IMPROVISED ENERGY HARVESTING DOOR MAT EQUIPPED WITH PIEZOELECTRIC TECHNOLOGY

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Presented to the Faculty of the
Regional Science High School for Region I
Bangar, La Union

In partial fulfillment of the
requirements in the subject
Research Project

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INDORSEMENT

This qualitative research entitled, **Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology,** prepared and submitted by **Irish Trisha A. Lardizabal, Eissah Gileen G. Milanes,** and **Yazmin Cyna R. Ramos** in partial fulfillment of the requirements for the subject, **Research Project**, has been examined and is recommended for Oral Examination.

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-The Researchers

DEDICATION

The researchers would like to offer this humble research paper
to the Almighty Father for His unending love
as he became their source of strength and wisdom
all throughout this study.
Lord God, they present to you the fruit of
their hard work to be blessed with your grace
that it may become as one of their
beautiful symbol of Your goodness.

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moral support and to be there every step of the way,
providing everything they needed during the time
when they were developing this work and
encouraging them that anything is possible and
teaching them to believe in themselves
in order to achieve great things in their lives.
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It's for them.

This piece of work is also dedicated
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in accomplishing this work and
never getting tired of this journey.

-The Researchers

RESEARCH ABSTRACT

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Abstract: The Philippines has a population of more than 100 million people, which presents various issues in terms of electricity infrastructure. The demand for the electricity section is currently rising as a result of the population's rapid rise. The difficulty facing the nation right now is how to maintain demand while having a sufficient resource that could satisfy, if not everywhere in the nation, at least some of the electricity needs

This study aimed to create an Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology, a device that produces electricity from the conversion of kinetic energy to electrical energy by the piezo electric transducer through mechanical pressure to generate natural electricity. This was tested by ten respondents with different weights from the Municipality of Bangar, La Union. They assessed the device through pressing the device for 5 seconds, each having 3 trials.

Based on the result, the average voltage output of the device is 12.77 volts to 18.42 volts, while the average voltage needed by a device is 12 volts to 24 volts. The current in the three trials can produce from 4.08 amperes up to 4.61 amperes and a normal power bank has an average ampere between 1 ampere and 3.5 ampere. The power generated per treatment has minimal changes and the device can produce a minimum of 56.90 watts to a maximum of 90.83 watts while a device normally uses an average power of 30 watts and 70 watts. This indicates that the device is effective and can provide power for small electronic devices.

The researchers arrived at a conclusion that the Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology is efficient in terms of producing voltage output, current output and power generated which means, it can be used as an alternative source of electricity. It can charge small electronic devices depending on the weight and pressure applied by a person. The researchers also concluded that the heavier mass produces higher voltage, current and power, but stronger pressure placed on the Piezoelectric Door Mat can also produces higher voltage, current and power regardless of weight.

TABLE OF CONTENTS

Page

List Of Tables

List Of Figure

List Of Plates

CHAPTER I

INTRODUCTION

The growth of global electricity demand is slowing sharply in 2022 from its strong recovery in 2021 due to slower economic growth, soaring electricity prices, and health restrictions, the International Energy Agency (IEA) said Wednesday. Global electricity demand is seen rising 2.4% in 2022, lower than the 3% forecast in January, and is expected to maintain a similar growth rate in 2023, down from a 6% rise in 2021 and in line with the five-year average prior to the COVID-19 pandemic (The Economic Times, 2022).

Specifically, the Philippines still has an issue with energy insecurity despite improvements in access to electricity. The nation is heavily dependent on coal power and extensive transmission lines in order to fulfill its expanding need for electricity. Yet, rural areas have lagged behind despite efforts to reach urban areas with electricity. This strategy has led to increasing electricity prices, unequal distribution of power between urban and rural areas, significant environmental damage, and system reliability that is in jeopardy (Taniguchi, 2019).

The Philippines has a population of more than 100 million people, which presents various issues in terms of electricity infrastructure. The demand for the electricity section is currently rising as a result of the population's rapid rise. The difficulty facing the nation right now is how to maintain demand while having a sufficient resource that could satisfy, if not everywhere in the nation, at least some of the electricity needs (The Philippine Statistics Authority, 2022).

Because of the transportation and industrial sectors, energy needs have risen sharply and dramatically over the last three decades. Indeed, the global economy is likely to consume more energy as developing countries' energy demands rise. Global energy consumption is increasing, and in the coming decades, people will almost certainly face a greater scarcity of nonrenewable energy, on which they currently rely.

Our current consumption model entirely depends almost on the assistance of non renewable energy sources such as oil, gas, coal and uranium. At the recent rate of consumption, oil will be the first fossil fuel to come to an end. According to estimates, there will be between 40 and 60 years of recognized reserves of conventional oil. Natural gas could be utilized for another 70 years. For coal, there will be about two centuries of reserves. Energy demands will really be amplified by the world's population as it will reach nearly 10 billion people in 2050 (Solar Impulse Foundation, 2017). As stated by International Energy Agency (IEA), global energy demand could increase by more than 50% by 2030 in the absence of public policies.

Everyone is witnessing the skyrocketing of energy costs while perceiving an exponential decrease in the supplies of fossil fuels (Sachdev et al., 2017). This necessitates the development of energy-saving methods that also prioritize environmental protection. Everyone is aware that fossil fuels are polluting and limited, and that energy scarcity is undoubtedly caused by overconsumption, overpopulation, and energy waste. People may be planning their own deaths if they continue to consume and promote these for an extended period of time.

Renewable energy comes from natural sources that replace themselves more quickly than they are used up. Examples of such sources that are continuously replenished are the sun and the wind. There are many different types of renewable energy available to us. On the other hand, non-renewable fossil fuels like coal, oil, and gas require hundreds of millions of years to create. When fossil fuels are used to create energy, they emit dangerous greenhouse gases like carbon dioxide. More emissions are produced by burning fossil fuels than by producing electricity from renewable sources. The key to solving the climate catastrophe is switching from fossil fuels, which now produce the majority of emissions, to renewable energy. In most nations, renewable are now more affordable and create three times as many jobs than fossil fuels (United Nation, 2022).

To establish a balance between socio-economic advances like using renewable resources when we think of environmental conservation and enhancing our economy with equal regard. Finding various natural sources of energy or electricity is a topic of inquiry for many scientists. It is rather obvious that we need to address this issue right away rather than wait until it starts to seriously affect us in 20 years. A new energy technology must undergo extensive research and development before it can be used.

The growth of renewable energy sources that harness the power of the wind, waves, and sun may appear to be insufficient as a supply of alternative electricity. This project aims to develop a power generator without the use of fossil fuels because using them would harm the environment. As we know, this causes many things on earth, such as climate change. That is why researchers attempted to discover other environmentally friendly sources of energy. Human body can be an alternative source of energy too. It contains enormous quantities of energy which can be used to fuel the movement and essential body

functions. However, most of the energy are wasted as heat and other types of energy. This wasted energy could be captured and turned into electricity (Dahari, 2018).

Energy from the human body is more reliable than energy from natural resources. Many technologies have been developed recently in order to harness energy from the human body. The most recent development today is the piezoelectric sensor as a renewable energy source, which makes use of the kinetic energy generated by the force being pressed to the door mat to generate natural electricity. Utilizing the piezoelectric phenomenon, this energy-harvesting idea produces energy by transforming mechanical stress into electric energy.

The capacity of some materials to produce an electric charge in response to applied mechanical stress is known as the piezoelectric effect. The fact that the piezoelectric effect is reversible means that materials showing the direct piezoelectric effect, which is the creation of electricity when stress is applied, also show the reverse piezoelectric effect, which is one of its special properties, which is the generation of stress when an electric field is applied. The production and detection of sound, the formation of high voltages, the generation of electronic frequencies, microbalances, and ultra-fine focusing of optical assemblies are only a few of the applications where the piezoelectric effect is particularly helpful. The piezoelectric effect is also employed in less sophisticated settings, such as in cigarette lighters, where it serves as the ignition source (Nanomotion, 2018).

This study aimed to create an Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology, a device that produces electricity from the conversion of kinetic energy to electrical energy by the piezoelectric transducer through mechanical

pressure. The study compile started from September 2022 to June 2023. This was evaluated by ten residents from the Municipality of Bangar, La Union using varying weights. They assessed the device by pressing for 5 seconds and each respondent has three trials with different weights or force. The electrical current and voltage output was measured by the researcher through a digital multimeter. One of the limitations of this project is that it solely depends on the pressure being pressed through the piezoelectric sensor and the acceptability of the device Improvised Energy Harvesting with Piezoelectric Technology.

This study aims to determine the effectiveness of Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology as a natural source of energy.

1. What is the device's level of efficiency in terms of producing:
   a) Voltage output
   b) Current output, and
   c) Power generated
2. What is the correlation between user's weight and production in terms of:
   a) Voltage output
   b) Current output, and
   c) Power generated
3. What is the level of effectiveness of the Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology as an energy source for small electronic devices?

This study will help to raise awareness to people on how to be responsible in using electricity and to use renewable electricity and should help to solve problems during

blackouts and encourage the community to use renewable energy. This study will be crucial in society because it will benefit everyone by providing energy for small devices. It generates electricity by converting kinetic energy into electrical energy, which can then be used to power electronic devices such as phones.

Without a doubt, it is the application of science that will assist people in conserving the natural environment and resources, as well as reducing the emission of pollutants and greenhouse gases, which is a major concern for our environment. It also has the potential to reduce energy costs due to the fact that this product is self-sustaining and generates electricity solely through mechanical stress. It only requires a one-time installation or purchasing cost, which saves money and energy in the long run. When used properly, there will be better energy management and savings, particularly at home and school.

Here are the key terms to further understand the content and concept of the study.

Renewable energy is defined as energy derived from natural sources that is replenished at a rate greater than that at which it is consumed. Sunlight and wind are two such continuously replenishing sources.

Piezoelectric Sensor do not require an external voltage or current source and can generate an output signal based on the strain applied. A piezoelectric sensor converts physical parameters, such as acceleration, strain, or pressure, into electrical charges that can then be measured. They are highly sensitive and small in size, making them ideal for everyday objects.

Kinetic energy is a type of power possessed by a moving object or particle. When an item is subjected to work, which involves the transfer of energy, it accumulates kinetic energy which is determined by its mass as well as its rate of motion.

Piezoelectric Effect occurs when kinetic or mechanical energy is converted into electrical energy as a result of crystal deformation. When a piezoelectric material is mechanically stressed, the positive and negative charge centers in the material shift, resulting in an external electric field.

Voltage is the pressure from an electrical circuit's power source that drives charged electrons (current) through a conducting loop, allowing them to perform tasks such as lighting a lamp.

Current is the movement of particles that begins when an external voltage is applied to one end of a conductor. As a result of being drawn to the positive terminal of the external

voltage, negatively charged electrons form an electric field around them. Electric current is classified as either direct or alternating.

Electric power is the rate at which electrical energy is transferred across an electric circuit. P denotes and measures power using the SI unit of power, the watt, or one joule per second. Electric batteries and generators are commonly used to generate and supply electricity.

CHAPTER II

METHODOLOGY

The study's methodology is covered in this chapter. It discusses each element of the hardware requirements and design considerations for the prototype. This chapter also demonstrates how to set up the ‘Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology’ properly. The following section explains the actions taken to examine the appropriate output energy through procedure and analysis. The main goal of this project is to produce output energy.

Research Design

Quantitative research involves collecting and analyzing numerical data. It is ideal for identifying trends and averages, making predictions, testing relationships, and generalizing results for large populations. This method is widely used in natural and social sciences, such as biology, chemistry, psychology, economics, sociology, marketing, and others (Fleetwood, 2023).

Specifically, experimental research design was used. Experimental research design is the process of conducting research in an objective and controlled manner to maximize precision and reach particular conclusions about a hypothesis statement. Typically, the goal is to determine the impact a factor, an independent variable, or a dependent variable has on another. Experimental research design is also a framework of protocols and procedures established to conduct scientific experimental research with a set of variables. Here, the variables serve as a constant and is used to calculate the experiment, which assists a

researcher in collecting the information required for better research decisions and establishing the validity of a study (Sirisila, 2022).

Materials and Equipment

The researchers gathered their materials from online shops from Lazada, which are the piezoelectric disc sensors. Materials such as vinyl tiles and rubber mat were bought in San Fernando City. The digital multimeter, battery, wires, PCB board, capacitor, diodes, epoxy glue, and lead wire were bought from Tagudin, Ilocos Sur. The other materials were already available, such as the cutter and soldering iron.

General Procedure

The researchers were assisted by an expert and based the procedure from a previous study in conceptualizing the “Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology” device’s external and internal working systems of the device.

Making The Platform

To create the base of the piezoelectric floor mat, the vinyl tiles used is 24 x 12 inches. The researchers used a vinyl tile since it is a good insulator as a platform for the 60 piezoelectric discs. The rubber mat below the vinyl tiles is used as a base support since if the material is too stiff, the piezo elements will break due to too much flexing and the piezoelectric discs won't bend at all thus converting less power.

Position and align all sixty (60) 35 mm piezoelectric disc in the vinyl tiles. Leave a 2.5 cm margin on all four sides of the vinyl tiles and 1.3 spaces between the piezoelectric discs. After fixing the lineup of the piezoelectric discs, next is to use the pencil to trace the

position of the piezoelectric discs on the vinyl tiles. Then the researcher uses a drilling tool to cleanly cut out the holes. Then the piezoelectric discs were glued above the vinyl tile hole with epoxy. The piezoelectric discs should withstand a lot of flexing because the user will be stepping on them repeatedly.

Linkage of Electronic Components

The researcher created circuits out of wires and connected them to each piezoelectric element. The wires were lengthened to prevent damage and disconnections. All wires are connected in series with the use of soldering iron because there is a greater need for voltage than current.

The wires were connected into the diode that are in full-wave bridge rectifier to convert the input to one of constant polarity as opposed to a half-wave rectifier which only passes one half cycle while blocking the other. It also converts alternative current (AC) supply voltage to direct current (DC) supply voltage.

The diode is connected to the capacitor which will act as a filtering capacitor that stores electrical energy. The diode, and capacitor are placed and connected in a 4x3 inches PCB board and were linked to the lithium battery that was placed beside the PCB board.

Constructing and Assembling Parts of Device

For the installation process and assembling the device, the vinyl tile is placed above the rubber mat with piezoelectric sensor. A small circular rubber was attached to the vinyl tile, when placed above the rubber mat, the piezoelectric sensor will bend if applied with

force above the vinyl tile thus producing electricity. The circular rubber were positioned carefully to correspond with the piezoelectric sensor's position.

Participants of the Study

The study entitled "Improvised Energy Harvesting Door Mat Equipped with Piezoelectric " used simple random sampling as a sampling process. Since the study was based on the different weights of the respondents, the researcher could randomly choose their respondents to test the device so that the researchers could determine the effectiveness of the device in terms of their weight.

A simple random sample is a subset of a statistical population in which each member has an equal chance of being selected. A simple random sample is intended to represent a group in an unbiased manner. (Hayes, 2022)

There were ten (10) respondents with different weights that were picked to test the device in three (3) trials to determine the efficiency of the device in terms of voltage output, current output and power generated.

Data Gathering Instrument

The researchers used a digital multimeter as the data gathering instrument, which is a measuring instrument that can measure quantities such as voltage, current, and resistance. Measured values are shown on a digital display, allowing them to be read easily and directly, even by first-time users.

To assess the condition of electronic devices such as the piezoelectric door mat device, measuring tools are required. Since this information cannot be seen, digital

multimeters are advised when you need to examine the state of an electronic item (Hioki, 2022).

Treatments

Chosen participants of different weights stepped on the device with both feet. There were three trials each per participant stepping on the floor mat. Every trial lasted for 5 seconds. The data observed and recorded was analyzed. The efficiency in electrical output for both voltage, current and power were assessed by the researcher using a digital multimeter and with the assistance of an expert. There are two treatments used to test the efficiency of “Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology” in terms of voltage output, current output and power generated.

T_0 – is the voltage, current and power produced by stepping with hard press of the respondent in 5 seconds with 3 trials.

Data Management

To determine the average results in the voltage output, current output and power generated, the collected data was analyzed by calculating the data's central tendency, also known as the statistical mean. (ΣX)/N represents the term "mean," which is the average score of a given variable. The statistical mean, which refers to the average value of a group of numbers, is the most commonly used measure of central tendency. The average, or mean, is calculated by adding all the figures and dividing by the number of values. It is derived from the formula u=(ΣX)/N, the sum of all the scores in the distribution (ΣX) divided by the total number of scores (N) (Sykes et al., 2016). This statistical tool is suitable

for this study because it only evaluates the electrical output of the improvised energy-harvesting floor mat without comparing it to any other treatment.

Ethical Consideration

It is the researchers' ethical responsibility to ensure, follow, and keep an eye on ethical considerations during the conduct of the study in order to achieve good and unbiased results as well as to ensure the quality and integrity of the research. The confidentiality and anonymity of the participants were respected because their protection of privacy had to be ensured. Before they tested the device, the researcher gave them a comprehensive explanation of the objectives and the importance of why the study was being carried out. Any type of communication in relation to the research was done with honesty and transparency. Hence, the data that was gathered was analyzed with such uprightness that there was no addition or omission of results just to support claims, hypotheses, or other data. Works of other authors used in any part of the research with the citation system were fully acknowledged.

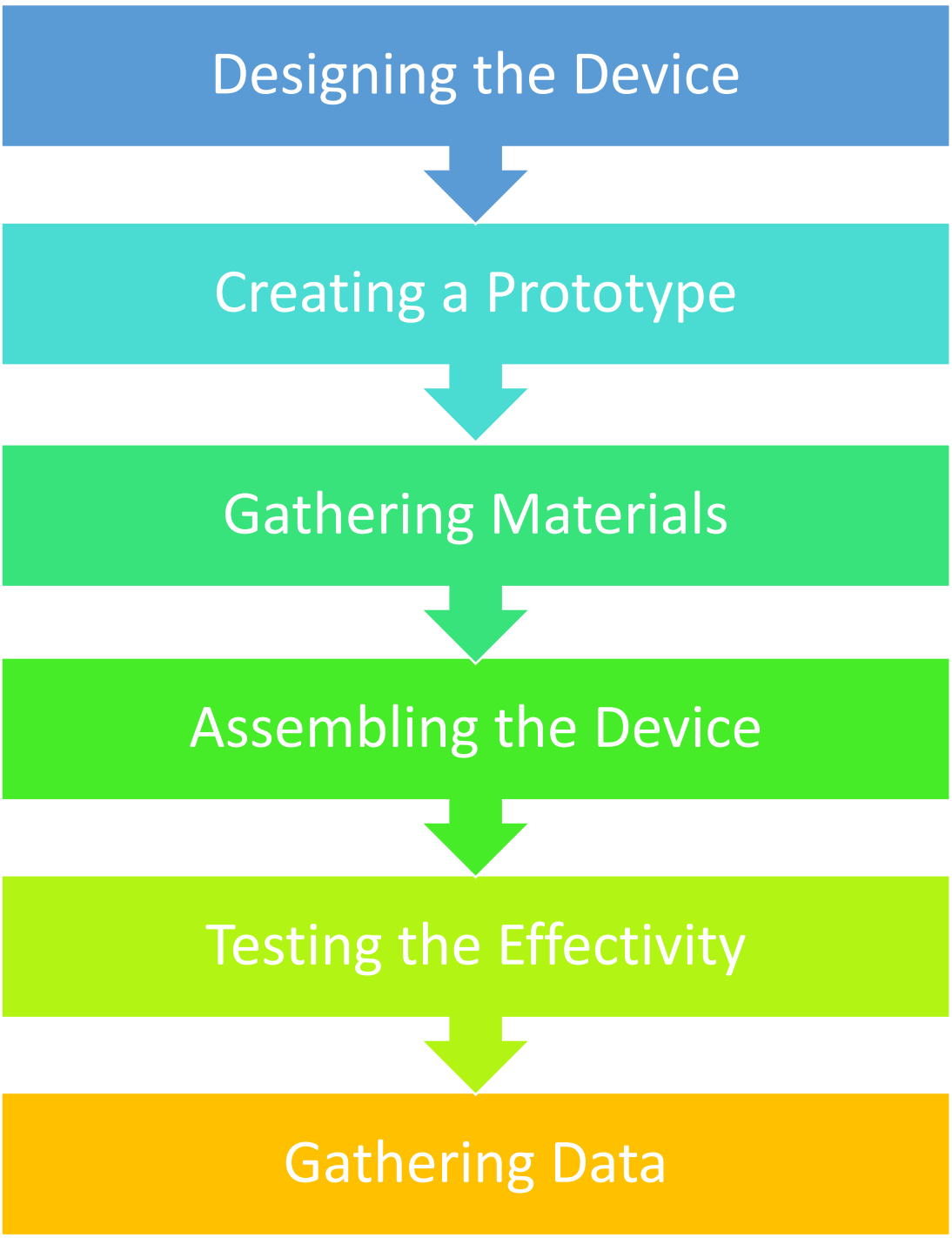

Figure 1. Flowchart of the Data Gathering Process

CHAPTER III

RESULTS AND DISCUSSIONS

This chapter includes the gathered data that were statistically analyzed with consequent findings and discussions.

Table 1: Comparison of Voltages Produced by Different Weights

	Trial		
Kg	1	2	3
42	13.6V	10.9V	14.3V
43	16.8V	14.3V	14.4V
45	19.3V	17.5V	15.4V
49	17.5V	17.6V	19.7V
50	17.4V	18.3V	19.5V
52	20.2V	19.5V	19.3V
53	19.9V	19.6V	19.4V
55	20.3V	21.1V	19.7V
56	20.1V	21.4V	20.9V
58	22.3V	21.7V	21.4V
Mean	18.72V	18.13V	18.4V

The Table 1 shows the comparison of voltage output produced by the respondents with different weights while pressing. Higher voltages were generated by the respondent with a heavier weight compared to the respondent with a lighter weight. As shown on the table in Trial 2, the voltage produced by the respondent with 42 kg is 10.9 volts, compared to the voltage produced by the respondent with 58 kg, which is 21.7 volts.

The voltage produced in Trial 1 by the respondent with 45 kg conducted 19.3 volts, unlike the 49 kg, which is a higher mass and conducted 17.5 volts. This indicates that the voltage generated from the floor mat doesn't rely solely on the weight of a person, it also varies depending on how the person steps on the mat, which may trigger the volts.

It also shows the comparison of average voltage outputs produced at different weights. The electrical voltage output is generated from the least weighted respondent to the highest weighted respondent. This means that the higher the weight and pressure applied, the higher the voltage output. The average voltage output of the Energy Harvesting Floor Mat Equipped With Piezoelectric Technology is 12.77 volts to 18.42 volts, while the average voltage needed by a device is 12 volts to 24 volts, which is enough to power most small electronic devices. This indicates that the device is effective and can provide power for small electronic devices.

Table 2: Comparison of Currents Produced by Different Weights

	Trial		
Kg	1	2	3
42	2.66 A	2.32 A	3.51 A
43	3.36 A	3.63 A	3.43 A
45	4.48 A	4.55 A	4.52 A
49	4.61 A	4.63 A	4.12 A
50	4.57 A	4.53 A	4.68 A
52	5.52 A	5.23 A	5.41 A
53	5.41 A	5.31 A	5.31 A
55	5.68 A	5.23 A	5.45 A
56	5.29 A	5.63 A	5.81 A
58	6.52 A	6.23 A	6.01 A
Mean	4.28 A	4.73 A	4.83 A

The Table 2 shows the comparison of current output produced by the respondents with different weights while pressing. Higher currents were produced by the respondent with a heavier weight compared to the respondent with a lighter weight. But we can also see that there is not much difference between the current produce by the lightest weight which is 42 kg and the heaviest weight which is 58 kg.

It also shows the comparison of average current produced at different weights. The electrical current is produced from the least weighted respondent to the highest weighted respondent. This means that the higher the weight and pressure applied, the higher the

current produced. Based on the table, the current in the three trials has minimal changes, and the device can produce from 4.08 amperes up to 4.61 amperes. A normal power bank has an average ampere between 1 ampere and 3.5 ampere, the higher the amperage, the faster the power bank will charge your devices. This indicates that the Energy Harvesting Floor Mat Equipped With Piezoelectric Technology is effective and can provide power for small electronic devices. This indicates that the power generated from the device doesn't rely solely on the weight of a person but also on how the person steps on the floor mat.

Table 3: Comparison of Power Produced by Different Weights

	Trial		
Kg	1	2	3
42	36.18 W	25.29 W	50.19 W
43	56.45 W	51.91 W	49.39 W
45	86.46 W	79.63 W	69.61 W
49	80.68 W	81.49 W	81.16 W
50	79.52 W	82.90 W	91.26 W
52	110.4 W	101.99 W	104.41 W
53	107.66 W	104.08 W	103.01 W
55	115.30 W	110.35 W	108.15 W
56	106.33 W	120.48 W	121.43 W
58	145.40 W	135.19 W	128.61 W
Mean	92.44W	89.33W	90.72W

The Table 3 shows the comparison of the power produced when pressed by the respondents with different weights. According to trial 2, respondents with heavier weights produced more power than respondents with lighter weights. Additionally, the power produced is not only dependent on the person's weight since, based on trial 1, responders weighing 45 kg produced 86.46 watts, but a respondent weighing 50 kg, who is heavier, produced 79.52 watts. This suggests that the power produced by the device depends on the user's footfall on the floor mat as well as their weight.

It also shows the comparison of average power generated at different weights. The electrical power is generated from the least weighted respondent to the highest weighted respondent. This means that the higher the weight and pressure applied, the higher the power generated. Based on the table, the power generated in three trials per treatment has minimal changes and the device can produce a minimum of 56.90 watts to a maximum of 90.83 watts while a device normally uses an average power of 30 watts and 70 watts. This indicates that the Energy Harvesting Floor Mat Equipped With Piezoelectric Technology is effective and can provide power for small electronic devices.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

The researchers arrived at a conclusion that the Improvised Energy Harvesting Door Mat Equipped with Piezoelectric Technology is efficient in terms of producing voltage output, current output and power generated which means, it can be used as an alternative source of electricity. It can charge small electronic devices depending on the weight and pressure applied by a person. The researchers also concluded that the heavier mass produces higher voltage, current and power, but stronger pressure placed on the Piezoelectric Door Mat can also produces higher voltage, current and power regardless of weight of the user. It may take longer for the battery to be fully charged, but the researcher can say that having free energy without paying a large amount for electricity is already a big benefit, especially since the project only uses a massive amount of energy that has been wasted day by day in the past. Now that there is such a device that can not only lighten people's burdens but also lessen the burden that the environment is currently experiencing because piezoelectric discs do not produce any product waste that can harm the environment. This project uses renewable resources and is environmentally friendly.

This study recommends that the design and physical features of the device should be improved to make it more effective and efficient. The electrical components should be wired systematically to avoid damages, disconnection and to ensure the safety of the user. The device should be used with materials that are waterproof so that the internal components are protected from external environment and the user will not be harmed by being electrocuted as the device gets drenched with water.

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Appendices

Appendix A

Appendix Table 1: Mean of Voltages Produced by Different Weights

	Trial		
Kg	1	2	3
42	13.6V	10.9V	14.3V
43	16.8V	14.3V	14.4V
45	19.3V	17.5V	15.4V
49	17.5V	17.6V	19.7V
50	17.4V	18.3V	19.5V
52	20.2V	19.5V	19.3V
53	19.9V	19.6V	19.4V
55	20.3V	21.1V	19.7V
56	20.1V	21.4V	20.9V
58	22.3V	21.7V	21.4V
Mean	18.72V	18.13V	18.4V

$$\mu = \frac{(\Sigma X)}{N}$$

=(13.6+16.8+19.3+17.5 +17.4+20.2+19.9+20.3+ 20.1+22.3) /10

=18.72V

$$\mu = \frac{(\Sigma X)}{N}$$

=(10.9+14.3+17.5+17.6 +18.3+19.5+19.6+21.1+ 21.4+21.7) /10

=18.13V

$$\mu = \frac{(\Sigma X)}{N}$$

=(14.3+14.4+15.4+19.7 +19.5+19.3+19.4+19.7+ 20.9+21.4) /10

=18.4V

Appendix Table 2: Mean of Currents Produced by Different Weights

	Trial		
Kg	1	2	3
42	2.66 A	2.32 A	3.51 A
43	3.36 A	3.63 A	3.43 A
45	4.48 A	4.55 A	4.52 A
49	4.61 A	4.63 A	4.12 A
50	4.57 A	4.53 A	4.68 A
52	5.52 A	5.23 A	5.41 A
53	5.41 A	5.31 A	5.31 A
55	5.68 A	5.23 A	5.45 A
56	5.29 A	5.63 A	5.81 A
58	6.52 A	6.23 A	6.01 A
Mean	4.28 A	4.73 A	4.83 A

$$\mu = \frac{(\Sigma X)}{N}$$

=(2.66+3.36+4.48+4.61 +4.57+5.52+5.41+5.68+ 5.29+6.52) /10

=4.28 A

$$\mu = \frac{(\Sigma X)}{N}$$

=(2.32+3.63+4.55+4.63 +4.53+5.32+5.31+5.23+ 5.63+6.23) /10

=4.73A

$$\mu = \frac{(\Sigma X)}{N}$$

=(3.51+3.43+4.52+4.12 +4.68+5.41+5.31+5.45+ 5.81+6.01) /10

=4.83A

Appendix Table 3: Mean of Power Produced by Different Weights

	Trial		
Kg	1	2	3
42	36.18 W	25.29 W	50.19 W
43	56.45 W	51.91 W	49.39 W
45	86.46 W	79.63 W	69.61 W
49	80.68 W	81.49 W	81.16 W
50	79.52 W	82.90 W	91.26 W
52	110.4 W	101.99 W	104.41 W
53	107.66 W	104.08 W	103.01 W
55	115.30 W	110.35 W	108.15 W
56	106.33 W	120.48 W	121.43 W
58	145.40 W	135.19 W	128.61 W
Mean	92.44 W	89.33 W	90.72 W

$$\mu = \frac{(\Sigma X)}{N}$$

=(36.18+56.45+86.46+80.68+79.52+110.4+107.66+115.30+106.33+145.40) /10

=92.44W

$$\mu = \frac{(\Sigma X)}{N}$$

=(25.29+51.91+79.63+81.49+82.90+101.99+104.08+110.35+120.48+135.19) /10

=89.33W

$$\mu = \frac{(\Sigma X)}{N}$$

=(50.19+49.39+69.61+81.16+91.26+104.41+103.01+108.15+121.43+128.61) /10

=90.72W

Plates

Plate 1. Materials

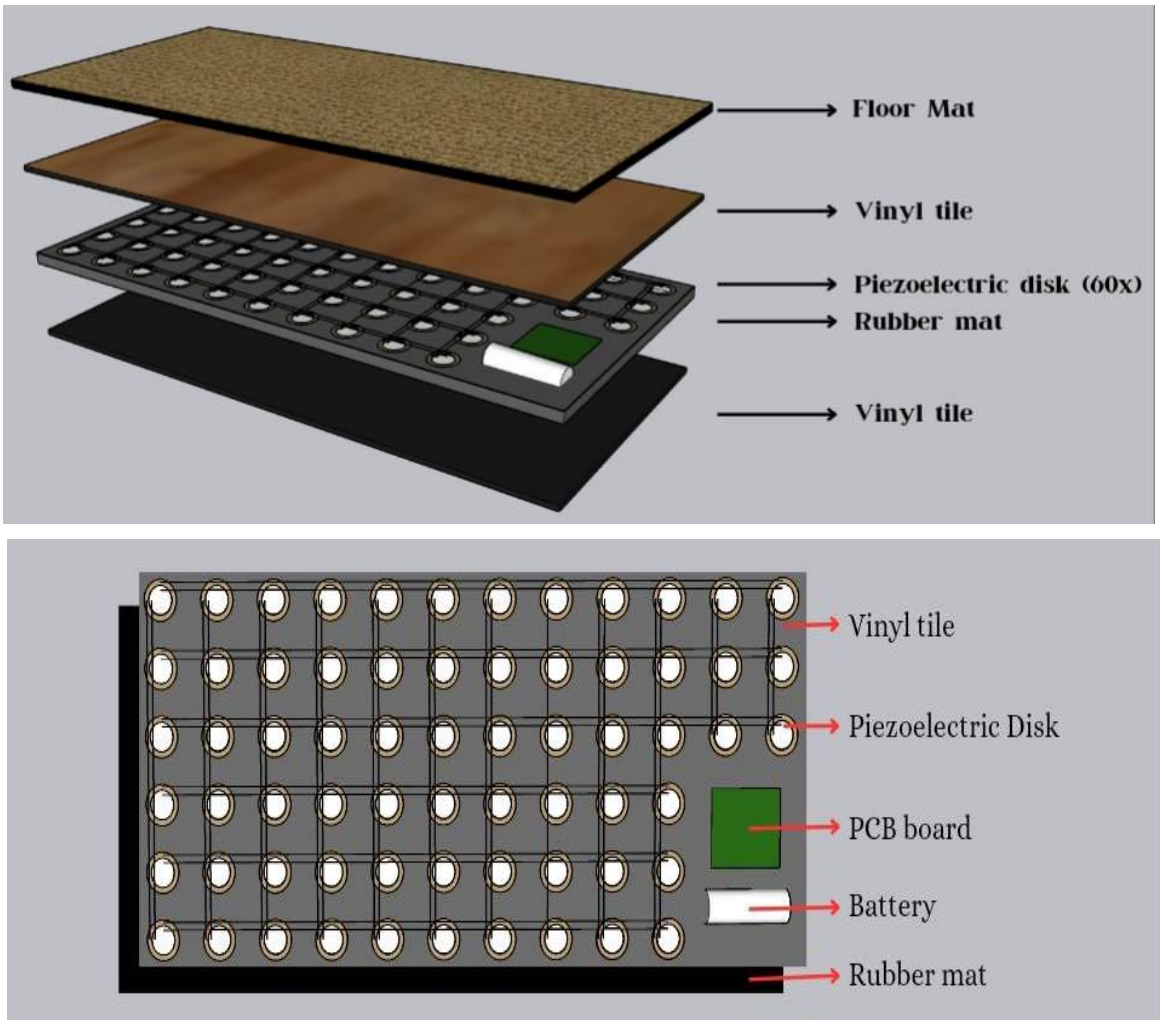

Plate 2. Virtual Prototype

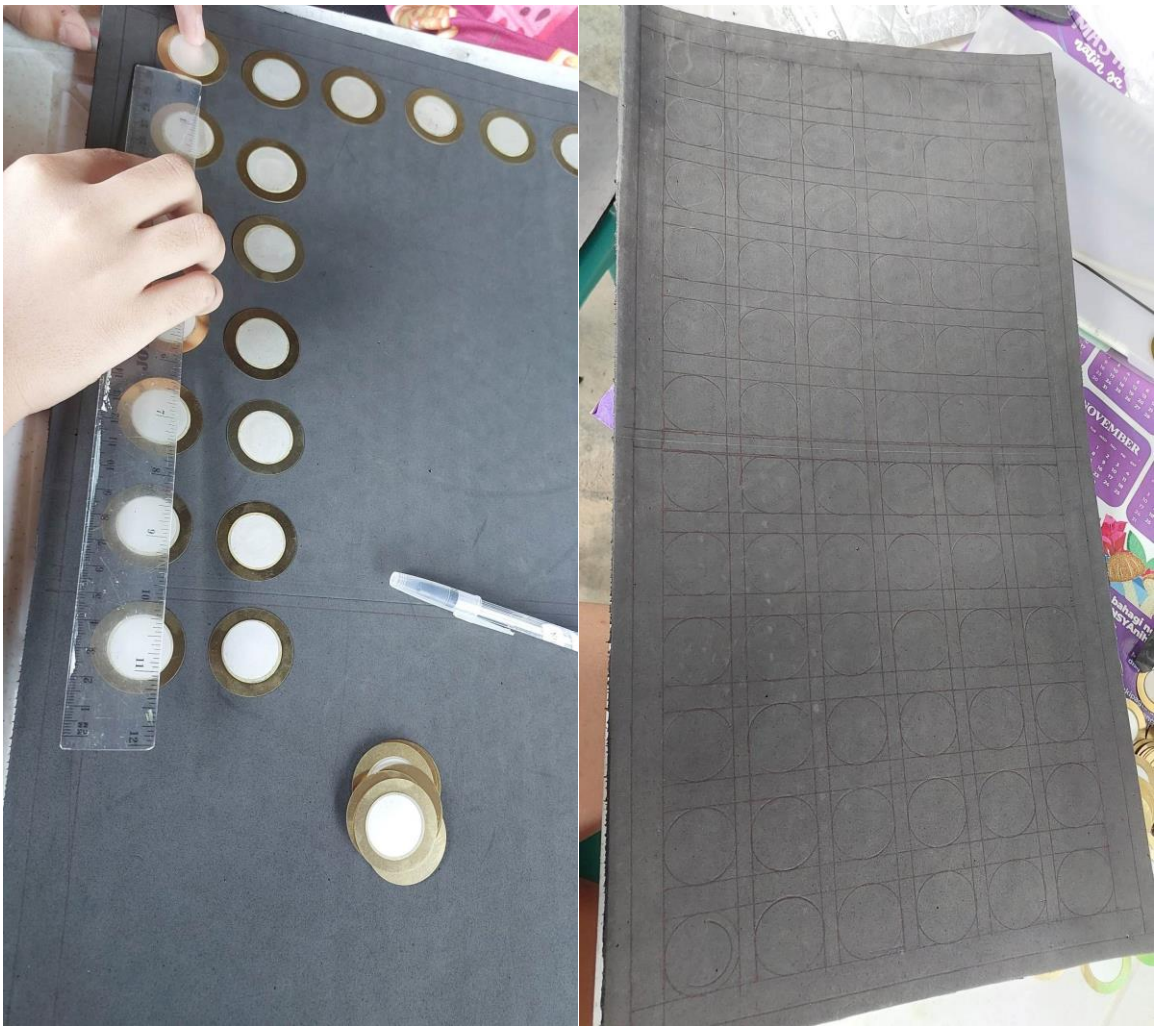

Plate 3. Align piezoelectric discs

Plate 4. Drilling of holes on the vinyl tile and rubber mat

Plate 5. Glue the piezoelectric discs above the vinyl tile holes

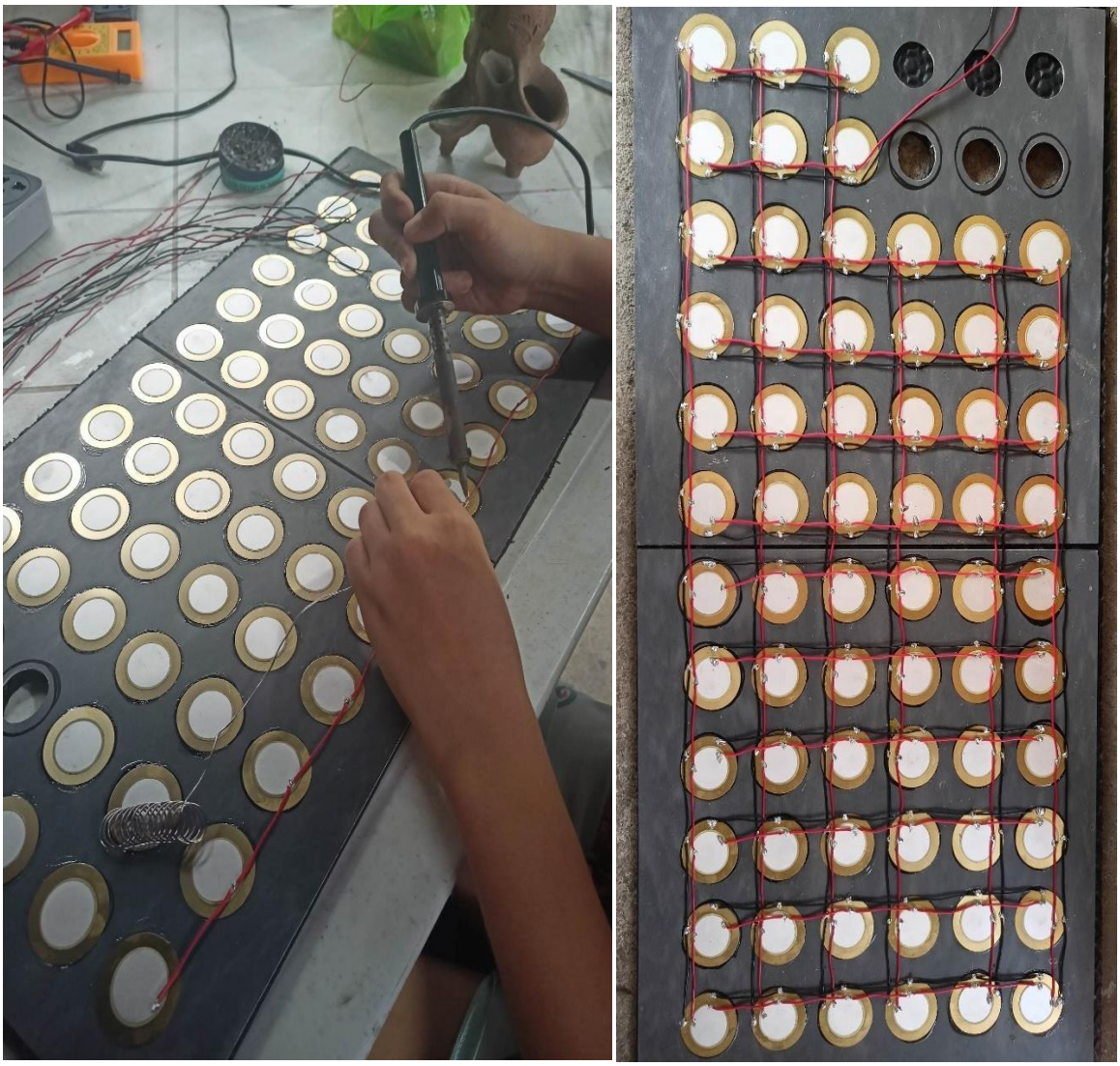

Plate 6. Connect wires in series with soldering iron

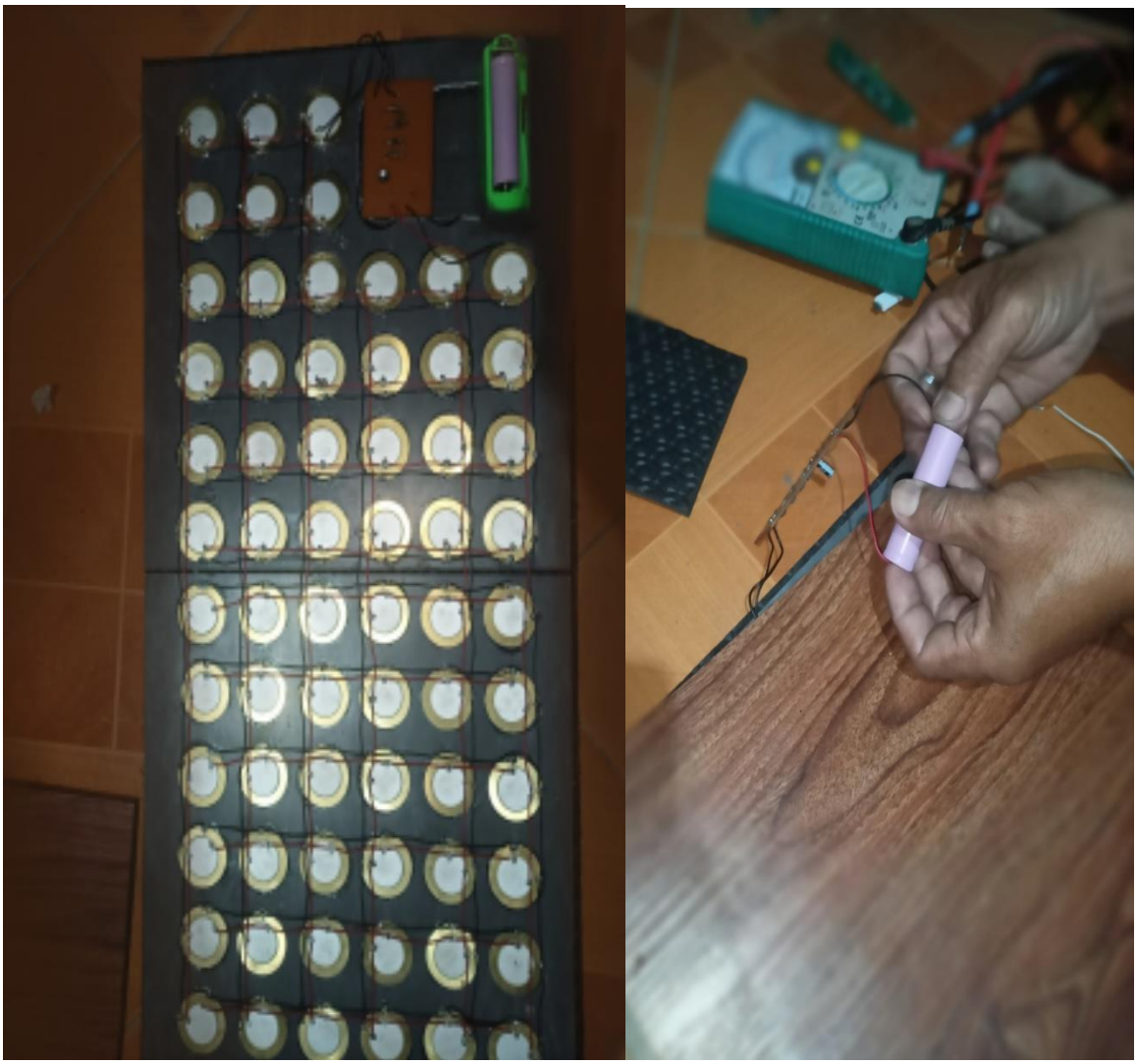

Plate 7. Assembling the Device

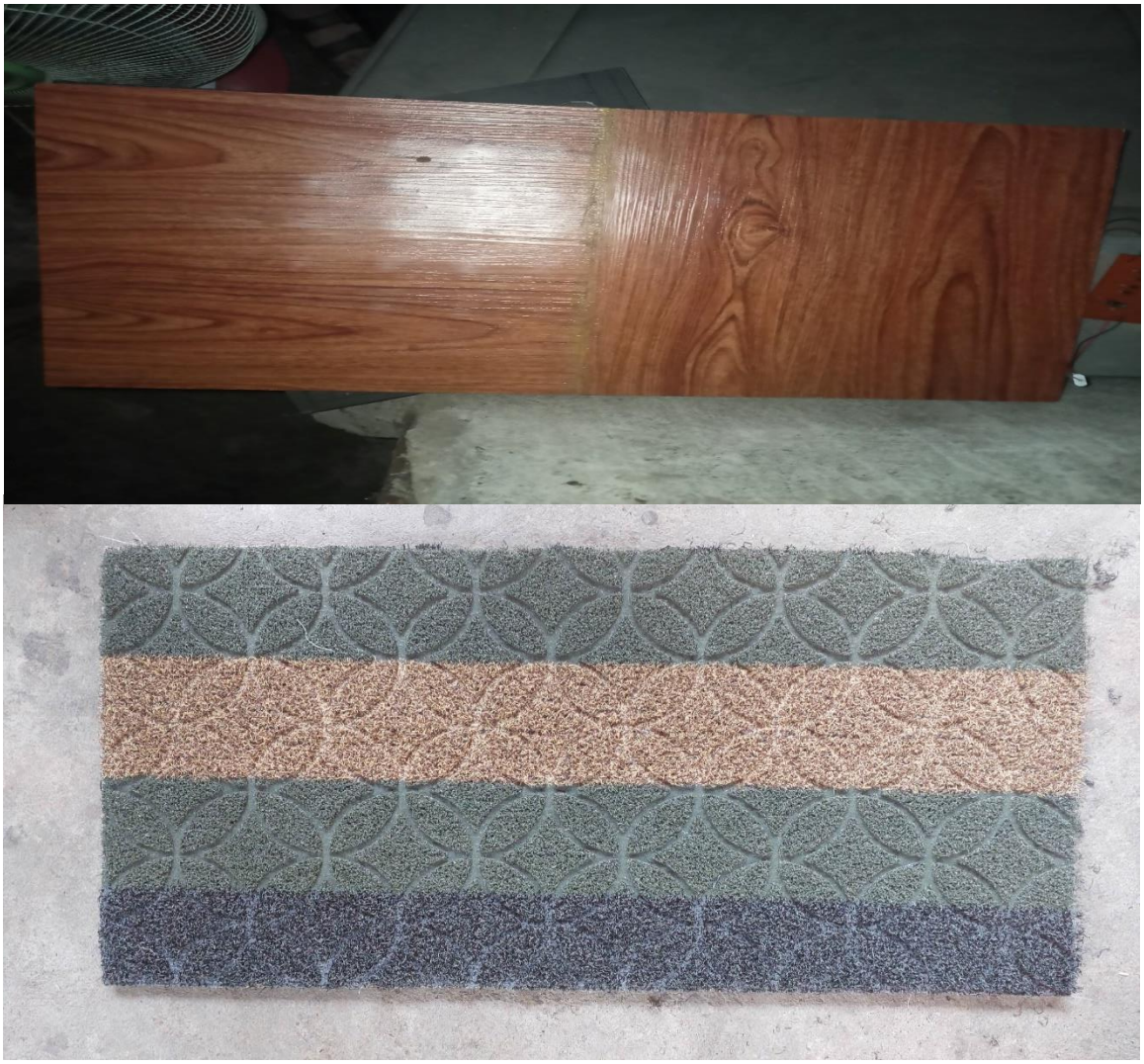

Plate 8. Final Output

Plate 9. Testing of device

Appendix B

Data Logbook

Activities	Date Started	Date Finished	Details
Choosing a topic and formulation of problem	August 25, 2022	September 13, 2022	The researchers where task to choose atleast 3 to 5 research topic for title defense.
Title defense	September 14, 2022	September 16, 2022	The study "Energy Harvesting Floor mat" was defended
Making of Chapter I	September 22, 2022	September 25, 2022	The researchers started their chapter I after gathering important information
Checking of Chapter I	September 27, 2022	September 27, 2022	The research adviser checks the chapter I if there's any error
Revising of Chapter I	October 1, 2022	October 2, 2022	The researchers revised and formulated the Chapter I
Revising and finalizing of chapter I, including the research title	November 8, 2022	November 12, 2022	The researchers finalized their Chapter I and the title was changed to "Energy Harvesting Door mat equipped with Piezoelectric Technology"
Making of Chapter II	November 21, 2022	November 25, 2022	The researchers worked on their Chapter II
Checking of Chapter II	January 13, 2023	January 23, 2023	The research adviser check if there's any error on the chapter II
Finalizing Chapter II	January 14, 2023	January 15, 2023	Chapter II was formulated
Gathering of Materials	January 15, 2023	January 25, 2023	The researchers gathered their materials for their device
Planning for the Device	February 18, 2023	February 19, 2023	The researchers formulated a plan on how to assemble the part of the devices
Assembling of the device	March 15, 2023	March 30, 2023	The researchers assembled the device and checked if the device is functioning
Gathering of data	April 5, 2023	April 06, 2023	The researchers gathered data needed for their research

Making of Chapter I to Chapter IV	April 28, 2023	April 29, 2023	The researchers formulated and rechecked their Chapter I to Chapter IV for the Pre-Oral defense
Pre-Oral defense	May 1, 2023	May 1, 2023	Pre-Oral defense was conducted in order for the research adviser to assess the study of the researchers
Revising the manuscript	May 2, 2023	May 05, 2023	The researchers revised and formulated the parts of the manuscript
Changing the Platform of the device	May 15, 2023	May 16, 2023	The researchers change the platform of the device to generate more Voltage.
Finalizing of the device	May 16, 2023	May 17, 2023	The researchers finalized and assembled the device
Gathering of data	May 18, 2023	May 19, 2023	The researchers gathered the data needed in their research
Interpretation of the data	May 20, 2023	May 20, 2023	The researchers interpret and analyze the result of the gathered data
Revising of Chapter III	May 21, 2023	May 21, 2023	With the results and findings, the Chapter III and Chapter IV were formulated
Making of the Manuscript	May 23, 2022	May 23, 2023	The research formulated and finished the manuscript for the Oral Defense
Oral Defense	May 25, 2023	May 25, 2023	The researchers defend their research study
Incorporation of Suggestions and Revision	May 26, 2023	May 27, 2023	All the recommendation and the revision of the research paper were incorporated in the manuscript
Finalization of the Manuscript	May 30, 2023	May 30, 2023	The manuscript we're finalized by the researchers

Appendix C

CURRICULUM VITAE

L A R D I Z A B A L , I R I S H T R I S H A A .

RESEARCHER

PERSONAL INFORMATION

Age:	18
Gender:	Female
Date of birth:	February 15,2005
Place of birth:	Bio,Tagudin,Ilocos Sur
Address:	Reyna Regente,Bangar, La Union
Mother:	Mary Jane Lardizabal
Father:	Roland Lardizabal
Civil Status:	Single
Religion:	Roman Catholic
Nationality:	Filipino

EDUCATIONAL BACKGROUND

Primary Education: Saint Christopher Academy
Central East #1,Bangar,La Union

Secondary Education:

JHS: Regional Science High School for Region 1
Ma.Cristina West,Bangar, La Union

SHS: Regional Science High School for Region 1
Ma.Cristina West, Bangar, La Union

CURRICULUM VITAE

M I L A N E S , E I S S A H G I L E E N G .

RESEARCHER

PERSONAL INFORMATION

Age:	18
Gender:	Female
Date of birth:	December 27,2004
Place of birth:	ITRMC San Fernando City, La Union
Address:	Rizal,Tagudin,Ilocos Sur
Mother:	Geraldine G. Milanes
Father:	Frederick V. Milanes
Civil Status:	Single
Religion:	Roman Catholic
Nationality:	Filipino

EDUCATIONAL BACKGROUND

Primary Education:
Las-ud Elementary School
Las-ud, Tagudin, Ilocos Sur
2012-2017

Secondary Education:

JHS:
Asean Institute for Research Technology of the Philippine Inc.
Rizal,Tagudin, Ilocos Sur
2017-2021

SHS:
Regional Science High School for Region 1
Ma.Cristina East, Bangar, La Union
2021-2023

CURRICULUM VITAE

RAMOS, YAZMIN CYNA R.

RESEARCHER

PERSONAL INFORMATION

Age:	18
Gender:	Female
Date of birth:	April 03,2005
Place of birth:	Bangued, Abra
Address:	Barraca,Bangar,La Union
Mother:	Leila R. Ramos
Father:	Julius M. Ramos
Civil Status:	Single
Religion:	Roman Catholic
Nationality:	Filipino

EDUCATIONAL BACKGROUND

Primary Education: Fort Del Pilar Elementary School
Baguio City, Benguet

Caggao Elementary School
Bangar,La Union

Secondary Education:

JHS: Regional Science High School for Region 1
Ma.Cristina West, Bangar, La Union

SHS: Regional Science High School for Region 1
Ma.Cristina West, Bangar, La Union