



**POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ
SHAH**

SMART PET'S LITTER BOX

NAME	MATRIX NUMBER
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DEPARTMENT OF MECHANICAL ENGINEERING

SESSION II : 2021/2022

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This report is submitted to the Department of Mechanical Engineering in compliance with some of the requirements of the Diploma in Mechanical Engineering.

DEPARTMENT OF MECHANICAL ENGINEERING

SESSION II : 2021/2022

DECLARATION OF ORIGINALITY

SMART PET'S LITTER BOX

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2. We acknowledge that 'The project above' and the intellectual property contained therein are the result of our original work / design without taking or imitating any intellectual property from the other parties.
3. We agree to release the ownership of the 'Project' intellectual property to 'the Polytechnic' to meet the requirements for our Diploma in Mechanical Engineering award.

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Last but not least, a million thanks to everyone who helped make this project a reality, whether directly or indirectly. The assistance provided to us was invaluable, from the tiniest to the largest.

ABSTRACT

The conventional litter boxes had evolved throughout the century, the need of scooping the clumping litter itself is a filthy task and triggering of unpleasant smell if unattended. Thus, to address the above statement, Smart Pet's Litter Box is a project that will assist pet owners in resolving the most common problem that faced during cleaning their pet litter. The main objective for this project is to design a Smart Pet's Litter Box that help pet owners deals with their pet's excrement in an easy and practical way by employing an automated system using mechanical system combined with several electronic devices. This project uses a PIR motion sensor device as an input signal to detect the presence of pets and sends the data to the Arduino PIC micro-controller. The microprocessor engaged to send commands to the stepper motor and servo motor, which moves the rack, and control the waste tray throughout the cleaning operation. This prototype was success, and the cleaning procedure went easily as the average cleaning time was 3 minutes with an average of 75% clean percentage per process. In terms of recommendations, this project potentially improved by introduce noise suppressor for stepper motor thus reduce the motor sound. In conclusion, from this project, all of the cleaning work is no longer a burden for pet owners, and it may help them to save time, money and energy while maintaining the highest level of cleanliness in their homes and surroundings.

ABSTRAK

Kotak najis haiwan peliharaan konvensional telah berkembang sepanjang abad, tetapi keperluan untuk menapis dan membuang najis itu sendiri adalah tugas yang kotor dan mencetuskan bau yang tidak menyenangkan jika tidak dijaga. Oleh itu, untuk menangani kenyataan di atas, Smart Pet's Litter Box adalah projek yang akan membantu pemilik haiwan peliharaan dalam menyelesaikan masalah paling biasa yang mereka hadapi ketika membersihkan najis haiwan peliharaan mereka. Objektif utama projek ini adalah untuk mereka bentuk Smart Pet's Litter Box yang membantu pemilik haiwan peliharaan menangani najis haiwan kesayangan mereka dengan cara yang mudah dan praktikal dengan menggunakan sistem automatik serta sistem mekanikal bersama beberapa peranti elektronik. Projek ini menggunakan gerakan PIR peranti sensor sebagai isyarat input untuk mengesan kehadiran haiwan peliharaan dan menghantar data ke pengawal mikro PIC Arduino. Mikropemproses terlibat untuk menghantar arahan kepada motor stepper dan motor servo, yang menggerakkan rak, dan mengawal dulang sisa sepanjang operasi pembersihan. Prototaip ini berjaya, dan prosedur pembersihan berjalan dengan mudah kerana purata masa pembersihan ialah 3 minit dengan purata peratusan bersih 75% setiap proses. Dari segi cadangan, projek ini masih perlu diperbaiki kerana motor stepper menghasilkan bunyi yang bising, yang boleh dikurangkan dengan menggunakan peredam bunyi. Kesimpulannya, daripada projek ini, semua kerja pembersihan tidak lagi membebankan pemilik haiwan peliharaan, dan ia boleh membantu mereka menjimatkan masa, wang dan tenaga sambil mengekalkan tahap kebersihan tertinggi di rumah dan persekitaran mereka.

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CHAPTER 1 INTRODUCTION

1.1 - RESEARCH BACKGROUND

Pet owners have long found a simple and sanitary way to dispose of their pet waste that accumulates in the home. Many pet owners have had some success training their pets to expel waste in a container that contains disposable absorbent medium. The absorbent medium encases the pet waste, forming clumps that are later removed by the pet owner.

This project eliminates the need for pet owners to manually sift litter clumps from litter in order to prevent the drawbacks of conventional litter boxes. A mechanically driven comb using Stepper Motor, Servo Motor, an Infrared Sensor, an Arduino and a waste receptacle are used in the Smart Pet's Litter Box to separate the clumps. With a great combination of using motion sensor and timer components in this project, it could prevent any unwanted encounters, such as the pet being harm during the cleaning session. Aside from that, this project will include an Arduino as its micro-controller unit as it has a large and free code library, and does not need an external programmer.

The Smart Pet's Litter Box are suitable for both cats and dogs and is best suited to be used by an indoor pets. This project were also designed to be as long-lasting, comfortable and adaptable as the current conventional litter box for the pet owners along side with their pets. A minor change is made to include an automated system for handling and cleaning pet waste. This is where our innovation comes in handy; it is practical to be used, user friendly, environmentally friendly, time saving and disinfectant.

1.2 PROBLEM STATEMENT

The main problem for most of the pet owners nowadays were that cleaning up after their pets always takes a lot of time, resources and is unsanitary. The job of manually looking for their pet excrement is a chore that many pet owners despise. Due to the strong odour, shoveling the faeces every time would be a major hassle. Worse, the odour of faeces can evaporate into the air, contributing to emissions. Furthermore, the growing number of pet owners has raised concerns about the dangers of pathogenic diseases spread by open litter. Since certain pet diseases are transmissible to humans, exposure to pet excrement poses a health threat.

1.3 - RESEARCH OBJECTIVES

The objectives of this research are:

- I. To design a Smart Pet's Litter Box to help pet owners deals with their pet's excrement in an easy and practical way.
- II. To fabricate pet's litter box with an automated system using mechanical system along side with several electronic devices for handling and cleaning pet waste.
- III. To test this Smart Pet's Litter Box is safe, practical to use and easy to handle for pet owners.

1.4 - RESEARCH QUESTIONS

This study will answer the following research question:

- I. Is it possible to fabricate pet's litter box that fully operates using an automated system?
- II. By using motion sensor and servo motor, how does this Smart Pet's Litter Box make cleaning process faster and easier?
- III. How does the electronic system works along side with mechanical system in this Smart Pet's Litter Box?

1.5 - SCOPE OF RESEARCH

Smart Pet's Litter Box is fabricated to assist pet owners in dealing with their pets excrement on a daily basis without having to do so manually.

The scopes and limits to this research are:

- i. The litter box is specified to be used by a single-cat or dog home and under 5kg.
- ii. The cleaning process depends on how frequent the pet use the litter box in a day as it is automated to do the cleaning process 5 minutes after the pet had used the litter box.
- iii. This Smart Pet's Litter Box is specifically fabricated for pet owners.

1.6 - SIGNIFICANCE OF RESEARCH

Conventional litter boxes are, without a doubt, rapidly changing in terms of design, dimension and mechanism. It all began with a paper-lined enamelled metal pan with an optional privacy screen, but the odour associated with urine and faeces was a concern, so clay litter was invented to address this problem. The litter box, like all things meant for greatness, had to evolve. Clumping litter became common and even a semi-auto litter box was fabricated. Despite the fact that it was a brilliant idea, scooping the clumping litter itself is a filthy task. Thus, to address the above issues, this Smart Pet's Litter Box project will assist pet owners in separating and fully sealing their pet's faeces. It solves the issue of dealing with pet faeces and the stench. Pet owners can save a lot of time and energy by using this Smart Pet's Litter Box that is fully automated feature and efficient human-computer interaction function to process pet faeces.

1.7 - DEFINITION OF OPERATIONAL TERMS

- I. **Servo Motor:** A rotary or linear actuator that can control angular or linear orientation, velocity and acceleration with precision. It consists of a suitable motor coupled with a position feedback sensor.
- II. **Stepper Motor:** A brush-less direct current electric motor that divides a full rotation into a series of equal steps.
- III. **PIR Motion Sensor:** A type of electronic device that detects and measures infrared radiation in its surrounding.
- IV. **Arduino:** An open-source framework that can be used to create electronic projects. Arduino is made up of a physical programmable circuit board (micro-controller) and software (Integrated Development Environment) that runs on the computer and is used to write and upload computer code to the physical board.

1.8 - CHAPTER'S SUMMARY

The studies in this chapter describe where the project concepts and inspirations came from. All of the objectives were derived from the problem statements. The main goal of this project would be to create a Smart Pet's Litter Box that will use mechanical system in conjunction with electronic devices to address the primary concern of pet owners who must manually clean the litter box on a daily basis. In addition, the scope of this project will be focused to the limitations of the mechanical and electronic equipment mounted in the litter box, as well as how it can assist pet owners in cleaning their pet's faeces in a realistic manner. As a result, both pet owners and their pets can benefit from this Smart Pet's Litter Box.

CHAPTER 2 LITERATURE REVIEW

2.1 - INTRODUCTION

A literature review is a body of material that seeks to summarize the most important aspects of current knowledge and/or methodological methods on a certain issues. This chapter explains and describes studies that were conducted using scholarly sources such as reference books, written articles, the internet and journals. Elaboration on conventional pet litter box, an automatic litter box and a motion sensor activated servo motor using Arduino will be explained in details throughout this chapter. The goal of this chapter is to help provide a better understanding on the concept of the project through simpler and precise description.

2.2 - CONVENTIONAL PET LITTER BOX

Prepared by: Noor Aini Natasha Binti Vera Nu @ Veera Nu (08DKM19F1022)

A litter box, also named a sandbox, a pet box, a litter tray, a cat pan or litter pan, is an in-house faeces and urine box for animals, as well as rabbits, ferrets, small dogs, and other pets who use this repository naturally and through instruction. Animals who are free to travel from a building, but cannot or do not always leave to excrete metabolic waste. Many owners of such animals choose to avoid being let out for fear of succumbing to outdoor hazards. It's difficult to recall a time when this equipment wasn't commonplace, but litter boxes only became widespread in 1947, when pet owners started to think of cats as cherished family members who wanted to be kept healthy indoors [1].

Clumping pet litters are designed to extract urine and feces quickly from the box without emptying the whole box. Much of them contain a substance called bentonite, which makes the litter a good stable clump as the litter collects fluid. Alternative natural fibers are also available, which will closely clump the pet litter. The safest litter box for kittens or little pets, is around 2-3 centimeter lower. For pets of a full growing size, the box is 24 cm long or high, with 4-inch walls [2]. The pet owners need a litter box because litter box are necessities for all indoor pets. Litter box does not only provide contained and predetermined locations for a pet to urinate and defecate, but they also allow the pet owner to easily clean up after their pet throw feces. Despite the obvious uses of litter boxes, these receptacles are also very important to the mental well-being and overall health of a pet.



Figure 2.2: Conventional Litter Box

2.3 - AUTOMATIC PET LITTER BOX

Prepared by: Siti Nazierah Aqina Binti Mokta (08DKM19F1026)

Despite all of the advances in litter boxes over the last century, one big problem still remained. Pet owners still need to scoop their pet's urine and faeces. In 1991, the first patent for an automated self-cleaning litter box was issued. It proposed using a motor-driven rake to filter the solids out, similar to many modern models, which was possibly made possible by the invention of clumping litter. The early self-cleaning litter box market was dominated by rake mechanisms. Engineer Brad Baxter inherited two cats in 1999 and learned a few things. First, scooping the litter box is a dirty job. Second, using a litter box with an automated raking device can be even get dirtier. They discovered, like so many other pet owners, that the rake mechanisms would often jam or overflow, collecting faeces and waste that was a pain to clean off. [3]

The invented automatic litter box is a win-win situation for both pet owners and their feline. Pet owners can avoid scooping, and their feline can enjoy a waste-free toilet at all times. The automated pet litter box has the obvious advantage of allowing owners to go weeks without seeing a pet litter scoop and still have a happy pet. Automatic litter boxes sense when the pet has gone to the bathroom and then rake will sift the waste into a special waste receptacle, eliminating the need for them to clean the poop. A self-cleaning litter box ensures that the owner does not have to think about keeping the potty area clean because the litter box cleans itself.



Figure 2.3: Automatic Litter Box

2.4 - MOTION ACTIVATED SERVO MOTOR WITH ARDUINO

Prepared by: Siti Nuraini Binti Sazali (08DKM19F1006)

The entire circuitry and mechanism of Smart Pet's Litter Box are controlled by an Arduino in this project. A PIR motion sensor and servo motor are included to conduct a full mechanism in Smart Pet's Litter Box. To put in simple words, Arduino is a free and open-source electronics platform with simple hardware and software. The Arduino project began in 2005 as a tool for students at the Interaction Design Institute Ivrea in Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators [4]. Arduino boards can read inputs (a light on a sensor, a finger on a button) and convert them into outputs (activating a motor, turning on an LED).

As for PIR Motion Sensor, it works by detecting heat energy in the surrounding environment using a pair of pyroelectric sensors. These two sensors are placed next to each other, and when the signal differential between the two sensors changes, the sensor will engage. Meanwhile, a servo motor is a self-contained electrical device that rotates machine parts with high efficiency and precision. This motor's output shaft can be moved to a specific angle, position and velocity.

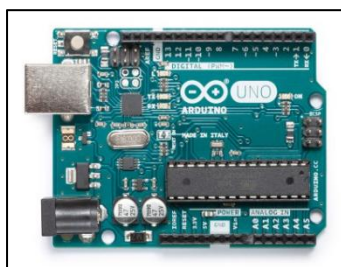


Figure 2.4.1: Arduino



Figure 2.4.2: PIR Motion Sensor



Figure 2.4.3: Servo Motor

In Smart Pet's Litter Box, the PIR (Passive Infrared) sensor will serve as its input and triggering device, detecting any movement of pets within its field of view. When movement is detected, the data is immediately sent to the Arduino board, which then activates the servo motor connected as the output. The circuitry of the device is as shown below.

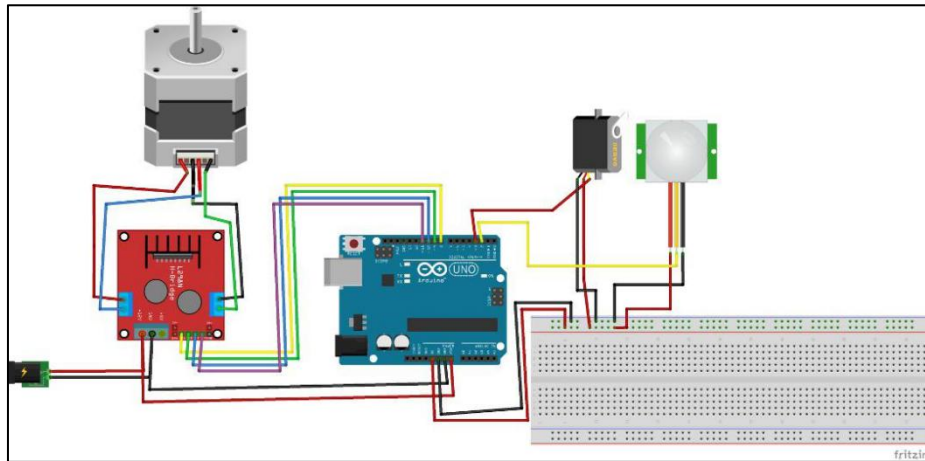


Figure 2.4.4: Smart Pet's Litter Box Circuitry

2.5 - CHAPTER'S SUMMARY

All relevant theoretical material used in the study for Smart Pet's Litter Box was reviewed in this chapter. Through this chapter, it is clear that fabricating an automatic litter box is necessary nowadays. Conventional litter boxes can still be utilized and have their own set of advantages and disadvantages, but they are too inconvenient for pet owners who are too busy to deal with their pets' waste for the day. It was also revealed that an automatic litter box has been invented in recent years, but is it too expensive for pet owners to own. As a result, this project attempts to tackle the problem by fabricating the automatic litter box and put it in the market at a reasonable price so that pet owners can purchase it and relieve their burden from the need to manually clean their pet's litter box. Besides, this chapter also include the study of methodological strategy that will be used in fabricating this Smart Pet's Litter Box.

CHAPTER 3 METHODOLOGY

3.1 - INTRODUCTION

Methodology provides an overview of the research methods used in the study. The research design that was adopted for the purpose of this study, as well as the reasons behind that choice, is described under methodology. The data gathering approach is also detailed, as are the techniques employed to carry out this project. The instrument that was used to fabricate this project are also detailed, as are the methods that were followed to conduct this project. Finally, the ethical considerations that were taken into account during the procedure are highlighted.

This chapter will go over the steps involved in fabricating Smart Pet's Litter Box in greater depth. The programming of the system are designed using Arduino IDE Software. Following that, Autodesk Fusion 360 Software are used to design the project modelling and prototyping of the product. The component, as well as all of the method implemented for the project, will be discussed. Apart from that, a flow chart and a Gantt Chart of our project will also be discussed, which will display and explain all of the project's processes and planning across the 14-week period.

3.2 - FLOW CHART

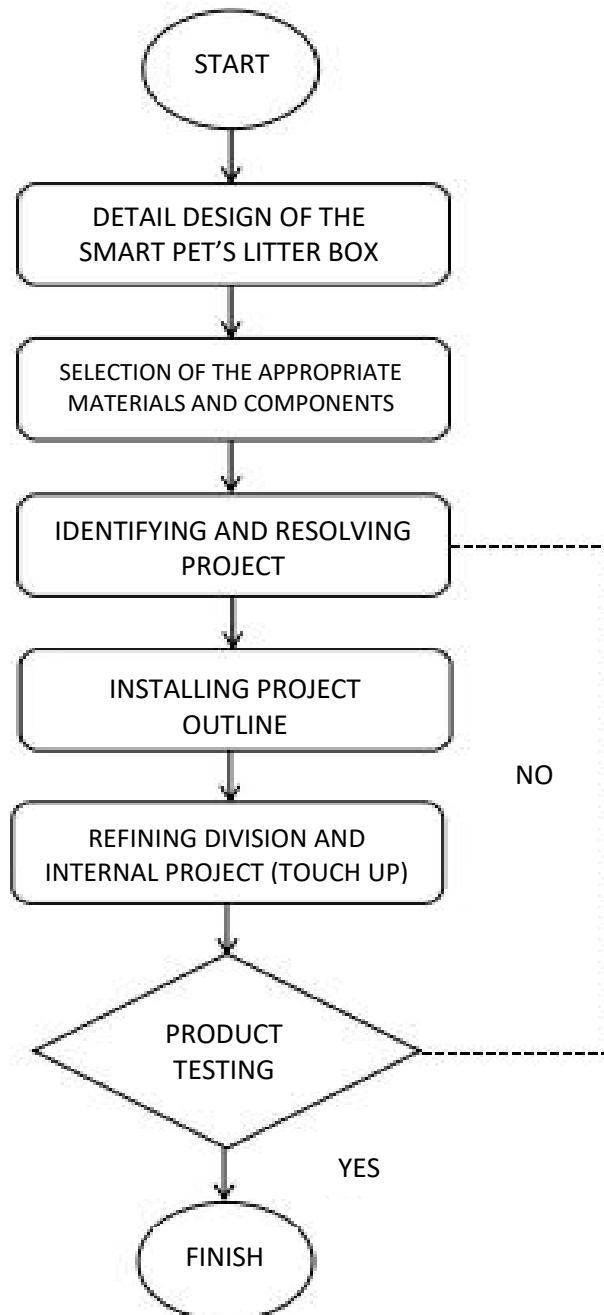


Figure 3.2: Project Flow Chart

3.2.1 - FLOW CHART EXPLANATION

Detail design of the Smart Pet's Litter Box

- The supervisor has briefed us on the final project. We also brainstorm few ideas based on the title given for our final project.

Selection of the appropriate materials and components

- We purchased the required materials and components for the project, and they came on time for us to begin installing them.

Identifying and resolving project

- We begin to establish strategies for identifying and resolving the required approach for installing all of the project's components.

Installing project outline

- We start installing all of the components and materials at the litter box using the proper method.

Refining divisions and internal project (touch up)

- We conducted multiple installation touch-ups as soon as we finished installing the components at the litter box.

Product testing

- We tested the product multiple times to guarantee that the prototyping is working properly.

3.3 - GANTT CHART

Table below show the planning schedule and implementation of project production activities.

Project Activity	Weeks													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Discussion and Guidance	Planning	Planning	Planning	Planning	Planning	Planning	Planning	Planning	Planning	Planning				
	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual				
Product Assemble			Planning	Planning	Planning	Planning	Planning	Planning	Planning	Planning				
			Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual				
Testing and Troubleshooting					Planning	Planning	Planning	Planning	Planning	Planning				
					Actual	Actual	Actual	Actual	Actual	Actual				
Project Improvement						Planning	Planning	Planning	Planning	Planning				
						Actual	Actual	Actual	Actual	Actual				
Video Making											Planning	Planning		
											Actual	Actual		
PITEX Presentation													Planning	
													Actual	
Report Writing												Planning	Planning	Planning
												Actual	Actual	Actual

Table 3.3: Gantt Chart

	Planning
	Actual

3.4 - PRODUCT DESIGN AND PROTOTYPING

Prepared by: Siti Nuraini Binti Sazali (08DKM19F1006)

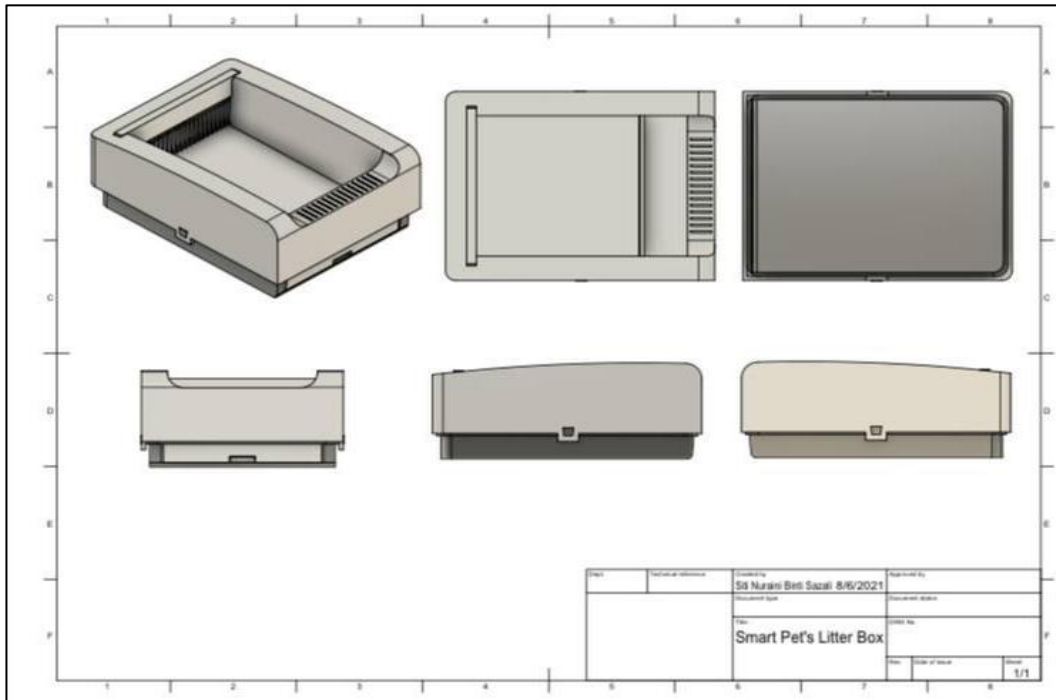


Figure 3.4.1: Product Design of The Main Body of Litter Box

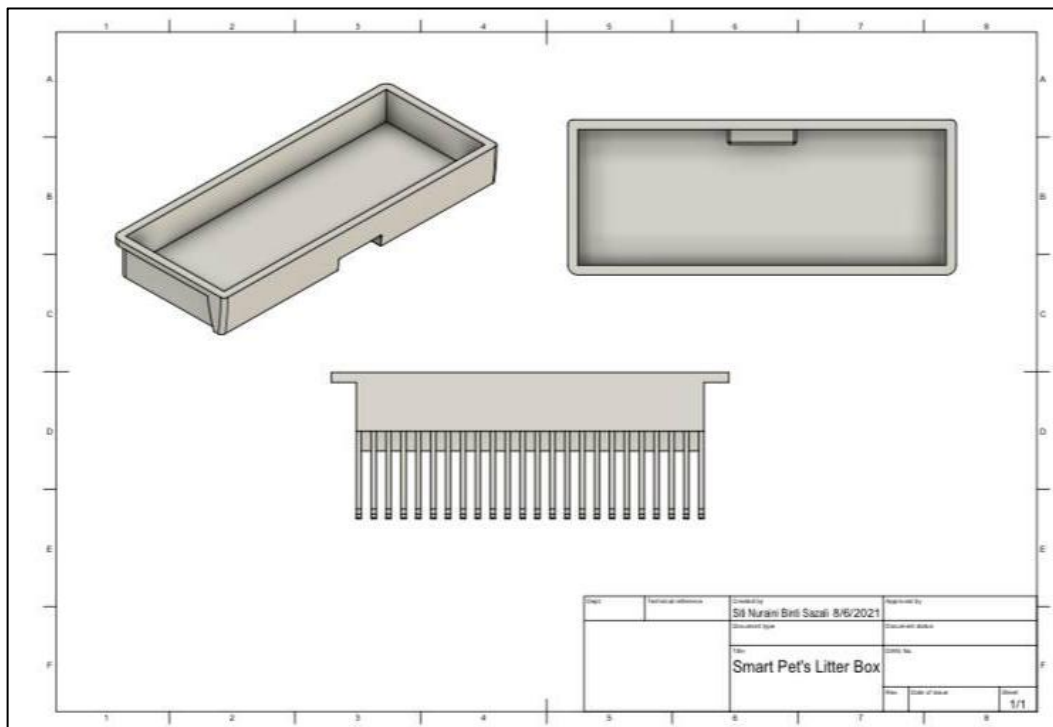


Figure 3.4.2: Product Design of The Waste Tray and Rack



Figure 3.4.3: Prototyping of The Main Body of Litter Box

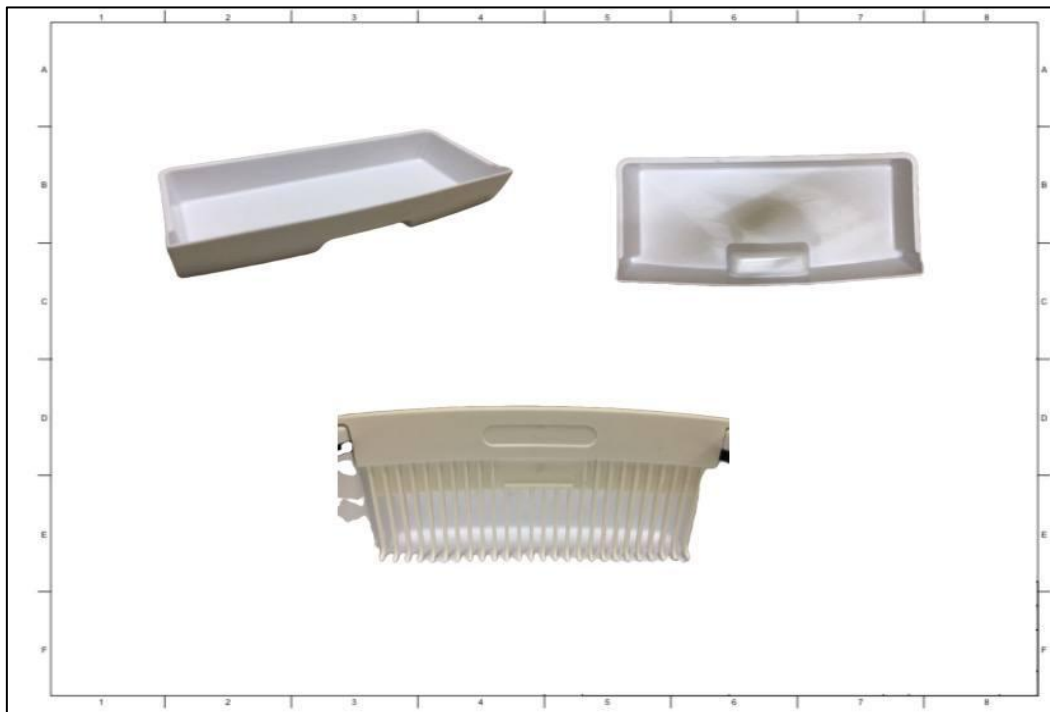


Figure 3.4.4: Prototyping of The Waste Tray and Rack

3.5 - MATERIALS AND EQUIPMENT

Prepared by: Noor Aini Natasha Binti Vera Nu @ Veera Nu (08DKM19F1022)

The most important part of the project is the litter box. In this project, the litter box is the main part that will hold the mechanical and electrical devices to conduct the cleaning process.



Figure 3.5.1: Litter Box

The main electronic device is the Arduino micro-controller. The Arduino is an open-source micro-controller board based on the Microchip ATmega328P micro-controller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits .

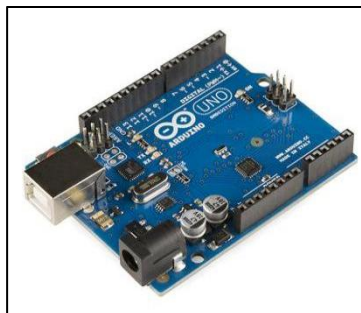


Figure 3.5.2: Arduino Micro-controller

Next, the PIR motion sensor, the functions is used when the pets enters the sensor's range, it will detects movement because the pet's body emits heat energy in the form of infrared radiation.



Figure 3.5.3: PIR Motion Sensor

To connect all the electronic and mechanical devices together, a breadboard and dupont jumper wire were implemented. The purpose of the breadboard is to make quick electrical connections between components, and to test the circuit before permanently soldering it together. As for jumper wires, they are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering.

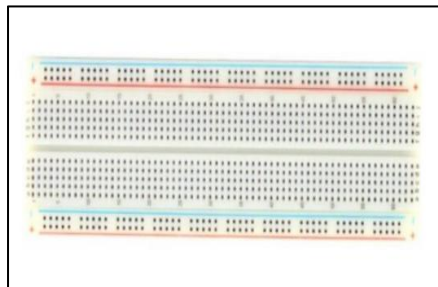


Figure 3.5.4: Breadboard 830 Holes



Figure 3.5.5: Dupont Jumper Wire

As for the mechanical devices, The MG995 servo motor is a high-speed standard servo that can rotate 360 degrees. Using this servo motor that moves to a specified angle, it is able to control the waste tray opening and closing. Other than that, the stepper motor is used to move the rack across the litter box during the cleaning process.



Figure 3.5.6: Servo Motor

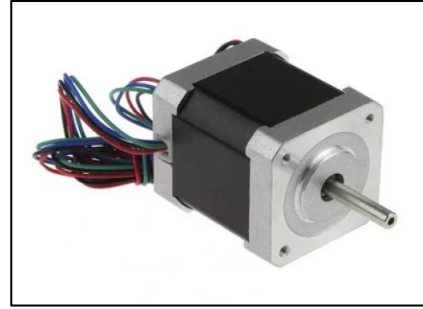


Figure 3.5.7: Stepper Motor

3.6 - METHOD IMPLEMENTED

Prepared by: Siti Nazierah Aqina Binti Mokta (08DKM19F1026)

This method procedure that has been implemented for the product is critical in verifying that the prototype works properly. These approaches helped us avoid wasting money and time while developing the product. There are two of them:

I. Software Method

Arduino Code:

Encoding with Arduino code is the method of choice that we implemented. We use a USB cord to connect the Arduino to the PC, then open the Arduino IDE and pick the appropriate board and port. Then, copy the code and open it in the Arduino IDE until the code is uploaded to the Arduino. This method is used to demonstrate how the rack is processed automatically when the timer and motion sensor detect the used litter box.



```
sketch_jan20a | Arduino 1.6.11
File Edit Sketch Tools Help
sketch_jan20a
void setup() {
  // put your setup code here, to run once:
}
void loop() {
  // put your main code here, to run repeatedly:
}
```

Figure 3.6.1: Arduino Encoding

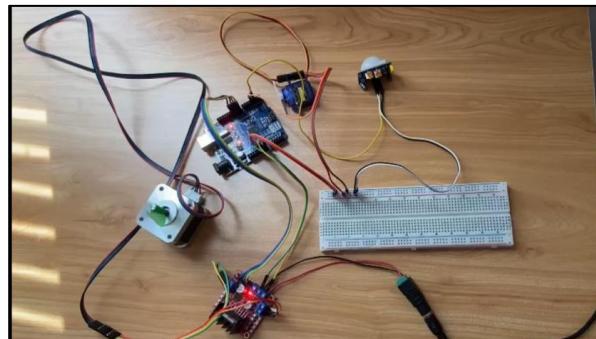


Figure 3.6.2: Circuitry

II. Hardware Method

a. Sticking using hot glue gun:

Because our project is made of plastic rather than metal, we used a hot glue gun to assemble it. The purpose is to connect existing components such as wire, an Arduino board and a box where all of the components will be stored. By merging all of the components, this project becomes more organized and safe to use.



Figure 3.6.3: Hot Glue Gun



Figure 3.6.4: Installing The Servo Motor Using Hot Glue Gun

b. Drilling

We made a hole bored in the litter box for the installation of the motion sensor equipped with timer to detect the presence of cats while entering or exiting the litter box before starting the cleaning process.



Figure 3.6.5: Drilling Process

c. Screwing

We screw a platform at the right of the outer litter box to accommodate the presence of a stepper motor to aid movement of the rack for the cleaning process.



Figure 3.6.6: Screwing Process

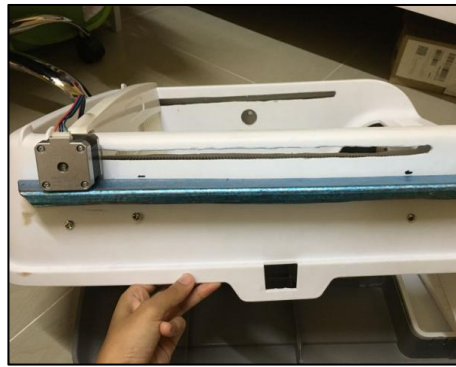


Figure 3.6.7: Screwing Installation

d. Rod Cutting

We purchased a 50cm long rod, but only required a 35cm rod, so we chopped the surplus rod by 15cm. This figure shows the cutting rods to be placed on the rack for rack movement supported by rods fused with gears and pinions.



Figure 3.6.8: Rod Cutting Process

3.7 - DATA COLLECTION METHOD

Various data collection procedures were employed to obtain data that would be beneficial during the analysis stage of this research. One of the data collection methods is the questionnaire. The two types of data that can be acquired are primary data and secondary data.

I. Primary Data

Primary data are critical to the study. The study's objectives will not be met if there is insufficient data. As part of the data collection process, questionnaires are delivered to respondents. As a consequence, 54 people were selected at random.

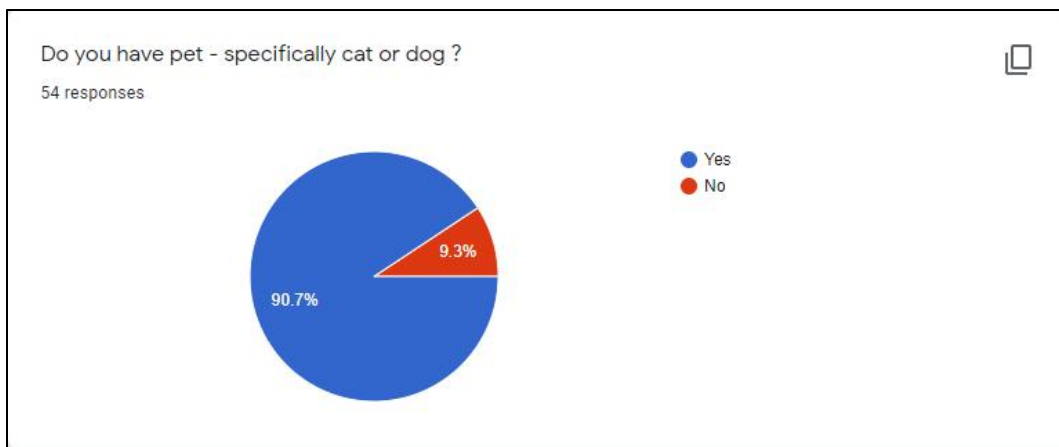


Figure 3.7.1: Google Form Analysis 1

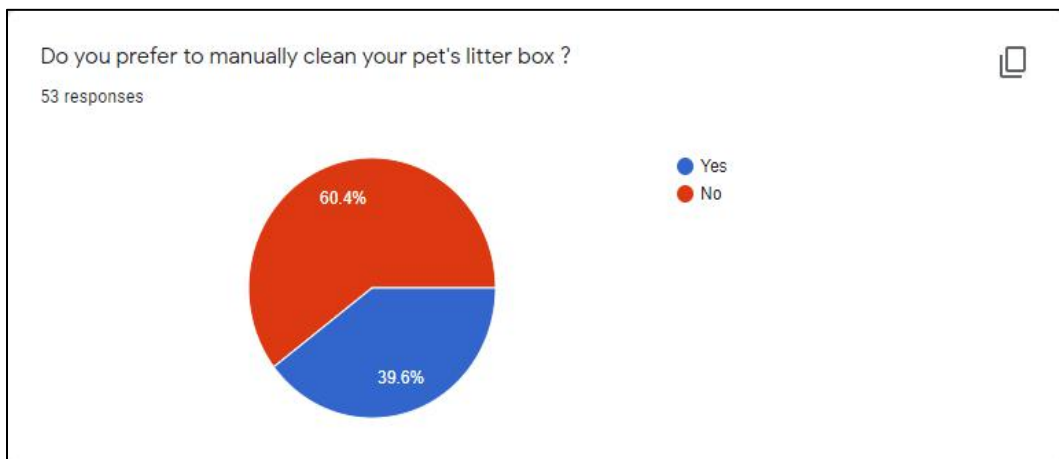


Figure 3.7.2: Google Form Analysis 2

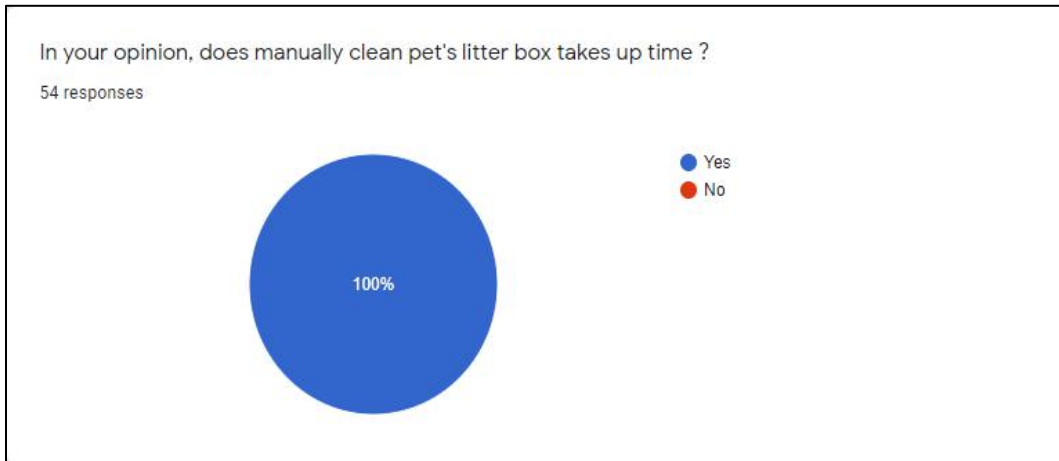


Figure 3.7.3: Google Form Analysis 3

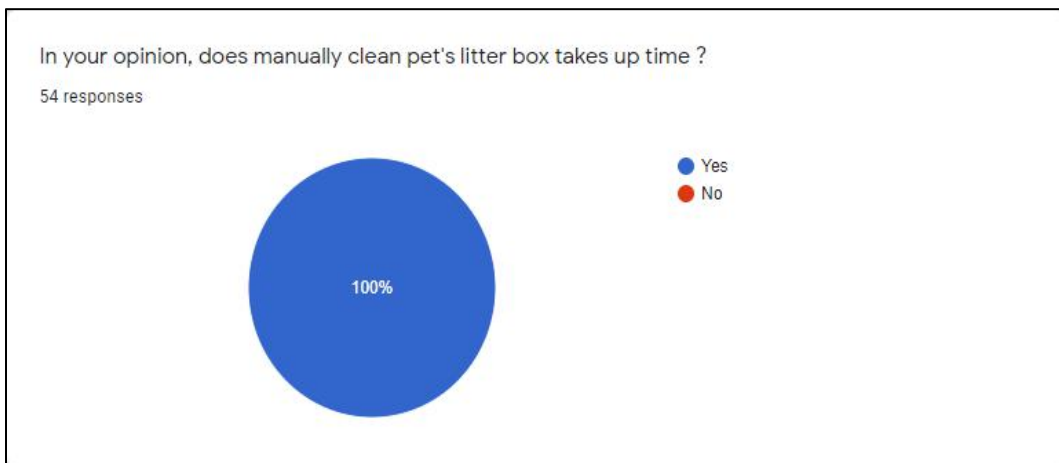


Figure 3.7.4: Google Form Analysis 4

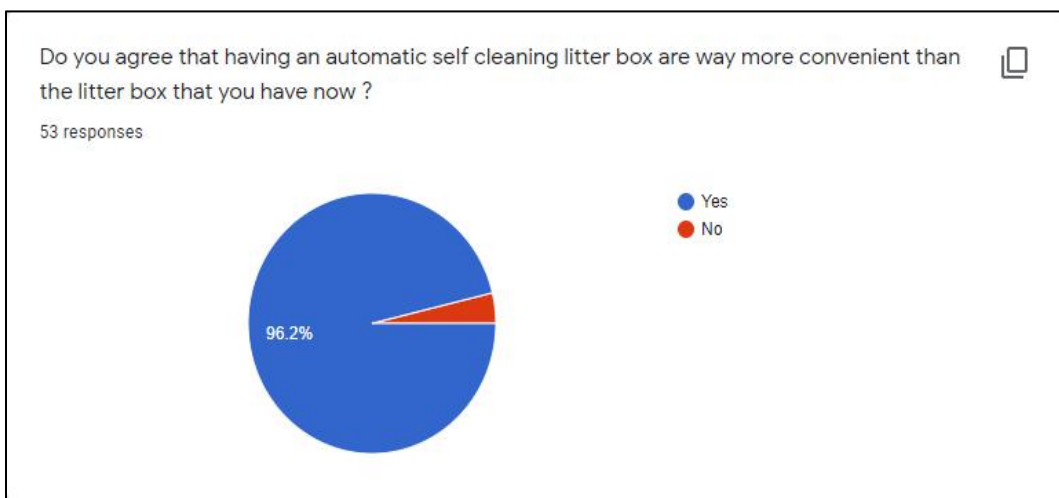


Figure 3.7.5: Google Form Analysis 5

II. Secondary Data

Secondary data includes literature reviews and other sources such as theses, books in the topic of study, local newspapers, journals, and other publications linked to the study. These resources were evaluated based on their applicability and served as the foundation for this investigation. This information is available in this report's Chapter 2 under the topic of Literature Review.

3.8 - CHAPTER'S SUMMARY

The studies in this chapter explain the project's methodology flow chart and Gantt chart, product design and prototyping, materials and equipment, method implemented, and data collection method. The flow chart for methodology is the first section presented in this chapter. To have a better understanding of this project, the explanation was completed. The Gantt chart, which explains the project production planning timeline and implementation, is discussed in the following portion of this chapter. More information is offered on product design and prototyping, which first demonstrates the product design in 3D modelling, and then the product design outcome that has been applied to a real-world project. This chapter contains more information on the materials and equipment part for Smart Pet's Litter Box. This chapter includes detailed the approach used and the data collection method in order to provide a comprehensive overview of how we collect data for this project.

CHAPTER 4 RESULT

4.1 - INTRODUCTION

This report was created to accomplish the three main goals outlined in Chapter 1, section 1.3. The results are presented in accordance with the three main areas of concern, which are to design a Smart Pet's Litter Box that can assist pet owners in dealing with their pet excrement in an easy and practical manner, to fabricate a pet's litter box with an automated system, and to test this Smart Pet's Litter Box is safe and practical to use. Throughout this chapter, the results for each area will be elaborated on and discussed.

4.2 - RESULTS AND ANALYSIS

OBSERVATION	RESULTS
Time Taken To Complete A Process	3 minutes
Cleaning Frequency	As frequent as the pet using the litter box
Average Cleaning Percentage	75% clean per session

Table 4.2: Results and Analysis

Smart Pet's Litter Box is a project that aims to improve on the design of the current conventional litter box. This project intends to create an automatic litter box with new capabilities and designs that will assist pet owners in dealing with their pet's faeces in a simple and practical manner. The automatic sensor and the ability of the stepper motor to move the rack over the litter box to complete the cleaning procedure are the innovations of this litter box. The smart idea of introducing a timer following the sensor detection allows the litter box to avoid any unwanted encounters from pets during the cleaning process, as well as to pass safety standards.

Nevertheless, based on table 4.2, we can deduce that a session takes 3 minutes to finish. Next, the cleaning frequency is determined by how frequently the pet uses the litter box, as the cleaning procedure begins only when the motion sensor detects movement. Aside from that, the average cleaning percentage is 75% clean per session, which can be increased by adding another stepper motor to the opposite end of the rack, as there is currently only one stepper motor in use, causing the rack's push action to be slightly slower and resulting in a low clean percentage.

4.3 - ADVANTAGE AND DISADVANTAGE

A. Advantages

Cleaning pet feces is a very unpleasant task. The creation of Smart Pet's Litter Box can make it easier for pet owners to manage it. Here the advantage that can be gained.

- I. It helps pet owners save time and effort because the litter box cleans itself after each use, pet owners won't have to clean it or scoop up its faeces manually.
- II. Pets will be able to enjoy a clean litter box because this Smart Pet's Litter Box is ideal for pets. It gives a sense of peace and comfort.
- III. Keeping the litter box clean helps control odor. As a result, Smart Pet's Litter Box have advantages over conventional litter boxes after each use.
- IV. Prevent pets that like to dispose of faeces evenly as it can stain the house. Among the reasons why pets make it probably because the litter box is dirty and they are not comfortable throwing faeces there.

B. Disadvantages

Pet owners may appreciate the convenience of semi automatic self-cleaning litter boxes, but their pets may not. Many pets are wary of new, unexpected objects, and the fact that the self-cleaning litter box moves on its own can be frightening to them.

- I. The mechanical components, it may not always function properly and maintenance may be more difficult.
- II. Smart Pet's Litter Box are not suitable for all pets and larger pets may struggle to fit into this model.
- III. This can diminish pet health monitoring because the pet's excrement and urine might reveal a lot about his health, and they won't be able to monitor his waste because the machine removes it right away.

4.4 - CONCLUSION

This chapter's conclusion is that this project has both advantages and problems. We believes that the benefits of this product will provide comfort and advantages to the community. In terms of the downsides, we will encourage the future ones to see these as opportunities to improve the product and perform additional study on this project. This initiative will be advantageous in the future. More testing and analysis should be performed in the future to make the product more accountable.

CHAPTER 5 DISCUSSION AND CONCLUSION

5.1 - INTRODUCTION

The decision made for this chapter is based on all of the results obtained from the experiments performed and the discussion in the previous chapters. The relevant matters in this chapter is also the objectives of the study and the recommendations on the study conducted. Furthermore, the conclusion will be made based on the discussion and the upgrade plan that have been developed.

5.2 - DISCUSSION

The first change that should be made to this product, based on references and observations made on the data acquired, is the material of the rack. Though the rack we chose is sturdy enough to sustain little and large clumps of litter, it cannot be denied that it made the construction of the litter box unstable. This is due to the fact that we installed a steel rod within the rack and connected each end of the rod to a gear and a rack inside the litter box. The rack movement became unstable as a result of the material variances, leading it to move slowly and with vibrations. As a result, other materials to the existing material, such as stainless steel, which is lighter and stronger, can be considered. This can help to ensure that the litter box's future rack is more stable. The mechanical component of the stepper motor is the next enhancement that needs be made to this litter box. The stepper motor should be equipped with a noise suppressor because it produces loud noises throughout the cleaning process. Aside from that, the average cleaning percentage is 75% clean per session, which can be increased by adding another stepper motor to the opposite end of the rack, as there is currently only one stepper motor in use, causing the rack's push action to be slightly slower and resulting in a low clean percentage.

5.3 - CONCLUSION

This project fosters creativity and critical thinking in us as we seek solutions to challenges. Problems with existing projects can be solved by making minor alterations and fabrications to the current design. The innovations developed on Smart Pet's Litter Box are not only convenient for the pets, but also for the pet owners. The automatic feature on the litter box will make it easier for pet owners to clean their pet's litter box without investing their energy and time. The waste tray function would also make it simpler for pet owners to dispose of clumps. When compared to the conventional litter box, the process would save a significant amount of time and energy. There is still area for development in this project that may be added to make it more functional, robust, and solid. This project has significant market potential and should be commercialised for advanced research and development.

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APPENDIX