Conference Paper

Sound Energy: An Electric Source of Noise Pollution Based Power Bank

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Abstract

The sound energy associated with the vibration of matter an abundant source of noise pollution, wherein the least of all types of pollution which most people ignore to recycle and turn into electricity sources. The purpose of this project is to design and develop a device that can make useful energy from noise known as noise pollution based power bank with suitable architectural design, component design, code generation, and integration system..The researcher chooses design science research methods and V Model procedure to make sure of the efficiency of the device. Noise Pollution Based Power Bank was tested in different noisy areas. The device had been tested in various places to prove capability to work in a variety of noisy environment. The efficiency of the device in terms of charging the power bank utilizing noise is proven effective especially in loud/ noisy places that make the power bank charged the battery continuously. Comparing to commercial power banks, noise pollution based power bank produced a parallel result. Charging is also performed with different gadgets that are most likely use power bank and found effective and efficient. With the future modification of the noise pollution based power bank, it is possible to make this device a basis of imminent technologies that will make a way of recycling noise pollution to be a secondary source of establishing a wide scale electricity source.

Keywords: Noise Pollution, Acoustic Energy, Sound Energy, Power Bank, Alternative Energy Source, Electric Source

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1. Introduction

One of the main problems for this generation is pollution and as we all know recycling is the only solution that we can do to lessen it, these are noise pollution or noise disturbances and this is the kind pollution are being ignored which happened because there is no possible way to clean our surroundings from noise, but on the other hand there is a way to recycle it into electrical energy produced by sound vibrations, these

vibrations cause waves of pressure, which translate them into noise of varying levels change sound to mechanical to electrical energy.

There are many ways of generating alternative energy coming from sound energy wherein a primary source of electrical energy of the Noise pollution based power bank, one example is through a transducer called the piezoelectric crystal that generates electric charges on its surface when mechanical strain is applied to it and the pressure and sound is transformed in the same manner, as the sound is in a form of vibrations that will be harvested on the piezoelectric material that will be converted into electricity. Piezoelectric materials [1], strengthen the urge for the proponent to think of a way to make use of noise pollution [2] wherein as an environmental hazard and how this type of waste needed recycling to be a useful material for it is available in most of the areas of our developing country [3]. This noise from different locations such as spots near public places, factories, and industries where the sound is clamouring. The idea of using the power bank as a main device, as it is one of the accessories of cellular phones which is a necessity of today's generation [4], [5] as described about cellular phones being one of the necessities in the present generation and how short the battery life affects the usage of this gadget for communications and entertainment, added to that he introduces the use of power bank as a device which can help give our phones a longer usage span that explained briefly the use of power banks an addition to the accessories of phones that gives extra life to the gadget. It is now being used as the phones nowadays are evolving, having a much wider screen, faster processor and multitasking capabilities, which requires the larger amount of electricity as it is discharging while being used.

The possibility of the renewable energy as the power bank's source other than the electricity coming from the convenience outlet [5]. Most of the projects that have been conducted earlier used solar energy until made a phone charger that used pressure as a source of energy with the help of piezo material to produce electrical energy [6]. The sound can also be a source of energy. This is feasible by the use of some components and equipment that can turn sound or acoustics to mechanical (pressure) and finally produce electrical energy [7].The process of piezoelectric material and how it can make energy from one form to another. Piezoelectric as a transducer [8], in this research's case, will act as a converter of harvested sound to become electricity with the strain that will be applied to it [9]. The strain will come from the vibration that is carried by the sound waves near the transducer.

Due to the technology available, the researchers chose to conduct a study that can help in recycling and produce a device that can help people with their everyday life as

long there is a noise or sound energy. Concisely, the proponent decided to develop a noise pollution based power bank. Noise pollution base power bank will convert noise pollution to electricity and store what it has converted for the moment of its need.

This research is developed to make use of noise pollution for a better purpose and improve the use of smartphones and mobile gadgets that are now becoming an essential device for every individual. [10]; [11]; [12] With noise pollution based power bank, pollution could be recycled for many useful purposes. With the use of piezoelectric material, transform sound energy into electrical energy passing through mechanical energy. [13]. Research Paradigm, Figure 1 below, is a visualization of the researcher's concept.

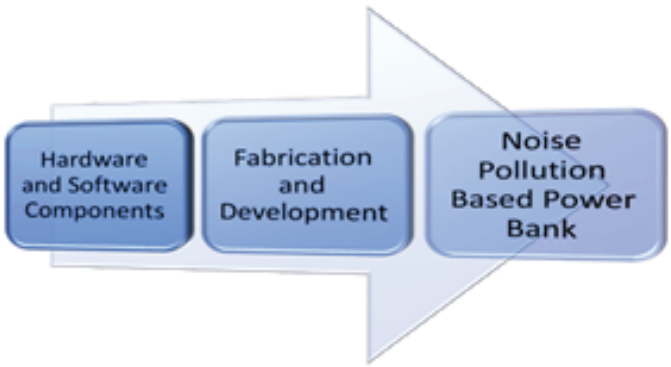

Figure 1: Research Paradigm.

The research Paradigm shows the development process of the noise pollution based power bank. It comprises the input, process, and output. The Input contains the hardware and software components needed to complete the anticipated device, then the Process contains the fabrication and development of the Noise Pollution Based Power Bank and the Output is the finished product produced by the researcher with the use of the input and process. The output is the noise pollution based power bank. The Research paradigm was strengthened by the conceptual paradigm as shown below.

The conceptual paradigm of the research. It presented the process of noise pollution based power bank. The figure also consists of the input, process and the output of the device. Noise, which is under input, will be harvested on the area will be used for the test. This is the sample that will undergo courses of the noise pollution based power bank and the piezoelectric material to come up with an output. During the process, using the noise pollution based power bank, the harvested noise will pass through the microphone and will come out as electricity.

This research aimed to develop a noise pollution based power bank. This will be more significant to researchers who need to investigate the conversion methods of

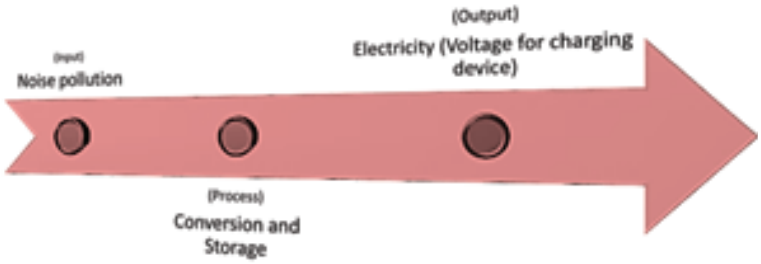

Figure 2: Conceptual Paradigm.

energy form to another which is sound energy to electrical energy to become a new source of usable energy [14]; [15].

2. Objectives of the Study

This research aimed to design and develop a device that has the ability to convert noise into electricity and store it for emergency use. The specific objectives were as follows: To determine the components needed to develop the noise pollution based power bank in terms of Hardware and Software; to describe the noise pollution based power bank circuitry and design architecture; to determine the noise or decibels to be harvested to create power; process the noise into power as source of electricity; and to determine how much electricity do the noise pollution based power bank will generate voltage, current, and resistance; to determine the efficiency of the Noise Pollution Based Power Bank when tested using different mobile gadgets.

3. Materials and Methods

This study used the experimental method to clarify the mechanisms by which these factors contribute to the design and developing a noise pollution based power bank and also utilized Design Science research methods that involve the creation of new knowledge through design of novel or innovative artifacts such algorithms, human/ computer interfaces, and system design methodologies or language [16].

The researcher chooses V Model procedure to make sure of the efficiency of the project. The appropriate model for this project is the V model. Figure 3 illustrates the process.

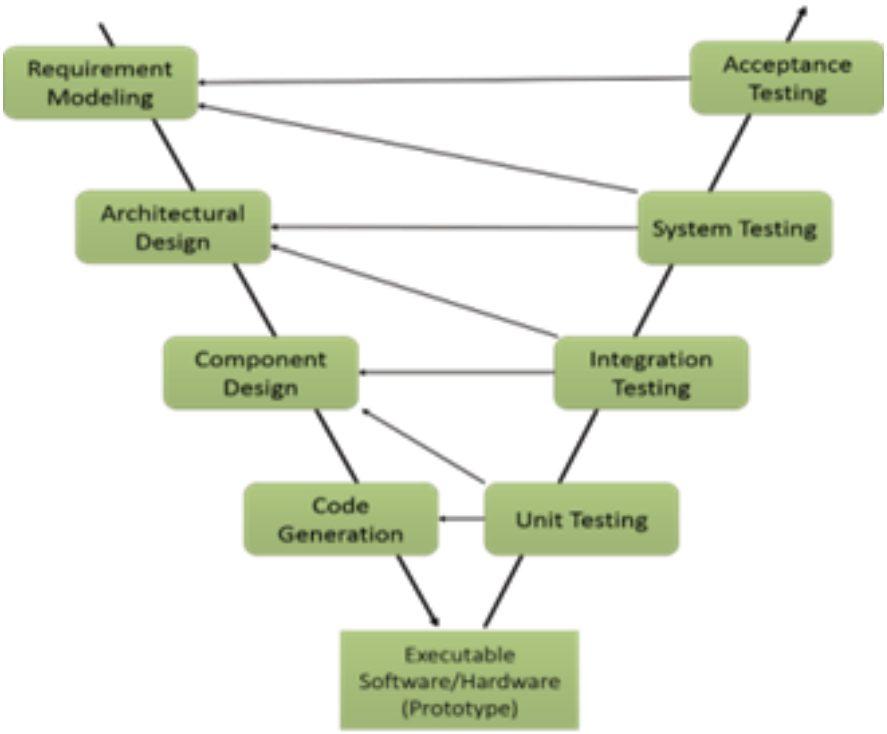

Figure 3: V-Model Procedure.

The proponent listed down the materials to be used in the development of the project, then the first thing the proponent did was the study and the gathering of data regarding the project. Furthermore, gathered data and information from different sources and the proponent gather the above components to start with the fabrication and finally, the software design which contains the details for the software side of the project such as a data flow diagram (DFD) illustrates how data is processed by a system in terms of inputs and outputs.

The diagram reveals external entities into the system showed how the data moved from one process to another. Subsequently, [17] this includes structure such as the source of vibrations, battery, and the users. Furthermore, the relation between the power bank and the entities. The sound or noise provides pressure to the noise pollution based power bank wherein the conversion takes place [18]. Thus, After conversion, the electrical energy output be transferred to the battery for the user's consumption..

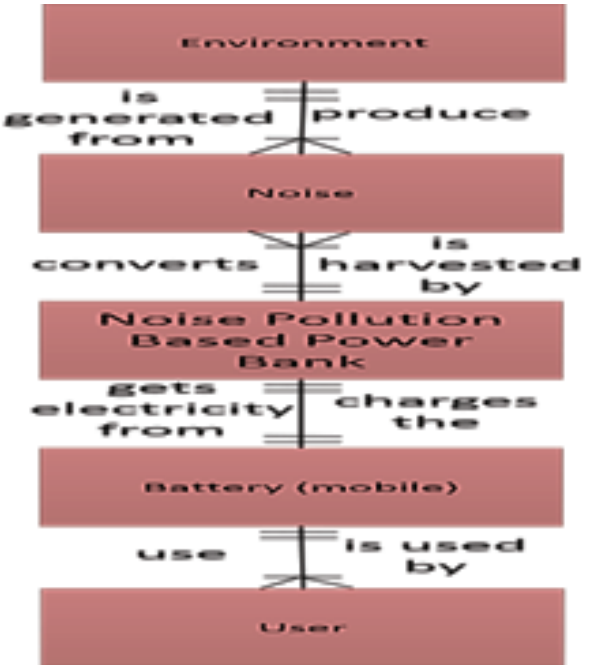

Figure 4: Data flow Diagram.

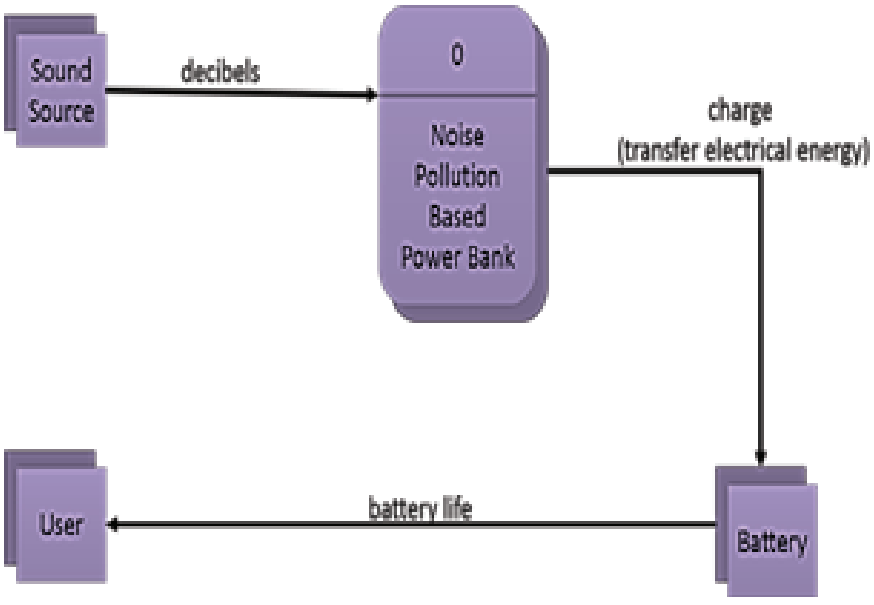

Figure 5: Entity Relationship Diagram.

The entity relationship diagram (ERD) shows the different types of environment that produce the high level of noise that can be provided for a power bank. The output of the power bank will charge the battery that is used by a single user.

The use case diagram illustrates the use of the Noise Pollution Based Power Bank wherein, the user needs to use the power bank together with the phone wherein the decibels and battery percentage were displayed.

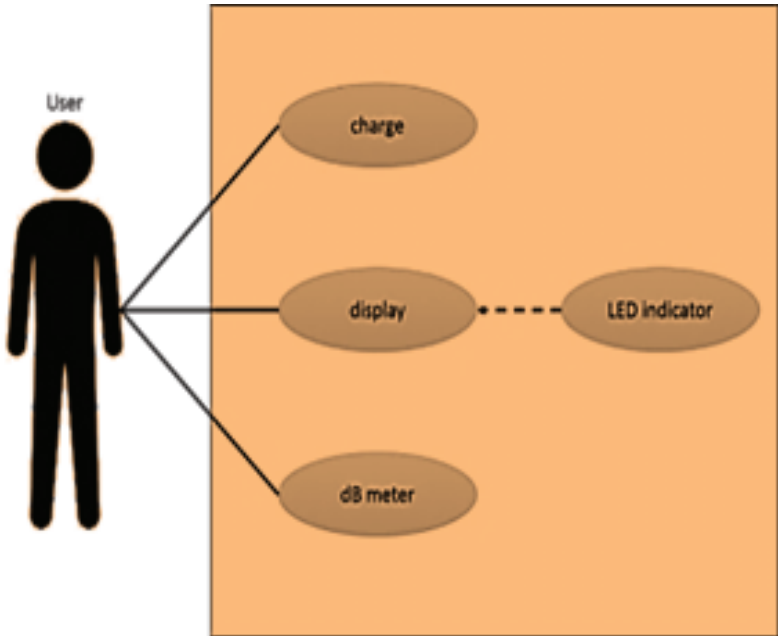

Figure 6: Use Case Diagram.

The main flow of the device's system workflow. It begins with the start process where the device captures noise for storage. When the devices are turned on, the system will be initialized then subsequently the system monitors the captured noise and prints the decibels measured, then the device will charge the external device connected to it.

The sampling of Noise Pollution Based Power Bank was tested at different noisy areas around Puerto Princesa City including the canteen, public markets, power industry, KTV bars, disco bars, public transport, malls, movie houses and other noisy places while the tools used for fabrication were the drill bit for making holes on the device enclosure, pliers, and cutter for the connection of wires, and soldering iron and soldering lead for soldering.

In determining the voltage, current and resistance, the proponent used the Ohm's Law, where: V = voltage, I = current and R = resistance.

In determining the sound level or decibel, the formula below:

$$20\log_{10}\left(\frac{V_{out}}{V_{in}}\right) \quad (1)$$

Where:

V_{out} = voltage going into the device

V_{in} = voltage coming out of the device

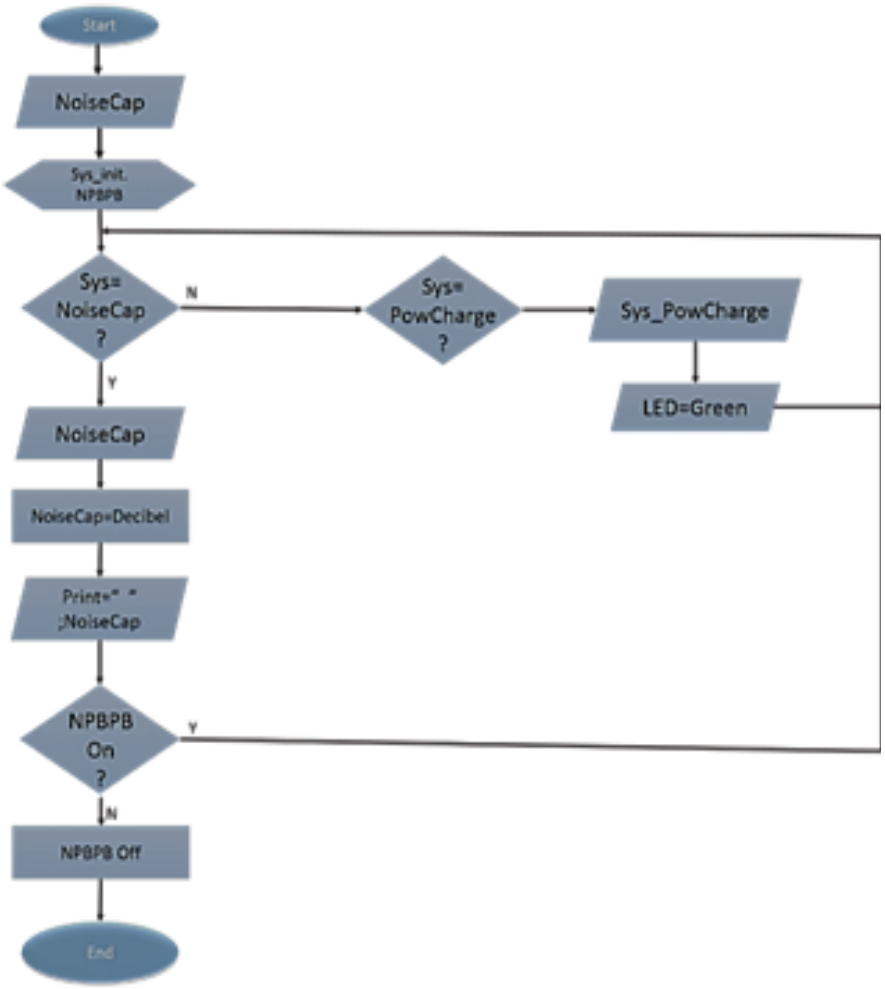

Figure 7: flow Chart.

The result of this formula is expressed in the unit of decibels (dB). Voltage gain is determined using the decibel by the equation:

$$\frac{V_2}{V_1} = 10^{(\frac{dB}{20})} \tag{2}$$

Electret microphone has a current consumption of 0.5mA max., but it doesn't affect the push of voltage to the capacitor. Instead, the current present between the microphones to the capacitor is computed using the equation:

$$I = \frac{V_b}{R} e^{-t/RC} \tag{3}$$

Where:

V_b = Source voltage

R = resistance

t = time

RC = time constant (resistance x capacitance)

4. Results and Discussion

The discussion is prepared according to the logical arrangement of the problem.

4.1. Components used to develop the noise pollution based power bank

The proponent used Arduino Uno Rev 3 as the main operator of the embedded system of the device. It is responsible for displaying the decibel measured on site; LCD or Liquid Crystal Display shows the information gathered by the microcontroller. It displays the decibel reading and its corresponding voltage; Sound Detection Sensor is being used to gather input. nevertheless, the information from the sensor is the basis of the display on the LCD wherein, Electret microphone collects the sound waves or acoustic energy to be used and convert the raw source to electricity subsequently, Lithium Ion battery that is connected in series parallel is used as the storage of electric charge for the Arduino and external devices so therefore, The 10k potentiometer connected to the LCD and Arduino for the contrast adjustment and then the Voltage Regulator is used to maintain a steady amount of voltage output supplied for the external devices connected to the power bank and so, the Capacitor serves as the temporary storage of electricity from the microphone before forwarding to the battery and finally, the diode leads the electricity to flow in one direction also keeps the current from alternating when arranged as a bridge diode.

In continuation, the LED or light emitting diode is used as the indicator of battery level while Green LED means the battery is used for charging, and Yellow LED means the battery is needed to be charged, also the Red LED means the battery is starting to drain. The resistors are used to limit the flow of electrical current to the desired amount that is needed whereas, The proponent used 2 toggle switch to be used in that locations that are higher part is for the LCD and the other one is for the power bank. So, therefore the Arduino software or Arduino IDE to run the assembled hardware and the software or codes loaded in the microcontroller is essential for the device to perform its purpose.

The function of the device. The microphone continuously collects noise for conversion and storage. When the system is initialized, either the device functions as a decibel meter or charge an external device. When the user switched on the monitor, the sensor capture sample and the LCD prints the computed value expressed in decibels. When

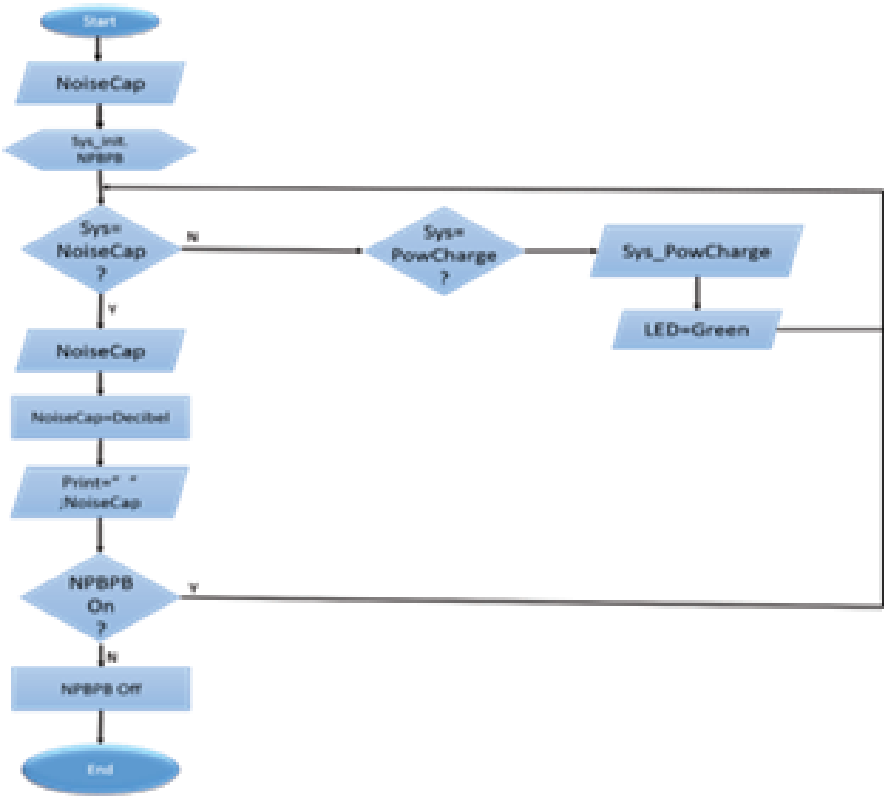

Figure 8: Pseudo Code.

the power bank is on it charges the external device connecter to it. This allows the microcontroller to be display the stored program on the LCD.

The diagram of the collector and regulator. Electret microphones are linked in parallel and connected to the bridge rectifier to help the flow of voltage from alternating. The capacitor serves as storage of voltage before forwarding to the battery.

4.2. Circuitry and design architecture Noise Pollution based Power Bank

The Noise Pollution Based Power bank design and Architecture is presented below.

The external architecture of the noise pollution based power bank. It is a device that uses sound as a source of energy for the power bank. It also includes a decibel meter and battery level indicator.

Based on the labeled parts, the LDC monitor displays the decibel measurement reading and below it is a 5 LED battery level indicator which tells the status of the device's battery.

The green led indicates that the battery is full or still usable to charge external devices while yellow led indicates that the battery is getting low and is advised to

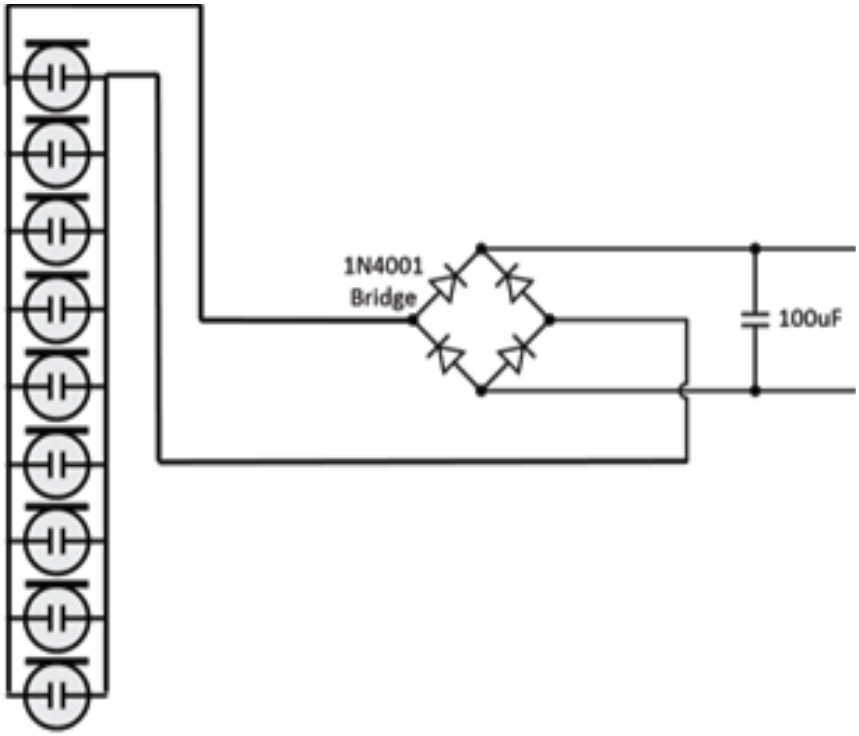

Figure 9: Collector and Regulator.

recharge again and the red led means that the battery is getting starting to drain and won't be able to charge devices and show display on the LCD. The potentiometer controls the contrast of the LCD. The device has 2 switches that control different part of the device.

The switch above the potentiometer turns the monitor on and the other switch is for the power bank supply for the external device. On the lower right side of the device is the USB port where the charger wire connects. On the other side is a group of microphone that collects the noise for processing and the topmost microphone serves as the Sound detection sensor. The USB Power jack that is used to connect the device to the computer for uploading codes, maintenance, and configurations. The DC Power jack is for secondary electricity source charging, 7v to 9v input can be connected to it.

The internal architecture of the device with each part labeled. The Arduino Uno Board stores the program running the device. There is 4 lithium-ion battery connected in series parallel to maintain the input for the board and 5v output for the external device. There are 2 groups of DC converter, made from capacitor and voltage regulator, one is for maintaining 9v for battery charging from the power jack and the other one is for the 5v supply of the power bank.

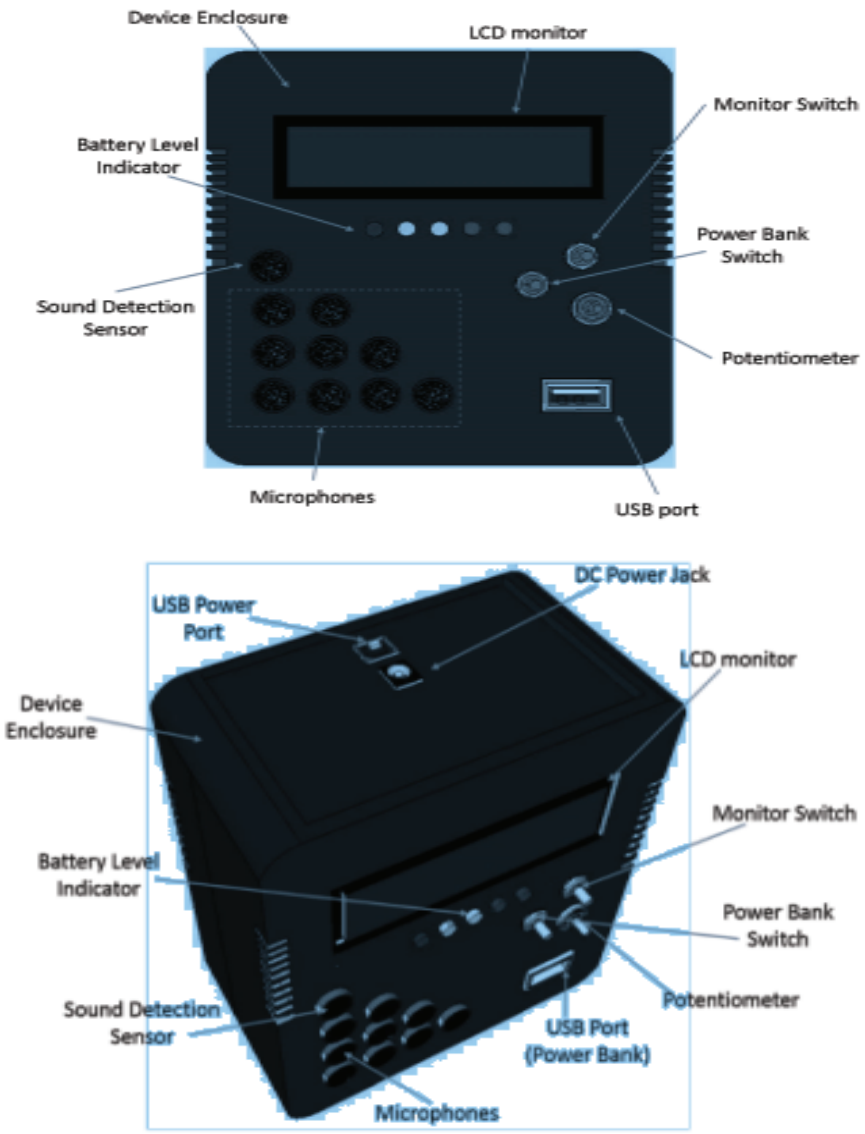

Figure 10: Noise Pollution Based Power Bank.

4.3. Noise or decibels harvested to create power (Voltage)

Noise/Decibel is a product of pressure in the air and its normal state measure 43-44 dB for normal noise or not polluted which no specific amount of noise/decibel that is needed to create power as long the microphone catches sound waves; most likely it will keep on converting its input to electricity. The charging of the battery varies from how low or high the pressure caught in a measure of time. The stronger the pressure the shorter the charging time. But since the measure of a sound wave traveling through air is not consistent, the time of converting/ charging will be different each time the battery charges. The results of harvested electric voltage shown in table 2**.**

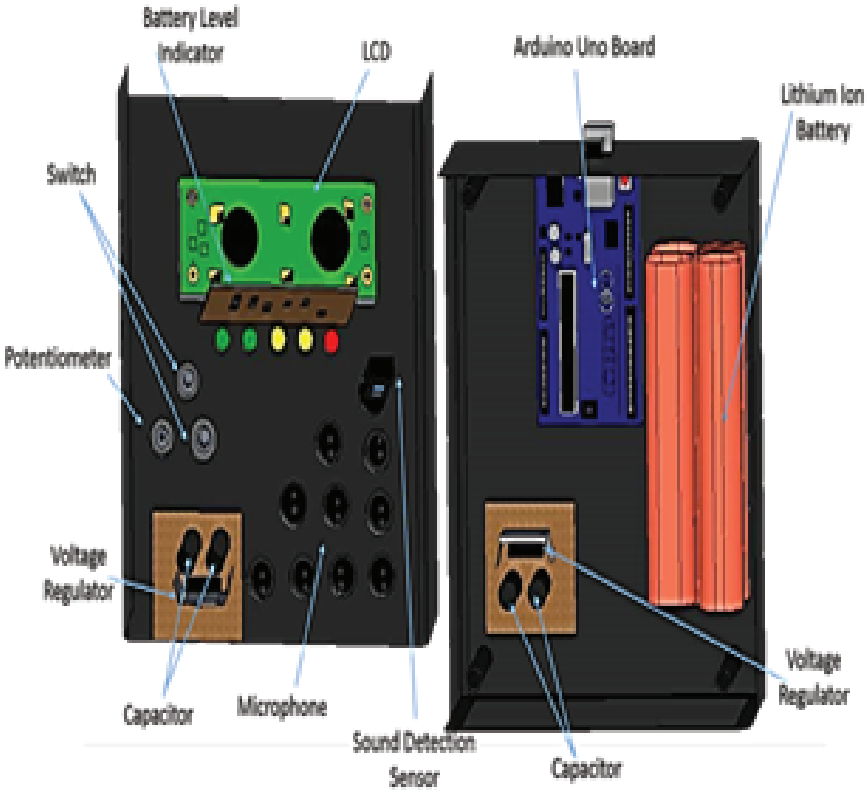

Figure 11: Internal Architecture of Noise Pollution Based Power Bank.

Table 1 shows the results of sound harvested to produced electric voltage, The highest voltages harvested using the Noise Pollution based power bank is 12,589mV (79-82 dB) at comedy bars and closed spaced karaoke bars, followed by voltage harvested of 8192 mV (79dB) at public transport. The lowest voltage harvested were from Houses and Schools Classrooms and canteens wherein the harvested voltage ranging 282mV to 501mV (49-74 dB)

4.4. Process of sound Energy to electrical energy

The proponent decided to use a microphone as the main component of the Noise Pollution Based Power Bank.

4.5. Noise pollution based power bank generated current, and resistance

The process flow of the noise pollution based power bank. Noise is harvested by microphone in the form of sound wave or signals. The diaphragm of the microphone moves up and down that makes converts the signal to electrical current. The converted

Table 1: Voltage gain Converted from Measured Decibels.

Noisy Places	**Decibels(dB)**	**Voltage Gain(mV)**
House:		
Normal (Sunny)	**44 – 49**	**282mV**
Rainy	44 – 55	562mV
School		
Canteen	44 - 54	501mV
Class Room	44 - 74	501mV
Hall Ways	**44 - 66**	**1995mV**
Malls/Market:		
Mall 1	44 - 58	794mV
Mall 2	44 - 75	5623mV
Mall 3	44 - 70	3162mV
Public Market	44 - 74	5011mV
Street/ Along Roads		
National Road	44 - 75	5623mV
Road Intersection 1	44 - 75	5623mV
Road Intersection 2	44 - 72	3981mV
Bars:		
Disco Bars	44 - 77	7079mV
Comedy Bars	44 - 82	**12589mV**
Karaoke;		
Closed	44 - 82	**12589mV**
Open	44 - 75	5623mV
Movie houses	44 – 73	4466mV
Public Transport	**44 - 79**	**8192mV**
Restaurant:		
Restaurant 1	44 - 76	6309mV
Fast food Chain	44 - 75dB	158mV - 5623mV

current in alternating form will pass though the bridge rectifier to make it into direct current and store it to the capacitor before transferring it to the battery. The current from the battery is supplied to three different sections of the device: battery level

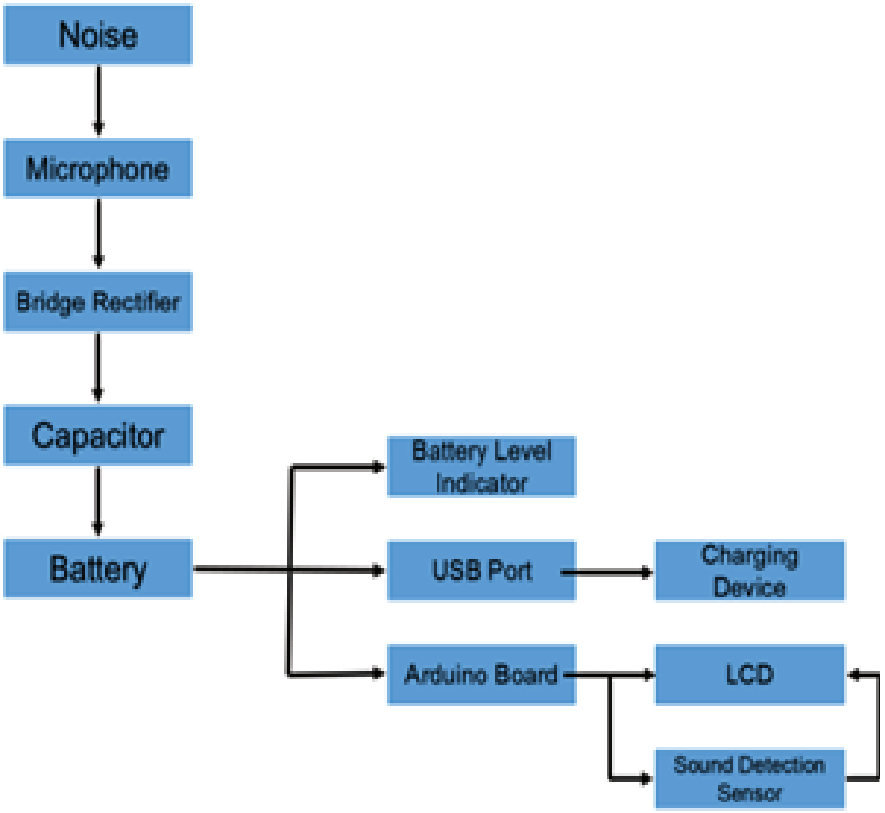

Figure 12: Process flow.

indicator, USB port and Arduino board. The battery indicator shows the status of the battery, and the USB port produce 5v output that can be used to charge phone. Arduino supplies power to the LCD and sensor to run, then the sensor capture samples for the display of the LCD. Microphone is a type of transducer that converts one form of energy to another. Inside this device is the diaphragm which is commonly made up of plastic, paper or aluminum. Attached to it is a magnet enclosed in a coil that produces the energy. As the microphone catches sound (acoustic energy) that is in the form of vibration that travels through air or other medium, the diaphragm moves and the electrons flow through the copper coil. Thus, this process creates electrical signal or current that is passed to the desired output, and in this research case, the battery. But since the current from the microphone is alternating, the proponent made a bridge rectifier to convert the current to direct before storing it to the capacitor and to the battery.

The table shows the converted electric current and resistance from harvested voltage of the measured decibels of the Noise Pollution based power bank, the highest current of 251.79 mA and resistance 124.20 mΩ m at 82dB sound levels. In Zero-dB standards, there is different measurement of resistance. Audio industry measures 600Ω

Table 2: Current and Resistance Converted from Measured Decibels.

Noisy Places	Decibels	Current	Resistance
House:			
Normal (Sunny)	**49dB**	**5.63mA**	**2.78 mΩ**
Rainy	**55dB**	**11.24mA**	**5.55 mΩ**
School			
Canteen	**54 dB**	**10.02mA**	**4.94 mΩ**
Class Room	74 dB	100.24mA	49.44 mΩ
Hall Ways	66 dB	39.91mA	19.68 mΩ
Malls/Market:			
Mall 1	58 dB	15.89 mA	7.84 mΩ
Mall 2	75 dB	112.47mA 8mA mA mA mA mA	55.48 mΩ
Mall 3	74 dB	100.24mA	49.44 mΩ
Public Market	70 dB	63.25mA	31.20 mΩ
Street/ Along Roads			
National Road	75 dB	112.47mA	55.48 mΩ
Road Intersection 1 11sectioIntersection 1	75 dB	112.47mA	55.48 mΩ
Road Intersection 2	72 dB	79.62mA	39.27 mΩ
Bars:			
Disco Bars	77 dB	141.59mA	69.84 mΩ
Comedy Bars	82 dB	**251.79mA**	**124.20** mΩ mmΩ
Karaoke;			
Closed	82 dB	**251.79mA**	**124.20** mΩ
Open	75 dB	112.47mA	55.48 mΩ
Movie houses	73 dB	89.34mA	44.07 mΩ mΩ
Public Transport	79dB	**178.25mA**	**87.92 mΩ**
Restaurant			
Restaurant 1	76dB	126.19mA	62.25 mΩ
Fast food Chain	75dB	112.47mA	55.48 mΩ

resistance, Television Industry measures 75Ω and Radio Frequency have 50Ω, which

is used for electro-magnetic field strength. Typically 50Ω is used for the calculation of the voltage-gain from sound wave pressure.

4.6. Efficiency of the Noise Pollution Based Power Bank banks when tested using different mobile gadgets

The Fully charged Noise pollution based power bank using noise pollution as electrical energy sources were tested its efficiency in charging different mobile chargeable gadgets or external device, The results is presented in table 6 below.

Table 3: External Device Charging from the Power Bank.

Phone	The power bank can add 20% - 25% battery life
Tablet	The power bank can add 20% - 25% battery life
Watch Phone	Charged from the power bank up to 65% of battery life
LED Light	Lights for 7 hours continuous connected to the power bank
Portable Fan	Fan rotates at a maximum level for 1 hour and 30 minutes when connected to the power bank
Arduino	The power bank can supply Arduino board for 30-40 minutes.

The charging of various device/gadgets depends on the voltage and current requirements of each device. This also affects the consumption of charges from the battery.

5. Conclusions and Recommendations

The following contain the Conclusions of the study:

5.1. Conclusions

The noise pollution based power bank has an external and internal architectures that has hardwires and software to harvest the sound energy levels (decibels) and converted to electrical energy as a primary source of electricity, wherein the device monitor displays inf value when the sensor captures as an input which it typically equal to 43dB.The sensor can measure more than 74dB, when the decibel is higher than 74dB, the sensor keeps steady reading of the peak value and LED that is used for the battery

level indicator of the power bank can consume charges from the battery that makes the external device to charge in shorter time.

The sound energy captured using microphones measured in decibels and harvest the electrical energy measured in Voltage, thus the noise pollution based power bank is an effective device to stored electrical energy coming from sound energy. Therefore, sound energy is capable to be a source of electrical energy.

The effective locations for harvesting sound energy is at closed room entertainment places such as bars or other similar places reaching higher decibel level of noise or sound with decibels of higher than 80 and the louder the noise or the longer the exposure of the device to noise the faster it charges, wherein the power bank can charge devices that require input voltage of 5v such as phone, tablets, watch phones, LED light, portable fan, and other external devices.

Noise is an effective source of electricity just like sunlight. Thus, because of the small voltage converted from the source it is better to have more microphones to gather the raw source wherein, to produce larger amount of voltage, microphones must be connected in parallel. Series connection increases the current but the voltage is too low. The power bank can supply the LED light the longest because it only requires 3.3v that makes the consumption of charges from the device much slower than those that needs 5v.

5.2. Recommendations

Based on the conclusions made, the following are recommended for consideration:

For public and private establishments especially those who specialize in entertainment, it is recommended for them to use this research to develop equipment that they can use to support their power consumption with the use of the sound they are producing at the same time. The concept of it is recycling their own waste to produce the electricity that they need.

For all travellers, it is recommended to bring power banks along every time they are on the road in case of emergency. It is much better if the power bank they have in hand are those that are using renewable source because electrical outlets are not always present on every locations. This device would be effective since sound is present anytime anywhere.

For future researchers, this research will serve as their guide to modify or improve more related device that can help people make us of sources that are already present in our daily surroundings. It is recommended for them to use a much powerful sensor to

enhance the reading of the decibel measurements, use more microphones to harvest sounds to charge the battery faster and make a battery indicator that uses LEDs with smaller voltage consumption to lessen the consumption of electric charges. Also, to modify the meter and include the current and resistance reading.

Appendix

The Noise Pollution based power bank was used to harvest the sound energy at the noisy places as shown in the figures below.

Figure 13: Sound harvesting in Bars and KTV Bars using Noise Pollution Based Power banks.

The Noise pollution based power bank was tested as charger of the external devices.

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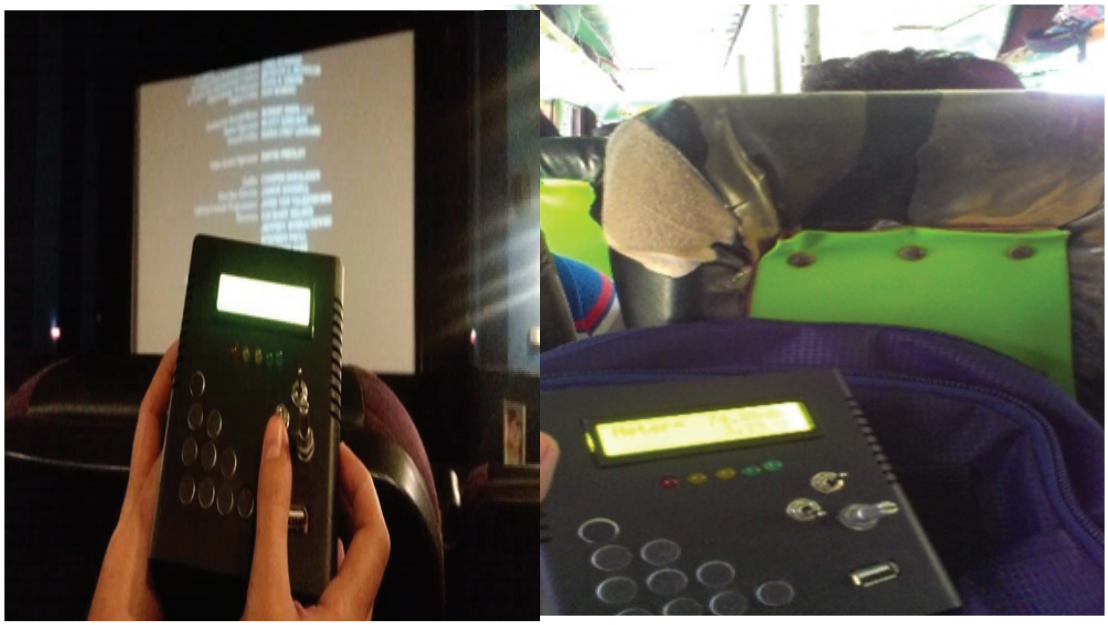

Figure 14: Sound harvesting at movie house and public transport using Noise Pollution Based Power banks.

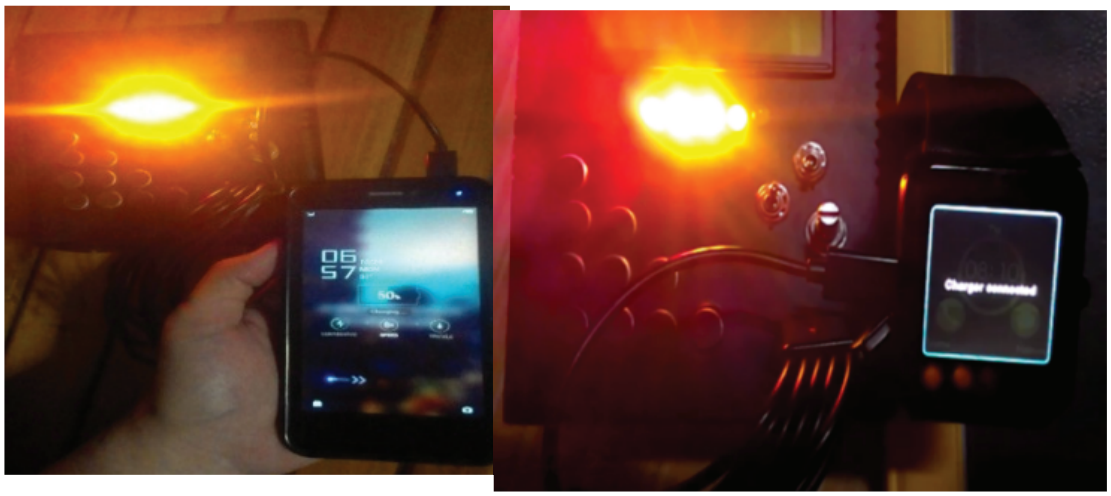

Figure 15: Phone and phone watch charging from Noise Pollution Based Power banks.

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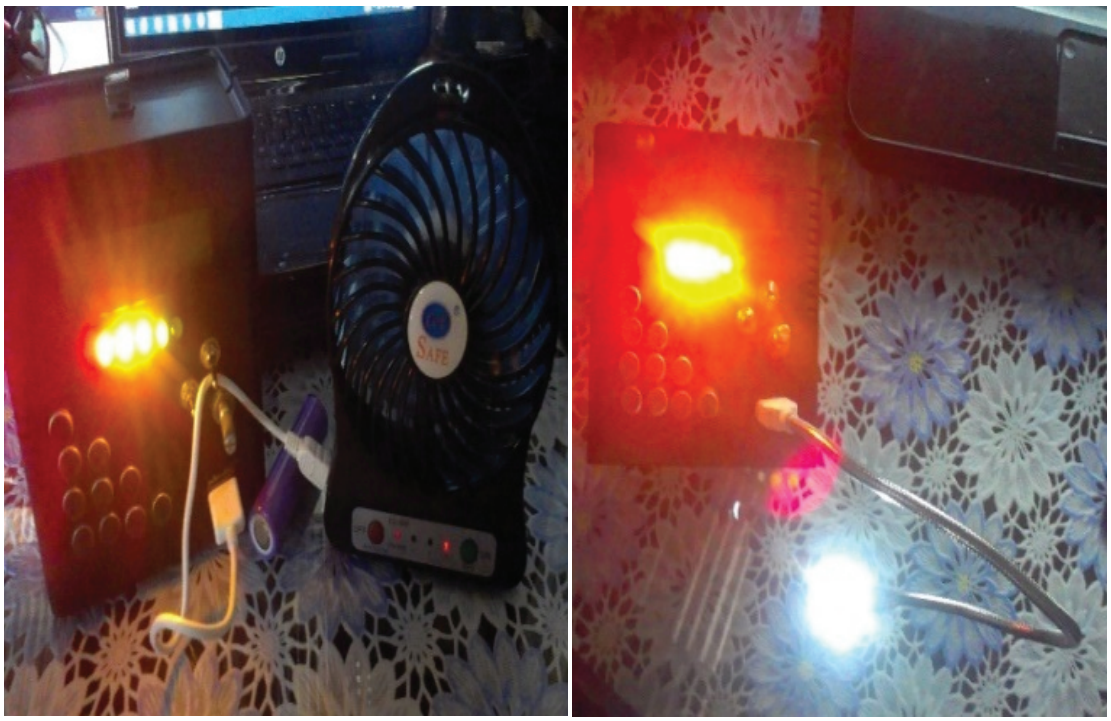

Figure 16: Portable fan and LED lights charging from Noise Pollution Based Power banks.

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