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Development and acceptability of multifunction survival off-grid power generating device (MGSOGPGD)

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Abstract: With the advances of technology and growing demand of sustainable energy and to address the needs of devices that can work during emergency because Philippines always suffer from natural catastrophe as well as for survivability during crisis, long travels, camping and search and rescue missions. This study constructed a multi-function survival off grid power generating device abbreviated as MSOGPGD. Using nominal test loads to test and measure every feature and specification of function, and parameter as well as its functionality, reliability, maintainability, usability, and performance. This developmental research employed two different activities such as direct observation and evaluation to target users: five (5) of them were DRRM practitioners, 15 electrical engineers/professors/instructors and 40 target users were chosen randomly. The motor generator delivers enough voltage to power up small electrical appliances such as lightings, radio, and cellphone chargers. The motor generator has a maximum of 50-60 watts output generation which already enough power to power up necessary gadget and appliances during emergency situations. The regulated DC output was stable enough to power up to maximum of 75 watts. The battery connected variable DC supply was operational from 1.2 volts up to 32 volts. The battery rating was 15,000mAH and can charge cellphone two times before it runs out of power with additional feature of flashlight and lighter/igniter functions properly and readily available. MSOGPGD gains a positive response from the randomly selected target users in which MSOGPGD was "Very Acceptable" in terms of design, composition, safety, and operating performance. Although the built-in generator generates less power than expected it still performs the operations which it intended to during emergency situations as DRRM personnels reiterated and very useful in life and death situations. It was also suggested that if it is mass produced it will help people during calamities and search and rescue operations and help to survive in harsh situations.

Keywords: Power generating device, Hand crank, Emergency device, Off-grid device, Emergency power generator, Survival charging device

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INTRODUCTION

"Necessity is the mother of all inventions," said the great philosopher Plato. In the advent of time, humans made and constructed things for their survival, but later they were made to live in comfort, and human works became fast and easy. However, when the world revolutionized with new things, it became a long-term problem rather than a solution. The industrialized world led us to a polluted and manmade catastrophe. As harsh as it sounds, there is no other way to make the situation go back to where it started. People cannot take away the fact that because of industrialization, the Earth is at risk, and one of the problems is global warming and pollution. As such, it has become a trending global issue in the 21st century, resulting in major problems and global catastrophes like climate change and natural disasters such as strange typhoons and flash floods with just a short rain.

Nowadays, everything is so expensive that, somewhat, people cannot afford things and daily necessities as well as devices that can be used during emergencies and survivability during natural calamities and disasters. Machines and tools that use gasoline or crude as fuel cost much, emit CO2, and require high maintenance, which adds up to air pollution and contaminates water reservoirs. With the advent of battery-operated machines, vehicles, tools, gadgets, etc. were now a trend to help alleviate this problem, and many inventions focused on charging them in non-pollutant alternatives like solar panels, wind, and water driven. However, during emergencies like typhoons, flash flooding, and earthquakes, people can only rely on themselves in order to survive. Having electronic communication devices that use batteries eventually drained their batteries out and just died, resulting in them not being able to be used in the meantime. Likewise, in off-grid places like camping and evacuation areas, there is a tendency for people to need a portable power-generating device that could charge the battery and provide lighting, giving ample power to operate necessary equipment and appliances during an emergency. Electricity is a necessity and is highly in demand. Other people switch to solar panels and live off grid, but only those who can afford it, since it is so expensive and unsustainable at night and depends only on sunlight. A wind-powered device may be effective, but it needs sustained winds to rotate the blade, and hydropower may also be effective, but not in the drought season.

Due to the problem the Philippines is facing nowadays, which always suffers many calamities and natural disasters all throughout the year due to climate change, Moreover, during emergency cases, except for water, food, and clean air, it is more important to prepare yourself. To survive, each family or individual should have an emergency kit that has to be customized to meet specific needs. To survive, you need to have a dispensable tool or device that will help during a life-or-death situation. Likewise, during camping and off-grid places or search and rescue operations in far-flung places, electricity is not available, but since communication is important as well as lighting, you need to have at least a tool or device that could charge if the battery hits low and produce light at night. Since a backup battery or power bank can only be used for a moment and after it drains out, it will not be usable, and if an emergency hits during the night, you need at least a flashlight, and if it's a cold night, you need to at least light the fire without too much effort. This MSOGPGD was materialized to help common people survive when disasters strike.

Statement of the problem

The primary purpose of this study was to develop a Multifunction Survival Off- Grid Power Generating Device (MSOGPGD).

Specifically, it aimed to achieve the following:

1) Find out the features and specifications of MSOGPGD in terms of generating AC voltage output (with load and without load), variable regulated DC power supply output, battery source variable DC power supply, USB charging, torchlight luminosity, and HV lighter/igniter.

2) Determine the load capacity of variable-regulated DC directly connected to the built-in generator using the necessary test load used in emergencies, traveling, and camping.

3) Determine the built-in battery charging with the use of a built-in power charging generator and an electric grid power source and the discharging time using a test load used in emergencies, traveling, and camping.

4) Determine the acceptability of MSOGPGD in terms of design, composition, safety, and operating performance.

METHODOLOGY

Research design

The study employed a developmental research design to create and evaluate a Multifunction Survival Off-Grid Power Generating Device (MSOGPGD). This approach integrated various innovative ideas and technologies to develop a portable device capable of generating power in off-grid scenarios. The focus was on designing a device suitable for emergencies, capable of powering small appliances and gadgets, and providing lighting, communication, and ignition functions.

Locale of the study and respondents
The study was conducted at the electronics laboratory of Capiz State University, Main Campus, Roxas City. The respondents consisted of 60 evaluators, including five disaster risk reduction and management (DRRM) practitioners, 15 engineers and electrical technicians, and 40 randomly selected target users such as students and entrepreneurs. These participants provided critical insights into the device's design, functionality, and acceptability.

Research instruments
The research utilized observation sheets and evaluation forms to gather data on the device's performance and acceptability. The observation sheets measured parameters such as voltage output, load capacity, battery performance, and functionality during pilot testing. The evaluation forms, validated by experts, assessed the device based on design, composition, safety, and operating performance using a Likert scale. Additional tools like multimeters, stopwatches, and digital displays were used to record accurate measurements.

Data analyses procedure
Data analysis involved the use of descriptive statistics, including mean computations, to evaluate the device's performance and acceptability. The parameters such as voltage output, battery discharging and charging rates, and usability were recorded and analyzed based on observation and evaluation results. The data were interpreted using weighted means and verbal interpretations for each criterion, ensuring a comprehensive understanding of the device's functionality and user satisfaction.

FINDINGS AND DISCUSSION

Features and specifications of MSOGPGD in terms of AC voltage generation

The features and specifications of MSOGPGD in terms of generator voltage output are presented in the date. The result was separated based on the working parameter, such as without load and with test load. The test load used was a 110/240 VAC/13 watt LED bulb and a 110/240 VAC/110 watt cellphone charger with rotation per minute (RPM) set to 200 rotations and rotated for 5 minutes. The rotation per minute was based on how fast the user rotated the shaft of the generator using hand cranking only. The result has been observed for three (3) trials: in Trial 1, the device generates 244 VAC at 700 Hz without load but becomes 219 VAC at 100 Hz when the load is applied; in Trial 2, it generates 245 VAC at 722 Hz, but when the load is applied, it becomes 218 VAC at 101 Hz.

Moreover, in Trial 3, the output was 244 VAC with a frequency of 725 Hz, but when the load was applied, it became 218 VAC with a frequency of 100 Hz. The mean voltage during trials was 224 VAC with 715 Hz when the generator had no load, but it became 218 VAC/100 Hz when the test load was applied. This means that the generator has enough voltage and frequency to operate test loads, but it may not be as good as grid electricity, but it can still deliver good AC voltage to make the load functioning. The

maximum wattage that can be accommodated by the generator based on the specifications from the market was at a maximum of 50 watts which means it cannot accommodate appliances with higher wattage than the generator itself. However, the device was not effective to appliances with transformer as their main source of power supply as it was hard to rotate the generator which also includes the devices that uses another motor.

According to Miller, et al. (2017) power frequencies as high as 400 Hz are used in aircraft, spacecraft, submarines, server rooms for computer power, military equipment, and hand-held tools. Such high frequency is usually confined to a building or vehicle which was convenient and lighter which was also advantage in the device which uses small generator that can be transported without affecting electronic appliances such as transformerless power supplies, gadget, and appliances but it was not ideal in inductive and resistive load such as motor and heaters as they reiterated.

Features and specifications of MSOGPGD in terms of DC variable regulated power supply

According to the working parameters of the variable regulated DC to DC buck converter and booster from its manufacturer and during pre-testing before installation, the working voltage of the power supply conformed to the specified specifications provided by the manufacturer, in which the working input voltage was 6.5 volts to 36 volts DC and the output voltage was set to 1.2 volts to 12 volts DC with an output current of 5 amperes, and the maximum power was 75 watts.

This means that users can conveniently plug in any devices or gadgets that use these voltage and current ranges. The digital display precision was plus/minus 0.1 V, and the voltage resolution was 0.05 volts with a current display range of 0.00–5.00 amperes. The conversion efficiency was 94%, and when used as a DC-generating power supply, the discharge rate was 0.05 per second. However, when a built-in generator is used to power up, the user needs to rotate it for 1 minute to charge the circuit because it still charges up the super capacitor. This super capacitor was used as a leverage battery so that when the user is tired of rotating the generator, there will be enough charge to power up the gadget attached to the MSOGPGD.

Moreover, it was also designed to be used as a common power supply if the need arises since the power supply is also attached to an AC input. With an output current of 5 amperes and a regulated voltage, it can do a wide range of tasks. According to Suryanarayana and Sudhoff (2016), DC power supplies are traditionally used for telecommunication and charging. Depending on the application, they were dependent on the current they produced to perform a specific task. With the significant advances in power electronics, the sophistication of power supplies was also part of it, and with different methods of construction, they could be varied and produce different power output voltages and currents that were beneficial to the user's needs.

With a super capacitor attached to the circuit, it also helps to maintain and stabilize voltage and slowly charge the super capacitor with a discharge rate of 0.05 volts per second, which means the variable regulated power supply can still deliver power until the super capacitor drains, which helps alleviate the user's tiredness of rotating the generator. The variable power supply also has a digital output display to visualize the voltage and current present in the circuit, which also helps the user accurately pinpoint the voltage and current they need to use for a variety of tasks without damaging the gadget or appliance they are attaching.

Features and specifications of MSOGPGD in terms of battery-sourced variable regulated power supply

According to manufacturer criteria and parameters, the working voltage of the module should not be lower than 3.8 volts or higher than 32 volts, or else the lifespan of the circuit components will be reduced. The boost converter was connected to a rechargeable 3.7-volt lithium-ion battery, and then it could boost DC output from 1.25 volts up to 32 volts. This boost converter is a DC-to-DC converter designed to step up the conversion of applied DC input. Although the battery was available, the other gadgets voltage needs were not suitable if they required a lower voltage; likewise, other appliances also require much higher voltages than those produced by the battery.

This device also provides a digital voltage display output for the users to see the changes in voltage when they select the suitable voltage they need in any applied appliances. The current was not displayed because it was designed to deliver constant current based on the manufacturer's specifications with more or less than three (3) amperes. A heatsink was also installed in the main component of the device, such as the buck converter regulator, to dissipate the heat if it was used for longer periods of time. This will ensure a longer lifespan and improve conversion efficiency since when the component is heated, conversion efficiency also decreases, resulting in inefficient power delivery to the load (Ramanath, 2022).

Features and specifications of MSOGPGD in terms of USB charging

The charging was done in three (3) trials, with the initial charge of the cellphone set at 15% as per the cellphone manufacturer’s advice that, to prolong the life of their battery, users should not drain the battery to 0%. Before the observation of every trial, the researcher and observers ensured that the built-in battery installed was on 100% charge, and after that, the cellphone was discharged again to 15% of the remaining charge, then it was plugged again into the device for the remaining charge available during the previous charging. The calibration of the display output from a battery charge was also done to ensure the consistency of the result since this was the first step to ensure that the display output conforms to the battery charge. The result of the first trial is that it takes about 7 hours and 27 minutes to fully charge the cellphone battery with 53% remaining charge, and the second charge takes up to 7 hours and 31 minutes with a remaining 18% battery charge. In the second trial, it took 7 hours and 43 minutes to fully charge the phone with 49% remaining charge, and the second charge took 7 hours and 33 minutes with a remaining charge of 16%.

In the last trial, it took up to 7 hours and 55 minutes with a remaining charge of 57%, then 7 hours and 42 minutes to fully charge the cellphone with a remaining charge of 13%. The average charge was 7 hours and 42 minutes with an average remaining charge of 53%, and the second remaining charge took an average of 7 hours and 35 minutes to fully charge the cellphone with 16% remaining charge. This was normal under certain conditions since the device was not designed for fast charging. The result implies that you can charge your phone twice.

Features and specifications of MSOGPGD torchlight luminosity

The data shows that there were only two torchlight settings since the strobe setting of the torchlight was hard to determine since the luxmeter was also unable to identify the correct value. Since it can produce the same results as a real luxmeter, the luxmeter in use was a downloadable application, according to electrical engineers. For a low light mode with an initial distance of 1 meter, it was observed that there was a record of 116 lumens and that it was visible to a maximum distance of 35 meters with 32 lumens. This lumen was considered enough to be visible for reading and everyday tasks, but in high light mode with an initial distance of 1 meter, 736 lumens were recorded, and it was visible up to 40 meters with 96 lumens, which is enough for night walks and camping.

However, the recorded value may not be enough to use during search and rescue operations, but it has enough light to help people see in the dark. With three modes, users can select an option of lighting helps people see in the dark. With three modes, users can select an option of lighting, and they can use strobe light mode during rescue operations. Moreover, the duration for use when using low light mode was 12 hours and 36 minutes, and for high light mode it was 10 hours and 43 minutes. The difference in time duration of use was due to the additional power consumed by the LED when the setting was in full blast.

Features and specifications of MSOGPGD high voltage lighter/igniter

The data shows the result during three (3) trials, and it was measured in seconds. The study used different combustible materials to simulate emergency cases or scenarios during calamities which these selected materials were readily available if needed. It uses materials such as cardboard, paper, wood, and dried leaves. When the cardboard was ignited, it takes 6 seconds during the first trials, and it takes up to 7 seconds during the second trials and 5 seconds during last trials with an average of 6 seconds. The changes in duration of ignition were also determined by the area where the carboard is lit up since there were parts that were too thick and thin.

When paper was ignited, it only took up to 3 seconds for the first trial and 4 seconds for second and third trials with an average of 3.66 seconds. This was because paper was thought, and the most combustible materials used in this research. When the wood was used for ignition, it takes about 15 seconds to ignite for the first trial and 22 seconds to ignite the second trial and 18 seconds for the last trial with an average of 18.33 seconds this result was only normal in each situation since wood was thicker than any other materials and partially combustible. The last material used was dried leaves which were perhaps most readily available anywhere and during the first trial it takes about 10 seconds and 9 seconds for second trial and 11 seconds for the last trial with a mean of 10 seconds. This varied time affects where the part of leaves has been ignited.

The load capacity of variable DC of MSOGPGD directly connected to the built-in generator without battery

The load capacity of variable DC directly connected to the built-in generator without battery was listed using different loads with different voltages and wattages. This was to test whether the built-in generator provides stable DC voltage for different appliances or loads. Since the generator only provided 50 watts of power, the appliances selected were lower than the power rating of the generator. It was also selected based on the most important devices and appliances during emergency situations, such as lighting and communication. The result was that when the generating devices rotated for five minutes without load and were set at 12 volts DC, it took up to 48 seconds for the first trial, 55 seconds for the second trial, and 50 seconds for the last trial, for an average of 51 seconds. The voltage was regulated at 12 volts when the generator was rotating, but when the rotation stopped, there was a sloping discharge rate of 0.5 volts per second. Likewise, for a lower wattage test load, there was a discharge rate of 0.05 volts per second when the load was applied, but much faster by a fraction of a second.

When the LED bulb with a rating of 12 volts with 12 watts was connected there was 20 seconds discharge rate, and 22 seconds during second trial and 19 seconds during last trial with an average of 21 seconds and there was a stable voltage of 12 volts but after the rotation for 5 minutes the discharging takes place, and it was also found out when 12 volts 5 watts LED bulb was connected but much lower discharging time, during first trials it was observed that it has 41 seconds until it dies of and 45 seconds for second trial and 50 seconds for last trials with an average of 45 seconds this result is normal under certain conditions since the second LED bulb used was of lower wattage than the first LED bulb. The next device applied was a small e-fan with a rating of 12 volts and 18 watts. It takes 23 seconds for the first trial, 22 seconds for the second trial, and 20 seconds for the last trial with a stable voltage of 12 volts.

The last device tested was a lower voltage 5 volt and 5-watt radio receiver, with an 85 second discharge rate for the first trial, 135 seconds for the second trial, and 150 seconds for the last trial, for an average of 143 seconds. The user can still listen to news and important information after cranking when the user gets tired; this means that it can be used during emergency situations when calamity strikes even if the built-in battery has a low voltage. The last device tested was a small e-fan with a rate of 5 volts and 5 watts. It takes up to 90 seconds to discharge in the first trial, 100 seconds during the second trial, and 99 seconds for the last trials, for an average discharge rate of 96 seconds. The temporary storage of power charge was designed if the user ever got tired of rotating the generator. Since the generator was designed to deliver voltage to the variable regulated DC power supply as well as the battery charger consecutively, it is controlled by a switch separately. The user can do two tasks separately by providing a stable power supply voltage as well as charging the battery.

Built-in battery charging time with the used of electric utility and built-in power generator

The initial charge of the battery was only 1% for two sources of electricity for AC input. It takes 7hours and 36 minutes during the first trial, 7 hours and 45 minutes in second trial and 7hours and 33 minutes in last trial with an average of 7 hours and 37 minutes with 14% charge per hour. When it switches to built-in generator it takes up to 9 hours and 28 minutes to fully charge for first trial, 9 hours and 33 minutes for second trial and 9 hours and 33 minutes for last trial with an average of 9 hours and 28 minutes with an average of 10% of charge per hour.

Moreover, it can be interpreted as 1% per 6 minutes of rotation from generator. The charging rate of different source has a large time gap in the duration of charging it may be because the built in generator delivers minimal wattage to the power supply converter to charge the battery while with electrical utility it retains its normal operation. This result was seemed average under normal conditions since the device was not designed for fast charging like a new technology trend and if ever the device been installed with this technology the price will be much higher compared to normal materials applied.

Moreover, battery was rated at 15,000mAH as per manufacturers parameters and specifications, with the battery rated 1,500mAH per battery and parallel connected to produce much higher ampere-hour output, this battery was delivering 1.5 ampere per hour for a single battery. The built-in power supply that charges the battery and provides DC supply to the system when connected to electric utility input delivers at least 2.5 amperes and with built-in generator it delivers at least 1.5 ampere. Moreover, it was advisable to as a rule of thumb, lithium-ion or lithium- polymer battery packs were recommended to be charged at about 10 to 20 percent of remaining capacity. Good lithium-ion rechargeable batteries generally have extensive protection and/or monitoring circuitry within the battery pack to prevent full discharge/overcharge and explosion (Shi, et al., 2018).

Built-in battery discharging time when tested in deferent necessary appliances and gadgets used during emergency situations

Since the device was design for the purpose of emergency scenarios and travels the appliance and gadget tested were selected in accordance with the necessary uses like LED bulb for lighting, fan small e-fan for heat dissipation and radio receiver for communication or listening to any news or information. The initial charge of the battery is 100% fully charge before testing and the first item been tested was LED bulb with a rating of 12 volts / 12 watts and it last up to 5 hours and 6 minutes to fully drain the battery for the first trial, 6 hours and 1 minute for the second trial and 6 hours and 6 minutes for the last trial with a total mean of 6.07 hours. The next appliance tested was LED bulb with 12 volts 3 watts rating and it takes up to 20 hours and 31 minutes for the first trial, 21 hours and 36 minutes for second trial and 20 hours and 1 minute for the last trial with a total mean of 20 hours and 13 minutes. When tested to small e-fan rated with 12 volts 15 watts, it takes up to 6 hours and 30 minutes for the first trials, 6 hours and 10 minutes for second trial and 6 hours and 15 minutes for the last trial with a total mean of 6 hours and 18 minutes until the battery drains out.

When the battery was tested with radio receiver rated 5 volts / 5 watts it takes 10 hours and 33 minutes for the first trial, 10 hours and 6 minutes for second trial and 10 hours and 22 minutes for the last trial with a total mean of 10 hours and 20 minutes continuous operation until the battery fully drains. Moreover, when the device was tested the last item which was small e-fan rated as 5 volts and 6 watts, it last up to 8 hours and 31 minutes for the first trial, 8 hours and 31 minutes for second trial, and 8 hours and 43 minutes for the last trial with a total mean of 8 hours and 35 minutes until the battery fully drains. These results mean that the higher the voltage and wattage the faster the battery drains and when the battery was used for lower rated voltage and power it lasts longer. This means that when the emergency strikes and the device was fully charged, it was helpful to users since it can be used for a longer period of time using necessary appliances during emergency.

Acceptability of MSOGPGD in terms of design

The result shows that MSOGPGD design was “Very Acceptable” when tested under normal conditions with a mean of 4.48. Then MSOGPGD was operational and always accessible when required for used with a mean of 4.75. MSOGPGD also operates as intended despite the presence of commercial products with a mean of 4.42. It can also be used effectively and efficiently in any emergency with a mean score of 4.42. Lastly, MSOGPGD can be controlled appropriately, operates, and use with proper label as intended with a mean score of 4.48. The overall Mean score of MSOGPGD in terms of design was 4.51 interpreted as Very Acceptable.

According to Dimitrios et al. (2019), every appliance is designed according to client’s preferences and needs, fulfilling every client's preference means that the appliance can always be bought. This includes the user’s friendly design, aesthetics, proper labeling and can always be understand and available for use. This statement of Demitrios was been a baseline of the design of MSOGPGD for innovation and development since the end users were the one who use the product so the design should be attractive and functional as it is and can always be use and operate in any giving situation and always can perform various task that the users’ needs.

Acceptability of MSOGPGD in terms of composition

The evaluation result shows that all the statement listed were all “Very Acceptable” which means that MSOGPGD system and connection covers all specific task with a total mean of 4.60, it also provides precise display output voltage and current result using Digital Display System and was designed accessible to user with display accuracy with a mean of 4.58. MSOGPGD can provide varied voltage output and was composed of precise and functioning component that accomplished specific tasks and also functions according to its intended purpose including parts and outputs with both of statement has mean of 4.65 and lastly, it provides desired service delivery of intended output of MSOGPGwith a mean of 4.57. The overall mean was 4.61 which means MSOGPGD was “Very Acceptable.” In the study of Patel and Deshpande (2016) overall equipment effectiveness in the composition of materials is one of the performance evaluation methods that are most common and popular in the production industries.

Overall Equipment Effectiveness (OEE) plays a vital role where performance and quality of the product are of importance to the customer needs and preferences. The OEE is intended at minimizing the breakdowns, increasing performance and quality rate, and thus improving the effectiveness of the machine/system. The availability rate of the machine composition, performance rate of the machine and quality rate of the products are considered as main parameters for maximizing the Overall Equipment Effectiveness (OEE) of product. It is found that poor composition of materials in the device affects the quality of the product. Good composition indicates of each product yield improved consumers satisfaction, improved quality, improved efficiency, reduced downtime, improved quality outputs, reduced turnover, and operating performance. This was the baseline of the MSOGPGD in selecting best quality materials for operation to improve the quality and performance to make sure that users satisfy in the performance and operation of MSOGPGD.

Acceptability of MSOGPGD in terms of safety

The results further show that MSOGPGD, in terms of safety, was "very acceptable," as shown with their mean score results. Moreover, MSOGPGD could be easily and safely cleaned and stored when not in use without harming its users, with a mean of 4.65; it also provided the desired functions of a monitoring system for power, voltage, and battery capacity with proper labeling and warnings, with a mean of 4.70. MSOGPGD functioned using a detachable drive shaft and could safely assemble and disassemble without problem, with a mean score of 4.50. It also interacted with the user using the user’s friendly interface for safety, proper labeling, symbols, and warnings, with a mean score of 4.55. It can also be operated in any environment with a mean score of 4.53, and lastly, it can be safely operated and used by all people with different walks of life and a range of characteristics and capabilities without harming them with a mean score of 4.57. The overall mean of 4.58 shows that the device was "very acceptable."

These results comply with IEC 60335-1 (Stull, 2020), an international standard that addresses the general requirements for electrical and electronic household appliances and similar applications. The standard covers devices with rated voltages up to 250 V for single-phase and up to 480 V for multi-phase. Devices that were once relatively simple machines now include a variety of electronic circuits enabling graphic displays, wireless communication, software interfaces, and other features which all factor into the overall safety of the product. This international safety standards are the baseline of fabrication of MSOGPGD that it was designed for the safety of the users. Moreover, the chassis was also designed for proper insulation to avoid leaking current and it makes sure the MSOGPGD will not harm the user since it was made of PVC which acts as insulator and very durable, heat and water resistant and lightweight.

Acceptability of MSOGPGD in terms of operating performance

The result shows that all the statements were “Very Acceptable” and the operating performance of MSOGPGD satisfies the users. This criterion was crucial, and the evaluators were then shown the observation report that transpired for the whole duration. This was to ensure that the evaluators know the real performance of the device based on real outcome that transpired during the observation phase. Furthermore, the response and processing time through output ratings of the product when performing its functions meet the requirements with a mean score of 4.68. Also, the amount and types of resources used by MSOGPGD when performing its function meet the requirements set by the objectives and desired result with a mean score of 4.63. The maximum limit of MSOGPGD, parameter met the desired requirement with a score of 4.60. Moreover, the ability of the user easily performs required tasks using MSOGPGD met the specified requirements with a score of 4.60 and lastly, the overall performance of the product met the required specifications with a score of 4.60. The overall performance of MSOGPGD has a mean score of 4.59 which means that the performance of MSOGPGD meets the desired specifications.

According to Bathia (2014) the performance data for devices that generates electricity can be misleading because they may refer to the peak efficiency (at design in accordance with driving source) or the peak power output (at the rated driving source). The data could also refer to the average output over a time period (e.g. a day or a month). Because the power output varies with the rotation speed, the average output over a period of time is dependent on the local variation in rotation speed from time to time. Hence to predict the output for a given generating device one needs to have output characteristics of the stable driving source speed but since the portability was also determine on how it generates electricity it also needs to understand the peak power rating before connecting the load to ensure that there will no further damage in appliances and the system itself.

Summary of the acceptability of MSOGPGD in terms of design, composition, safety and operating performance

The table further shows that the criteria listed in the table received a positive response from the evaluators and that MSOGPGD meets the desired requirements and applicability during emergency situations. MSOGPGD was "Very Acceptable" in terms of design with a total mean score of 4.51, composition with a total mean score of 4.61, safety with a total mean score of 4.58, and lastly, operating performance with a total mean score of 4.59. Although the built-in generator generates less power than expected, it still performs the operations it intended to during emergency scenarios, as DRRM evaluators reiterated. It was also suggested that if it is mass produced, it will help people during calamities and search and rescue operations.

With battery power and a built-in charging system as well as a power supply, it has a variety of functions that help people have access to charging, power up their radio, and receive important information about the weather, natural disasters, preparedness, and other emergencies. It can also be used to charge cellphones, which could help people communicate with their family, friends, or authorities if needed. The device comes with various features, such as recharging and powering up different voltage ranges of appliances, it recharges with a built-in generator and electric utilities; and it can also be charged using.

CONCLUSIONS AND RECOMMENDATIONS

Based on the summary of result, the researcher had drawn the conclusion: The device met the target specification in which the it delivers AC voltage that can power up any 110/220VAC appliances at a maximum power requirements of 50-60 watts, it also delivers 1.2 to 12 volts regulated DC drawn from generator with a maximum of 5 amperes that charge up to alleviate users tiredness in rotating the shaft, it also delivers 1.2 volts to 32 volts at a maximum of 3 amperes drawn from the battery, the Dual output USB functioning properly that can charge the phone rated 5,000mAH two times, the torchlight was also functioning properly and has enough light for travelling, camping and night walks, the high voltage igniter can ignite combustible materials to start a fire easily. The load capacity of variable regulated DC power supply operates in a convenient way that delivers 1.2 volts up to 12 volts with charge but not longer than battery with the discharge rate of 0.05 volts for 5 volts below and 0.5 volts for 6-12 volts. The charging and discharging of built-in battery operate under normal conditions it the charging time from electric grid was faster than the built-in generator but during the emergency situations and when electricity was cut off the generator can still charge the battery. Likewise, the discharging rate of the battery depends on the voltage and power of the test load the higher the voltage and power of the load the faster the battery drains. However, it was observed evidently that it operates for a longer period of time before it drains out. The device was "Very Acceptable" in terms of design, composition, safety, and operating performance.

Based on the conclusion drawn by the researcher, which also include with the suggestions of the evaluators, the following recommendations were drawn: There is a need to install a higher rating motor so that it can provide more beneficial electricity for a wide variety of uses and the researcher also recommend of providing a design for upgradable or detachable driving shaft for variety of driving sources such as wind, hydro and bikes.It is suggested to provide another chassis design such as a box type for more convenient storing and handling and provide an input connection in case the user wants to switch the charging system to solar power instead of a built-in generator. There was also a need to make the device waterproof or watertight so that it would not be damaged when used during calamities such as typhoon and flashflood and the battery should be upgraded for a higher rating to be more convenient for use for long periods of time. The device should be mass produced to help the search and rescue operation in far flung places.

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