacitor and somewhat higher than the electrochemical battery of 10,000 mAh. The stored energy of a Super Capacitor decreases to 50% in 30-40 days. A nickel based battery self-discharges of about 10 to 15 percent per month but Li-ion discharges only 5% per month.

Table 1 shows the comparison on the performance characteristics of the selected power banks available in the market with the Super capacitor power bank.

Table 1

Comparison on the Performance Characteristics of the Selected Power Banks in the Market with the Super Capacitor Power Bank

Performance Characteristics Function	Type of Power Banks	
	Super Capacitor	Lithium – Ion (General)
Charge Time	1-10 seconds	10-60 minutes
Cycle Life	1 million 0r 30,000h	500 and higher
Cell Voltage	2.3 to 2.75 V	3.6 to 3.7 V
Specific Energy (Wh/kg)	5 (Typical)	100-200
Specific Power (W/kg)	Up to 10,000	1,000 to 3,000
Cost per Wh	$20 (typical)	$0.5-$1.00(Large system)
Service Life	10 to 15 years	5 to 10 years
Change Temperature	-40 to 65oC (-40 to 149°F)	0 to 45°C (32 to 113°F)
Discharge Temperature	-40 to 65oC(-40 to 149°F)	-20 to 60°C (-4 to 140°F)

Design of the Super Capacitor Power Bank

The design of the Super Capacitor Power Bank developed by the researcher is shown below as reflected on its block diagram, schematic diagram, and PCB layout.

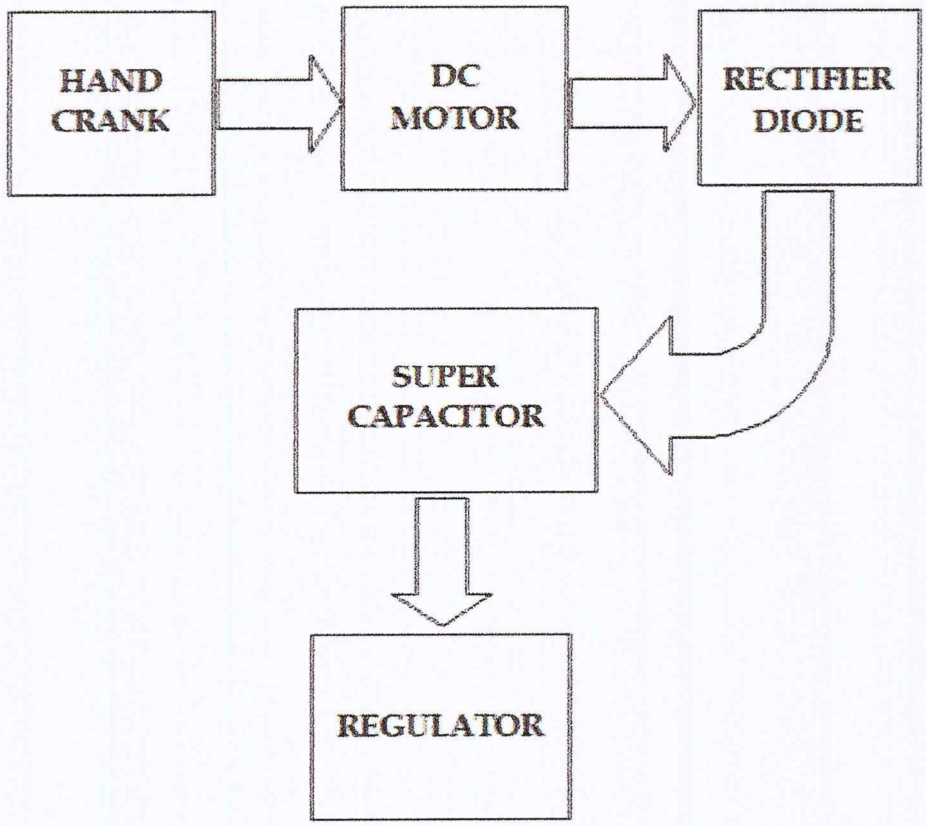

Figure 2. The Block Diagram of the Super Capacitor Power Bank

Hand Crank is the modified gear to produce 1:30 ratio of dc motor rotation that generate more voltage and charge the super capacitor when indicates as low voltages, **Direct Current (DC) Motor** generate Voltages when there's a rotation counter or clock wise **Rectifier Diode** is electronic component that will allowed the current to pass in one direction it used to fixed the polarity of voltage output from dc generator to by using a bridge diode, **Super Capacitor** is the storage of voltage has a capability to charge in a minutes and produce large amount of current, and 10 times life duration compare to battery. **Regulator** is responsible on reducing and maintaining voltages to the appropriate amount to avoid damaging of devices.

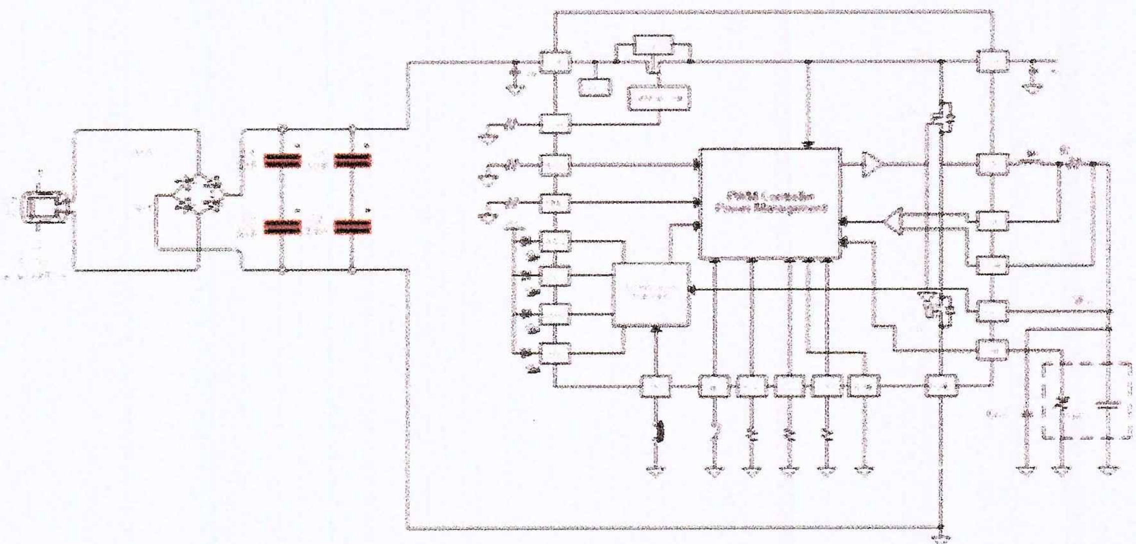

Figure 3. The Schematic Diagram of the Super Capacitor Power Bank

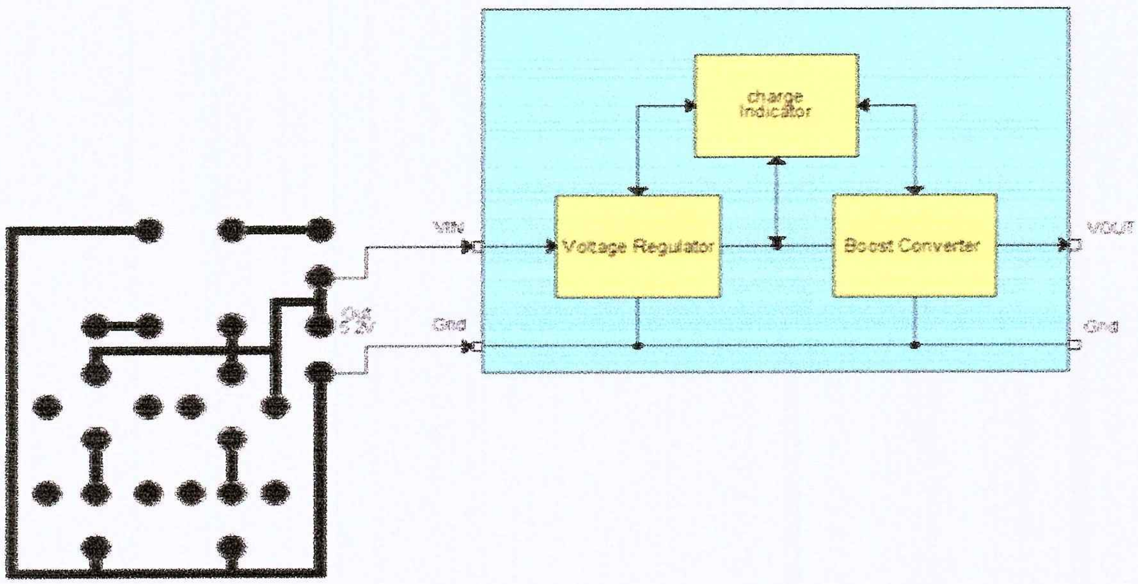

Figure 4. The Schematic Diagram of the Super Capacitor Power Bank (Bottom View)

Schematic Diagram and Bottom View

This shows the flow of the current from input to output using the different electronic components and guide for making the prototype and analyzed the flow and operation of the circuit.

In understanding the symbols of **diode**, identify first the terminal by finding the positive and negative terminal to avoid shorted of circuit. Pointed arrow represents the positive terminal and bar represents as negative terminal it used bridge type rectifier diode to maintain the output positive and negative, by using four diodes. **Super Capacitor** (C1, C2) is connected in series to add the two voltages 2.7 Volts that will sum 5.4 Volts parallel by (C3, C4) to add Capacitance value of 500 Farad when connected in series will be divided by two to obtain 1000 Farad it need four super capacitors with value of 500 Farad/2.7 Volts. **Integrated Circuit Power Management** regulate voltage to automatic increase voltages to 5 Volts dc and decrease if the voltages more than 5 Volts.

Bottom View is the lay-out in printed circuit board where in the parts are connected to right position for path of the current flow.

Development Procedures of the Super Capacitor Power Bank

The construction of the design and development of the super capacitor power bank is a systematic process, these procedure are:

1) Designing printed circuit board preparation;

2) Mounting of components into the printed circuit board, and

3) the operating procedures of the improvised gadget (super capacitor power bank.

Designing the Printed Circuit Board Preparation. The following steps in the preparation of printed circuit board using the circuit wizard simulation:

a. Prepare to open the circuit wizard and select the electronics components to the design circuit and run the simulation so it will determine if the circuit is normally operate according to the expected output.

b. Prepare the full scale foil pattern lay-out, for power supply circuit, transfer the design from circuit simulation to printed circuit board follow the diagrams bottom view. Then PCB to dissolve the copper the design in PCB will remain; wash by running water to remove the ferric chloride. Mark the holes as guide for holing printed circuit board apply a thin coat of natural varnish to avoid corrosion.

Mounting components into PCB. The following are the steps in the mounting the components of the project into the PCB:

1. Inserts and solders all the components into their respective location in the PCB, clean by lacquer thinner to avoid the short circuit.

Check all the connections:

2. See to it the connections are solder to the terminal from DC generator to the main board. All of this terminal should be wrapped with electrical tape installation.

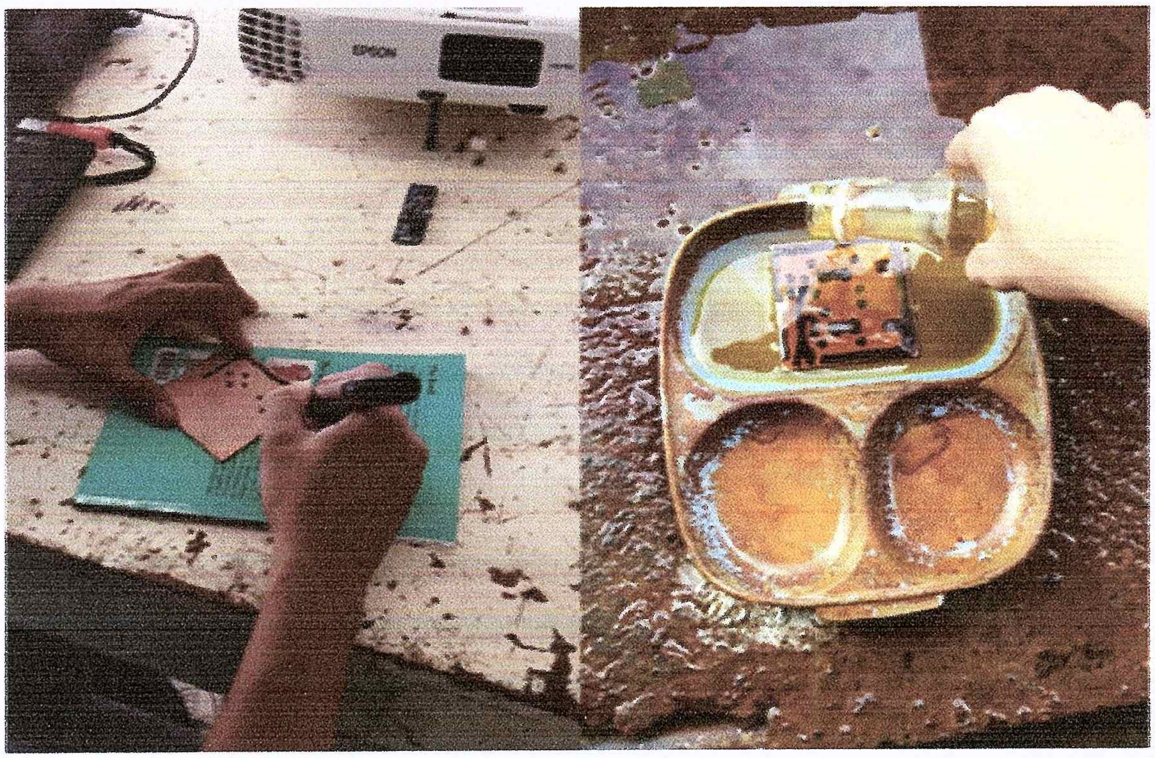

Figure 5. Lay-outing Printed circuit board and itching

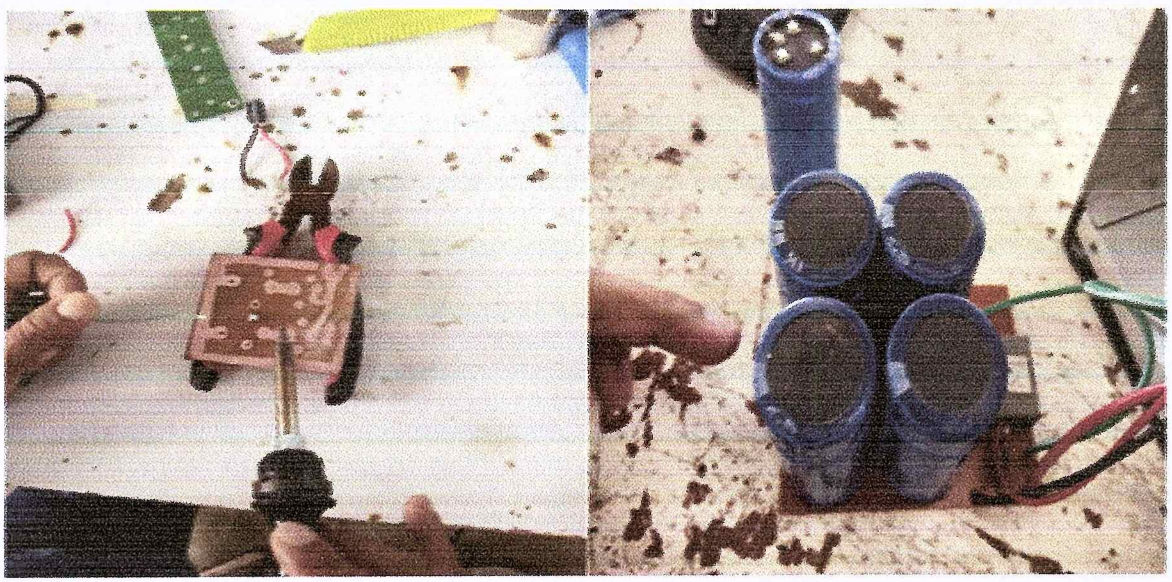

Figure 6. Printed Circuit Board Soldering and Positioning the Electrolytic Capacitor

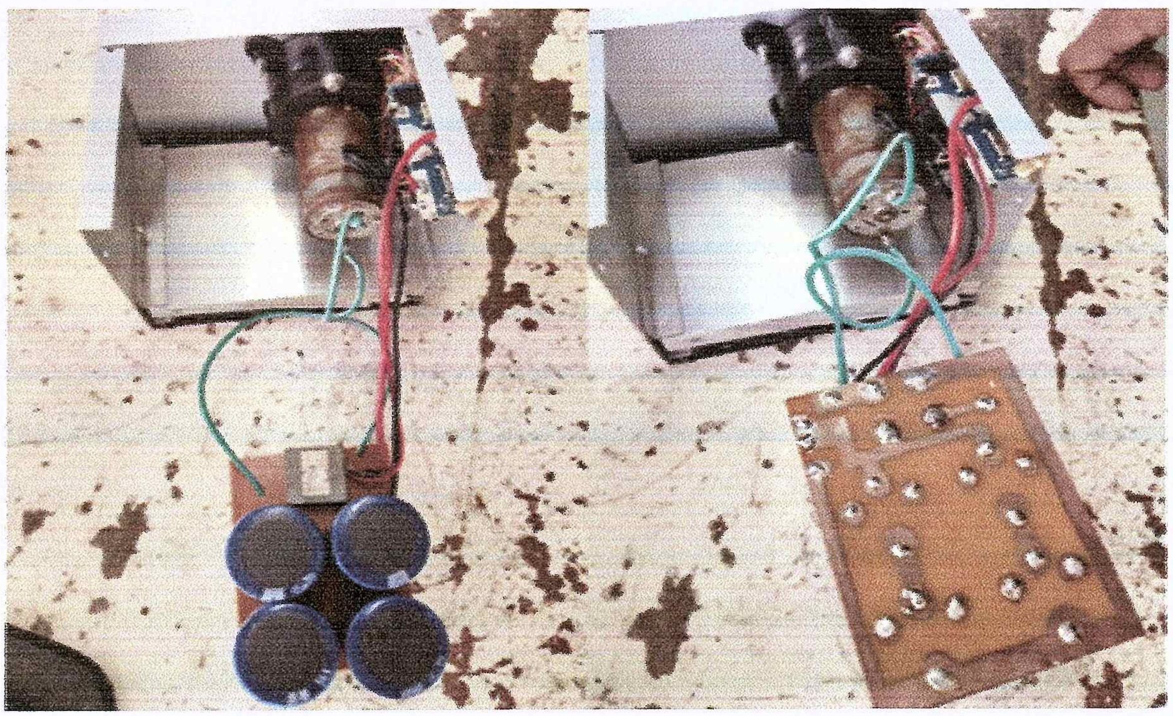

Figure 7. The Enclosure assembly

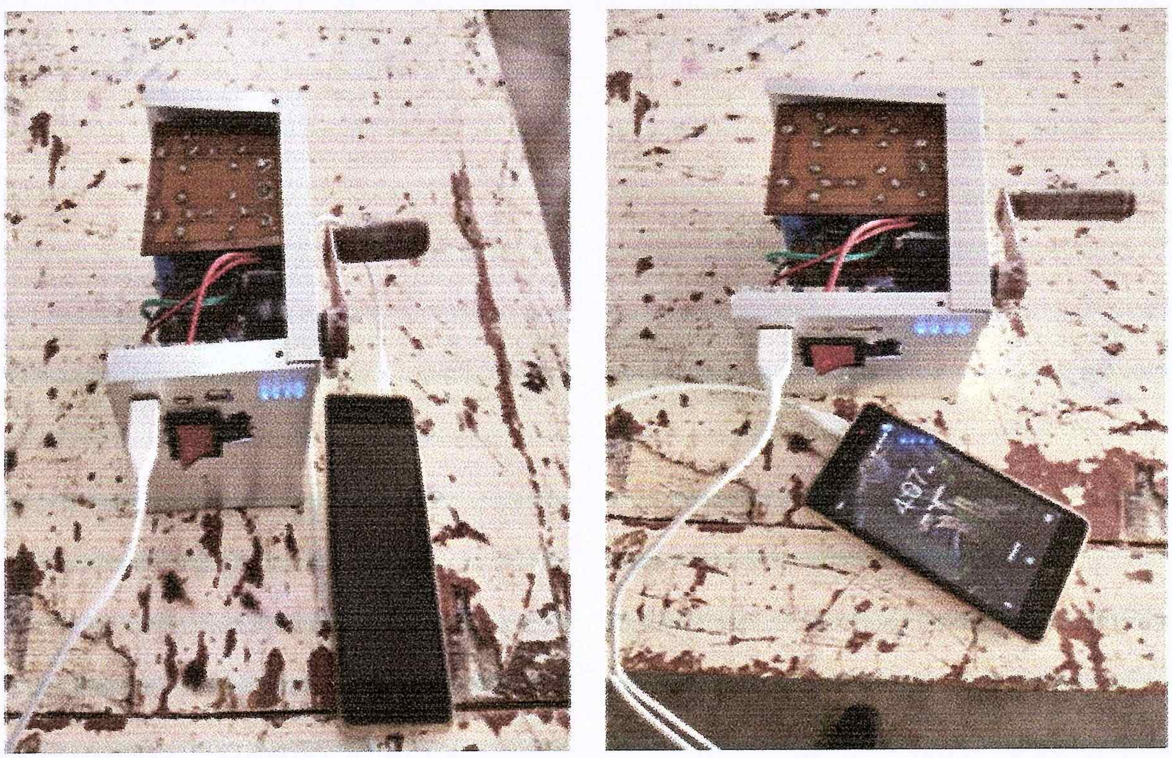

Figure 8. Initial test of completed project

3. Prepare the aluminum for enclosure assemble cut to the design length assemble the enclosure and finishing materials to the enclosure.

Operating Procedure of the Improvised Gadget. The following are the necessary steps in the operations of the gadget:

1. With the power switch ON position, connect the USB connector from cellphone to output terminal.

2. Look at to the LED indicator if it has a luminance indicate as charging.

3. Hand crank if the indicator is level of discharge

Assessment on the Effectiveness and Efficiency of Super Capacitor Power Bank

This section presents the assessment between the developed super capacitor power bank over conventional power bank in terms of functionality, charging time, durability, and cost analysis.

Functionality and Charging Time. As shown in Table 2 is the summary of the advantage of the develop power bank over conventional power bank of functionality of the gadget. It can be noted that only one major of functionality of the conventional power bank makes the developed the super developed power bank gadget quite.

Table 2

Assessment Comparison Between the Developed Power Bank over Conventional Power Bank along Functionality and its Charging Time

Developed Power Bank	Conventional Power Bank
Can charge any kind of cellular phones.	Can charge any kind of cellular phones.
Can full charge in 100% maximum of 2 hrs.	Can only charge in 66% in maximum of 2 hrs.
Can full charge 3 pieces of smart Phone.	Can full charge in a maximum of 1 pieces of smart Phone.
Can Recharge through hand cranking.	Can recharge through conventional outlet by alternating current source.

Cost Analysis. Table 3 shows the cost analysis between the developed super capacitor power bank and the conventional power bank. As can be gleaned from the table, the super capacitor power bank is little bit costly as compared to available conventional power bank in the market by P 127.00 only. However, the developed super capacitor power bank can charge more phones as compared to the conventional power bank.

Table 3

Cost Analysis between the Developed Power Bank and the Conventional Power Bank

Developed Power Bank	Conventional Power Bank
The developed power bank is more sophisticated power bank, more cellular phone to charge through hand cranking. The price of developed power bank is high about One Thousand Three Hundred Twenty Seven (P1,307) as a price list of material used.	The conventional power bank, price is less about One thousand Two Hundred (P1,200).

Level of Acceptability of the Developed Super Capacitor Power Bank

This section presents the results on the survey of the level of acceptability of the developed super capacitor power bank in terms of functionality, charging time, and durability.

Functionality. As reflected in Table 4, mostly the respondents have strongly agree on the different indicators of the super power bank such as the gadget can charge different types of cellular phones ($\dot{x}$=4.97;sd=0.183); the gadget can generate through hand cranking ($\dot{x}$=4.87;sd=0.346); the gadget can charge two cellular phones at same time ($\dot{x}$=4.80;sd=0.407); and the gadget can be user friendly device ($\dot{x}$=4.67;sd=0.547), all these weighted mean values interpreted as strongly agree. On the other hand, the indicator on the gadget can be portable to outdoor has a mean value of 3.63 which is interpreted as "agree" only. However, the overall weighted mean value on the acceptability level of the super capacitor power bank is 4.59 which is interpreted as "strongly agree". This means that the respondents have rated and perceived the super capacitors power bank with high acceptability level as compared to other power banks in terms of its functionality.

Table 4

Mean and Standard Deviation on the Level of Acceptability of the Power Banks in terms of Functionality

Indicators	Power Banks: Super Capacitor Power Bank			Power Bank 1			Power Bank 2		
	X̄	SD	Int	X̄	SD	Int	X̄	SD	Int
The gadget can charge different types of cellular phones.	4.97	0.183	SA	1.00	0.000	SD	1.00	0.000	SD
The gadget can generate through hand cranking.	4.87	0.346	SA	2.00	0.000	D	2.00	0.000	D
The gadget can charge two cellular phones at same time.	4.80	0.407	SA	2.23	0.504	D	2.23	0.504	D
The gadget can be portable to outdoor.	3.63	0.718	A	3.07	0.254	U	3.07	0.254	U
The gadget can be user friendly device.	4.67	0.547	SA	5.00	0.000	SA	5.00	0.000	SA
Over-all Mean	4.59	0.44	SA	2.66	0.15	U	2.66	0.15	U

Legend:

Scale	**Interpretation**
4.51 – 5.00	Strongly Agree (SA)
3.51 – 4.50	Agree (A)
2.51 – 3.50	Undecided (U)
1.51 – 2.50	Disagree (D)
1.00 – 1.50	Strongly Disagree

<u>Charging Time.</u> Table 5 reveals the acceptability level between the developed super capacitor power bank and the conventional power banks. As shown in the table, the super capacitor power bank resulted with the high level of acceptability of charging time for it attains weighted mean value of 5.00 (sd=0.000) which means that this super capacitor power bank has charging time 25-30%. This is also the same observation to power bank but not to power bank 2 for it obtains only of mean value of 4.00 with the standard deviation of 0.000 which means that power bank 2 has a charging time percentage of 19-24%. The data conclude that both the developed super capacitor power bank is almost comparable to power bank 1.

Table 5

Mean and Standard Deviation on the Level of Acceptability of the Power Banks in terms of Charging Time

Time Duration	Super Capacitor Power Bank		Power Bank 1		Power Bank 2	
	X̄	SD	X̄	SD	X̄	SD
1-6 minutes	1.00	0.000	1.00	0.000	1.00	0.000
7-12 minutes	2.00	0.000	2.00	0.000	2.00	0.000
13-18 minutes	3.00	0.000	3.00	0.000	2.00	0.000
19-24 minutes	4.00	0.000	4.00	0.000	3.00	0.000
25-30 minutes	5.00	0.000	5.00	0.000	4.00	0.000

Legend:

Scale	Interpretation
4.51 – 5.00	Charging Percentage of 25-30%
3.51 – 4.50	Charging Percentage of 19-24%
2.51 – 3.50	Charging Percentage of 13-18%
1.51 - 2.50	Charging Percentage of 7-12%
1.00 - 1.50	Charging Percentage of 1-6%

Durability. As a result of 7 days observation in electronics laboratory room at NwSSU the super capacitor power bank is still working in a good condition. The crank is made of steel and DC dynamo can conduct heat during charging time of super capacitor after it is full charge the super capacitor ignore the current produce by continues output of dynamo, life span of super capacitor will take 30,000 hours until meet its dying period while conventional power bank is 500 hours to end period, storage of conventional is lithium- ion, the table of comparison between super capacitor and lithium-ion below

Chapter 5

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents summary of the major findings of this study, the conclusions derived from its major findings, and the recommendations of the researcher are based on the conclusions framed by the researcher.

Summary of Findings

Based on the results of this study, the following findings were advanced by the researcher:

1. The commonly available power banks in the market are lithium-ion batteries that have limited performance characteristics because it has a battery rating of ranging 1500 to 5000 mAh only. The charging duration of these power banks required 5 to 8 hours and its discharging duration was only 5 to 7 hours only. While, the available supercapacitor power bank in the market it has a charging time of about 10 seconds and has battery rating of 5000 mAh up to 10,000 mAh. The stored energy of a supercapacitor decreases to 50% in 30-40 days. A nickel based battery self-discharges of about 10 to 15 percent per month but Li-ion discharges only 5% per month.

2. Designing the schematic diagram and making the lay-out using the circuit wizard simulation, then transfer to printed circuit board and itch using ferric chloride, marked the holes to drilled and connect the components in their respective location, connect all the wire in their corresponding terminals,

enclosure of the super capacitor power bank.

3. The different materials that used to develop the super capacitor power bank were super capacitor, DC dynamo, ACT8200 (IC), bridge diode, light emitting diode, stranded wire. Then, the super capacitor power bank can charge itself through hand cranking while the conventional power bank is need to plug-in an AC outlet to continue charging.

4. The super capacitor can full charge in 100% of maximum charging rate within two (2) hours simultaneously with the three (3) smart phones which is being recharge through hand cranking. On the other hand, the conventional device can only charge in 66% in maximum of 2 hours and can only full charge in a maximum of 1 piece of smart phone at a time by recharging it through conventional outlet from the alternating current source.

The super capacitor power bank is more durable as compared to the conventional power bank because based in the experiment conducted both devices are still working after the burning out in 24hours and 7 days and notice that its individual storage is very different in terms of their life span 30,000hours in super capacitor while in lithium is 500hours . However, in terms of cost, the super capacitor power is quite costly by P 127.00 as compared to the conventional power banks available in the local market.

5. In terms of level of acceptability of the developed super capacitor power bank along its functionality, charging time, and durability all of the given indicators as rated by the respondents were obtained a rate of "strongly agree"

which means that the developed super capacitor power bank is highly accepted by the respondents.

Conclusions

The following were the conclusions drawn by the researcher based from the salient findings of the study:

1. The available power banks in the market are made from lithium-ion batteries and some are already supercapacitors. However, it have limited performance characteristics only in terms of its power range capacity, charging and discharging rate, while, the designed supercapacitor power bank of the researcher has higher performance characteristics than the current available power banks in the market.

2. The supercapacitor power bank has its own unique, effective and efficient design as it is reflected on its block diagram, schematic diagram and PCB layout wherein other researchers can replicate or verify the work of the present researcher.

3. The component of super capacitor and power bank are available at online shop and the other material it can purchase locally. In terms of its development procedure, simply prepared the laptop open the circuit wizard simulation select components to create the schematic diagram and run the circuit if it's functioning according to expected output, and make the printed circuit

board (PCB) design, then assembles all the components and enclosure the device and test.

4. The super capacitor power bank is more effective and efficient as compared to the commercially available conventional power banks in the local market. Moreover, the developed super capacitor and power bank can charge 30 minutes to 1 hour while the conventional power bank it toke 2 hours to 8 hours to get fully charge level of battery.

5. The super capacitor power bank has high acceptability level as rated by the evaluators which means that is comparable to the existing commercially available conventional power banks in the local market.

Recommendations

Based on the salient findings and conclusions of the study, the researcher advanced the following recommendations:

1. The mechanism of hand crank model of the power bank should be improved and should be carefully design by mechanical engineer.

2. The design must be enhanced for more safety measures on the use of the device and more appealing to the end-users. Look to a storage device super capacitor and lithium-ion that internally packed into one component.

3. Improvement of the enclosure into pocket size for more aesthetic design and safety on the use of the device.

4. Further investigation on the improvement of the study will be investigated by the future researchers.

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APPENDICES

APPENDIX A

LETTER FOR THE BSIT ELECTRONICS AND ELECTRONIC COMMUNICATION ENGINEERING GRADUATE-RESPONDENTS

Republic of the Philippines
Commission on Higher Education
Region VIII
SAMAR STATE UNIVERSITY
COLLEGE OF GRADUATE STUDIES
Catbalogan City, Samar

Date: _______________

Dear Respondents:

Good day!

The undersigned is a student of the Master in Technician Education (MTE), Major in Electronics. As part of the requirements for graduation from the said degree, he is conducting a study entitled, "DESIGN AND DEVELOPMENT OF A SUPER CAPACITOR POWER BANK".

In this regard, the undersigned would like to ask favor from you to provide information relative to you and your choice of a career in the attached survey questionnaire especially for the purpose. Rest assured that your responses will be treated with utmost confidentiality.

Thank you very much and God bless.

Respectfully yours,

(Sgd.) RICHARD P. TALON
Researcher

APPENDIX B

SURVEY QUESTIONNAIRE

Part A. Respondent's Profile

Directions: Please provide the needed information by filling the blanks and by checking the appropriate answer on the space provided.

1. Name________________________________
2. Course/Year/Major:____
3. Sex: Male ( ) Female ( )

Part B. Acceptability Test.

Direction: Kindly check or fill in the space provided for relative to your evaluation of the gadget.

Scale Interpretation

5 Strongly Agree (SA)
4 Agree (A)
3 Undecided (U)
2 Disagree (D)
1 Strongly Disagree (SD)

Indicators	5 (SA)	4 (A)	3 (U)	2 (D)	1 (SD)
Functionality					
The gadget can charge different types of cellular phones.					
The gadget can generate through hand cranking.					
The gadget can charge two cellular phones at same time.					
The gadget can be portable to outdoor.					
The gadget can be user friendly device.					

Part C. Time Rate of the Device

Direction: Kindly check or fill in the space provided for relative to your evaluation of the gadget.

Scale	Interpretation
5	Charging percentage of 25-30%
4	Charging percentage of 19-24%
3	Charging percentage of 13-18%
2	Charging percentage of 7-12%
1	Charging percentage of 1-6%

Time Duration	Super Capacitor Power Bank	Power Bank 1	Power Bank 2
0 minutes			
1-6 minutes			
7-12 minutes			
13-18 minutes			
19-24 minutes			
25-30 minutes			

Thank you very much for your cooperation!

APPENDIX C

The Components of the Super Capacitor Power Bank and their Function

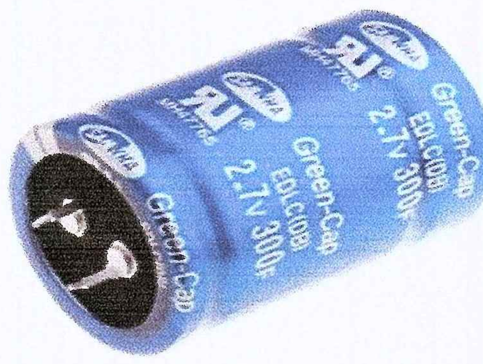

Figure 8a. The Super Capacitor

Figure 8b. Bridge Diode

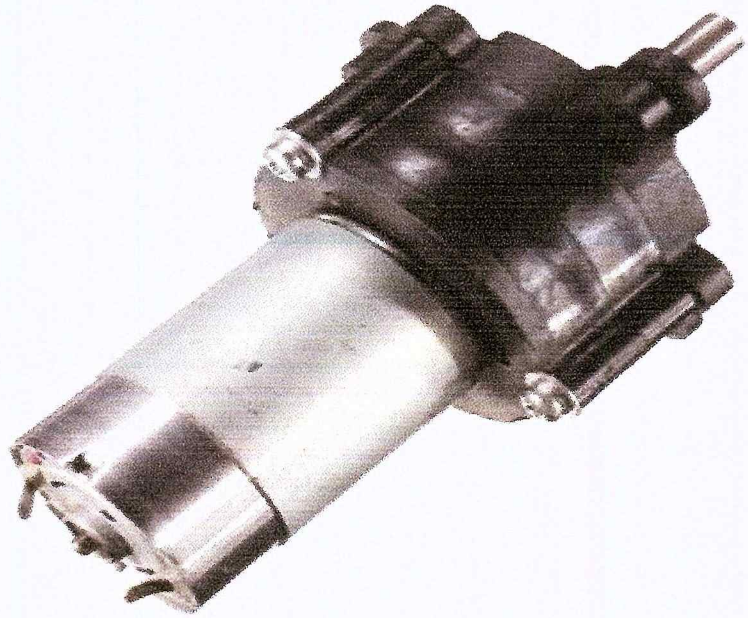

Figure 8c. DC Generator and Dynamo

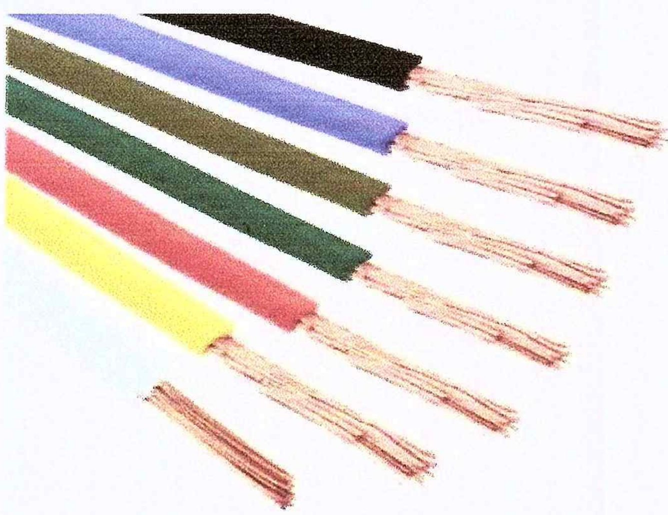

Figure 8d. Stranded Wire

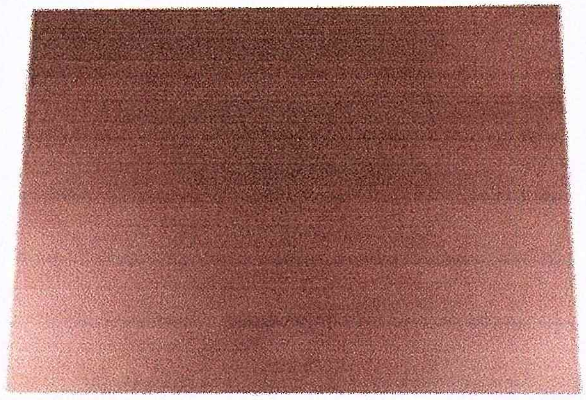

Figure 8e. Printed Circuit Board (PCB))

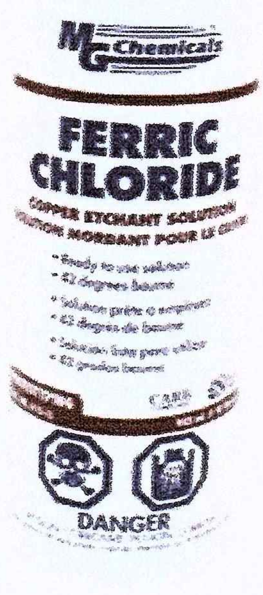

Figure 8f. Ferric Chloride

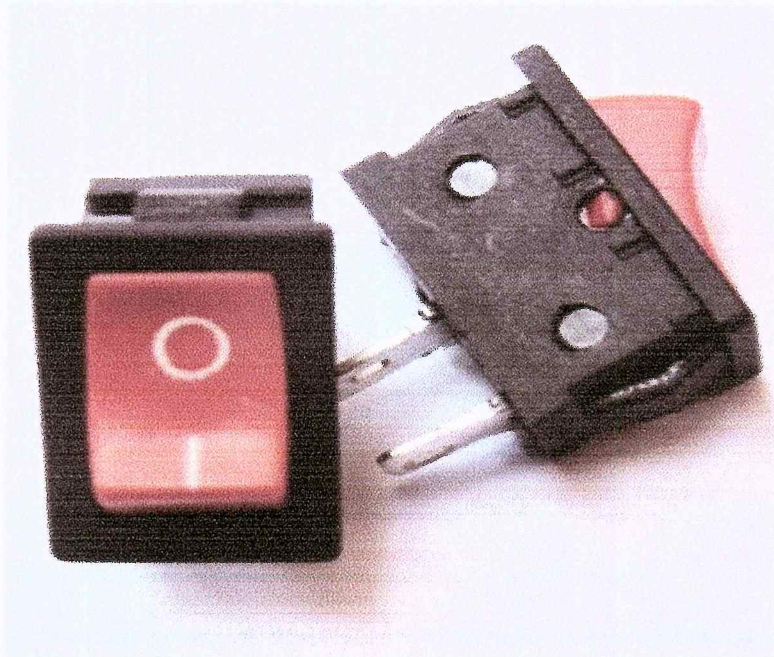

Figure 8g. Slide Switch

Figure 8h. Soldering Lead

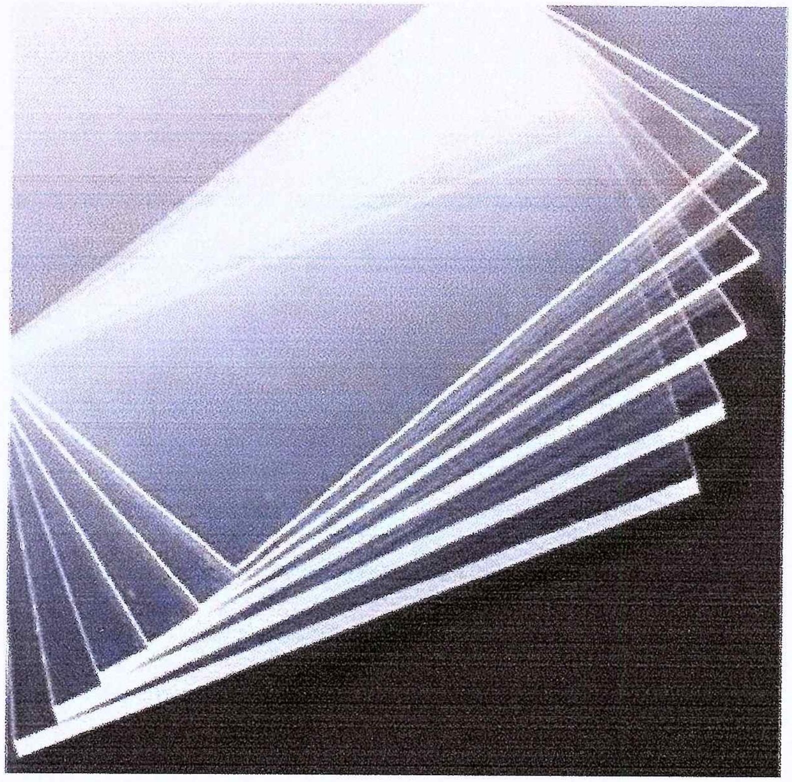

Figure 8i. Acrylic Fiber Glass

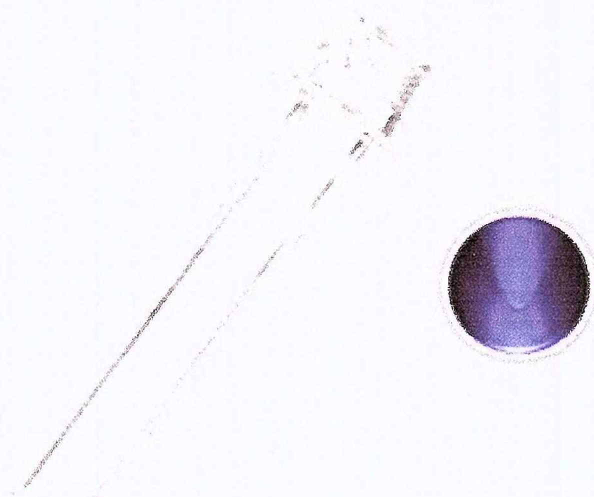

Figure 8j. Light Emitting Diode

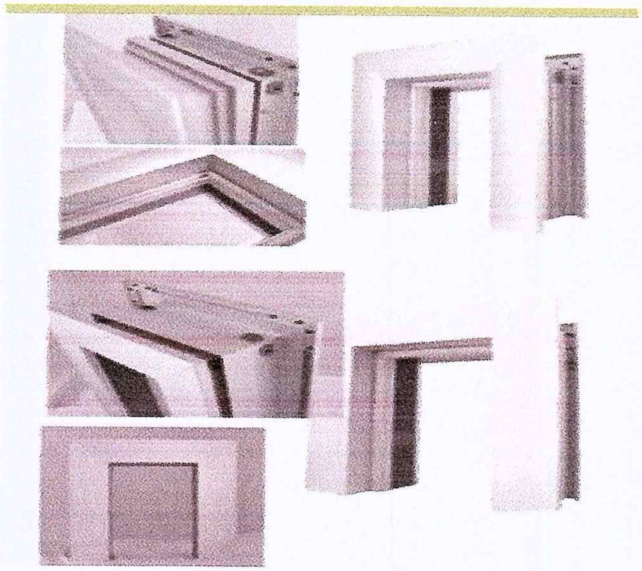

Figure 8k. Aluminum Counter Train

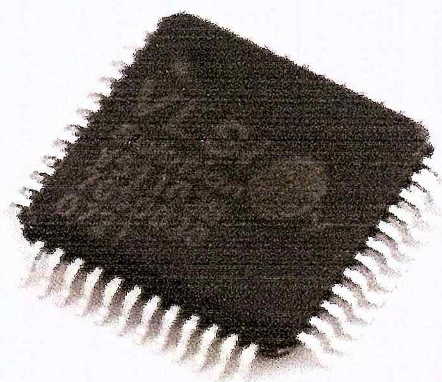

Figure 8l. IC ACT2800

Table 6 shows the complete specification as to the quantity, unit, name and description of components used in the construction of the project. Although some of the components were substituted, still it conforms to the specification of the original parts.

Table 6

List of Components on the Development of Super Capacitor of Power Bank

Quantity	Unit	Name and Description	Part Number
4	pcs	Super Capacitor 500 farad 2.7 WV	C1,C2,C3,C4
1	pc	Bridge Diode 20 Amps/100V	BR1
1	pc	DC Generator Dynamo 5-12V/1.8A	V1
1	mt	Stranded wire AWG#18	
1	PC	3"X3" PCB (Copper Clad Board)	
1	bot	Ferric Chloride (FeC12) 75ml	
1	pc	Slide Switch (NO)	
4	mts	Soldering lead 10/60	
1	pc	Acrylic Fiber glass12x12 in thickness 1mm	
4	pc	Blue 20mA Light Emitting Diode	D1,D2,D3,D4
1	pc	1 length Aluminum Countertrain 4 inches	
1	pc	IC ACT2800	IC1

Table 7 shows the different supplies and materials used in the construction of the super capacitor power bank that includes its quantity, unit, description, and its cost estimate.

Table 7

Supplies and Materials Needed in the Construction and its Corresponding Cost Estimate

Quantity	Unit	Name and Description	Cost
4	pcs	Super Capacitor 500 farad 2.7 WV	200.00
1	pc	Bridge Diode 20 Amps/100V	30.00
1	pc	DC Generator Dynamo 5-12V/1.8A	150.00
1	mts	Stranded wire AWG#18	18.00
1	pc	3"X3" PCB (Copper Clad Board)	30.00
1	bot	Ferric Chloride (FeC12) 75ml	30.00
4	mts	Soldering lead 10/60	40.00 15.00
1	pc	Acrylic Fiber glass12x12 in thickness 1mm	40.00
4	pc	Blue 3v, encapsulated	6.00
1	pc	length Aluminum Counter	20.00
1	pc	ACT2800	150.00
		Total Cost	**1, 307.00**

Table 8 presents the different tools and equipment used by the researcher in the construction of the super capacitor power bank.

Table 8

Tools and Equipment Used in the Construction of the Project

Tools and Equipment	Functions
Tools	
Phillips screw driver	Loosening, and tightening
Standard screw driver	
Long nose pliers	Bending component leads,
Soldering iron	Melting the lead joint the terminals.
Slip Joints Pliers	Holding screws, driving nuts and cutting.
Mini Drill	Boring and drilling holes to the PCB.
Equipment	
Multi-Tester	Checking resistance, voltages, and currents

APPENDIX D

CURRICULUM VITAE

PERSONAL BACKGROUND

Name	:	RICHARD P. TALON
Birth Date	:	January 4, 1984
Birth Place	:	Almagro Samar
Age	:	33 years old
Civil Status	:	Married
Citizenship	:	Filipino
Home Address	:	Brgy. Rawis, Calbayog City
Parents	:	Garido P. Talon +Lucrisia P. Talon
Email Address	:	ricotalon1@gmail.com
Contact #	:	09951209242

EDUCATIONAL BACKGROUND

Elementary	:	Bacjao Elementary School Brgy. Bacjao, Samar
Secondary	:	La Milagrosa Academy Calbayog City
Tertiary	:	TiburcioTancinco Memorial Institute of Science and Technology Calbayog City
Course	:	Bachelor of Science in Industrial Technology
Major	:	Electronics

LANGUAGE SPOKEN

Waray, Filipino, English

WORKING EXPERIENCE

2007-2009
Electronics Technician Sony

2009-2013
Talon Electronics Shop Owner/Technician

2014-2015
Part time Lecturer, Northwest Samar State University, Calbayog City

2015-Present
Temporary Instructor, Northwest Samar State University, Calbayog City

TRAININGS / SEMINARS ATTENDED

Training and orientation at hytech power incorporated
Novaliches, Sabarte St.
Green power orientation and research development presentation PACUIT
April8-12, 2017

Guide to research and innovation PAITE
Manila Grand Hotel
Sta. Cruz, Quiapo, Manila
April 22-26, 2017

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