

DESIGN AND DEVELOPMENT OF INNOVATIVE
CEILING FAN CLEANER

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DESIGN AND DEVELOPMENT OF INNOVATIVE CEILING FAN CLEANER

FARZANA BINTI DUSUKI

Thesis submitted in fulfilment of the requirements
Bachelor of Engineering Technology in Energy and Environmental

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STATEMENT OF AWARD FOR DEGREE

1. Bachelor of Engineering Technology

Thesis submitted in fulfilment of the requirements for the award of the degree of Bachelor of Engineering Technology in Energy & Environmental.



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ABSTRACT

Most of South East Asia especially in Malaysia, ceiling fans will be installed even though some houses use air conditioning as their cooling system. Ceiling fans create a tremendous amount of air flow, and dust is thrown around the room. The air always has a great deal of dust in it where larger particles can see, and microscopic. Large volume of the circulating air hits and collects dust on the blades of the fan. The traditional ways of cleaning the ceiling fan required users use a wet cloth and get up to the height of ceiling fan using a step ladder or use an extension rod with a brush. However, these methods are dangerous because a user may fall down from the ladder and cause environment hygiene problem. Furthermore, a user need to take more time to finish clean all the fan blades by using a non-suitable material which most of the dust will falls down to the floor during cleaning activities. Therefore, a portable ceiling fan cleaner are developed for the ease of operation in cleaning ceiling fan blades. The extension hose of vacuum cleaner can be attached to the ceiling fan cleaner to suck the dust and grimes from the blades without use a step ladder or stool. This design also can reduce time consumption in cleaning ceiling fan blade which took less than four (4) minutes. Next, a fan is used for thermal comfort which create a wind chill and give lower temperatures directly. By using the best material, all types of dust can be removed in a matter of minutes hence create high velocity of wind speed of fan blades and feeling cold which gives a good comfort for human daily activities.

ABSTRAK

Kebanyakan Asia Tenggara terutama di Malaysia, kipas siling akan dipasang walaupun sesetengah rumah menggunakan penyaman udara sebagai sistem penyejukan mereka. Kipas siling mewujudkan sejumlah besar aliran udara, dan debu dibuang di sekeliling bilik. Udara sentiasa mempunyai banyak habuk di mana zarah-zarah yang lebih besar dapat dilihat, dan mikroskopik. Jumlah besar mengelilingi udara dan mengumpul habuk pada bilah kipas. Cara tradisional membersihkan kipas siling adalah pengguna perlu menggunakan kain basah dan sampai ke ketinggian kipas siling menggunakan tangga atau menggunakan batang dengan berus. Walau bagaimanapun, kaedah ini berbahaya kerana pengguna mungkin jatuh dari tangga dan menyebabkan masalah kebersihan persekitaran. Selain itu, pengguna perlu mengambil lebih banyak masa untuk menyelesaikan semua bilah kipas dengan menggunakan bahan yang tidak sesuai dan sebahagian besar habuk akan jatuh ke lantai semasa aktiviti pembersihan. Oleh itu, pembersih kipas siling mudah alih dicipta untuk memudahkan operasi dalam membersihkan bilah kipas siling. Hos sambungan pembersih vakum boleh disambungkan ke pembersih kipas siling untuk menyedut debu dari bilah tanpa menggunakan tangga atau bangku. Reka bentuk ini juga dapat mengurangkan penggunaan masa dalam membersihkan bilah kipas siling yang mengambil masa kurang dari empat (4) minit. Seterusnya, kipas digunakan untuk keselesaan termal yang membuat angin yang sejuk dan secara langsung memberi suhu yang lebih rendah. Dengan menggunakan bahan yang terbaik, semua jenis habuk boleh dikeluarkan dalam beberapa minit dan seterusnya menghasilkan kelajuan angin yang tinggi dari bilah kipas dan rasa sejuk yang memberikan keselesaan yang baik untuk aktiviti harian manusia.

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LIST OF ABBREVIATION

Abbreviation	Meaning
cm	centimeter
μm	micrometer
mm	millimeter
g	gram
t	time (second)
A	area (m ²)
E	energy (J/s)
D	diameter (m)
EU	European Union
N	Newton
kg/m ³	kilogram per cubic meter
g/cm ³	gram per cubic centimeter
m/s	meter per second
RM	ringgit
°C	Celsius

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

A fan is a device that is held in the hand and moved back and forth to cool a person and that is usually shaped like a segment of a circle and composed of material such as feathers or paper mounted on thin rods or slats moving about a pivot so that the device may be closed compactly when not in use (Webster, n.d.). Ceiling fan usually located at the top of the house. Ceiling fans create a tremendous amount of air flow, and dust is thrown around the room. The air always has a great deal of dust in it where larger particles can see, and microscopic. Over time, a large volume of the circulating air hits and collects on the blades of the fan. The accumulation of dust on ceiling fan blades is not random. Most dust particles carry an electrical charge, and therefore can be attracted to one another where a dust ball is simply an accumulation of charged dust particles that have a fatal attraction (Larson, n.d.). Majority of community have more than one of ceiling fan in their house, but it is difficult to clean since the height of the ceiling fan are high.

The purpose of this project is to create an ergonomic ceiling fan cleaner and create the equipment that easy to operate. A ceiling fan cleaner use to clean each blade of the ceiling fan. Since using ladder, is quite difficult and dangerous because of the height, this ceiling fan cleaner are able to solve the problems. A solution to the cleaning of blades of a ceiling fan proposes using a mechanism or device that can be slipped onto the blades with a handle attached there so that the person cleaning the fan blades can manipulate this cleaning device from the floor by moving the device back and forth along the blade from the floor. There is also an arrangement similar to this in which a vacuum cleaner has been attached to the cleaning device to vacuum the dust from the blades (Bellardini & Tullio, 1994).

Due to the presently known dangerous of cleaning arrangements, the dust on the fan blades tend to accumulate to a large extent because the user doing the cleaning does not desire to climb step ladders or does not have the device to slip over the fan blades for

cleaning the same. Therefore, attachment of the ceiling fan cleaner to the vacuum cleaner will suck all the dust and avoid the dust from spreading all over the room which can affect health.

Ceiling fans are standard device for ensuring that a room gets proper ventilation especially in high humidity of Malaysia's climate and this project is about the simple cleaning system and economical manner. Ceiling fans are considered as the most effective ventilation methods in distribution air in the room for long-term cooling plan and they will be installed in every house even though some houses are using an air conditioning as their cooling system. This is because Malaysia situated near the equator caused a tropical climate with high temperatures and rainfall all year around but National Environment Agency (NEA) said that temperatures do not differ much from month to month and daily range of temperature is small. Ceiling fans are widely used in offices, houses, restaurants and many other types of buildings to circulate air and reduce the heating costs. But, Malaysia's people leave the dust in ease without considering the dust is interpreting that it may harm them. Thermal comfort is a condition of mind that expresses satisfaction with the thermal environment (Raish, n.d). It is depending on many factors which are temperature, humidity and air speed. Temperature control is the most concerned by residents and people right now because low temperature is the first choice for Malaysia's people. This also became a reason Malaysia's people loves air-conditioner that can control temperature while air speed can be increased by using ceiling fan. When more air-conditioners installation, more contribution to global warming and also deplete the ozone layer because of refrigerants. Moreover, people nowadays are lazier because of rushing in time and they are easy to get tired after back from work. Therefore, this project is also to overcome the human laziness and cleaning the fan is done regularly. The oversight of this project may seem simpler one, but this project involves two applications and suitable for all people to do.

1.2 PROBLEM STATEMENT

A ceiling fan is a mechanical fan, usually electrically powered, suspended from the ceiling of a room that uses hub-mounted rotating paddles to circulate. Ceiling fan typically rotate more slowly because since the blades of ceiling fan are exposed to the air so the surface of blades is easier getting dirty by thick layer of dust. Regular cleaning process using ceiling fan cleaner are needed to make sure it always clean and the dust do not spread everywhere.

However, cleaning the ceiling fan by manually is complicated. It is because the height of ceiling fan is difficult to reach to clean it. Therefore, a user needs a ladder or stool to clean ceiling fan blades. Moreover, cleaning manually using a normal cloth causes the dust spread everywhere because the material did not hold the dust efficiently. Furthermore, clean ceiling fan manually also consume much time since the cleaning process cannot wipe both side of blade at the same time and need to clean the falling dust after cleaning.

Therefore, an updated version of ceiling fan cleaner is created where it can attach with the extension of hose provided by any brand of vacuum cleaner to reach the blade of ceiling fan. A user can remove the dust from the floor without step ladder and do not sweep the falling dust anymore after finish cleaning ceiling fan. Lastly, this updated version of ceiling fan cleaner also can wipe both side of the blade which can reduce the time consumption by using the most efficient material.

1.3 OBJECTIVES

1. To fabricate a ceiling fan cleaner that can reach a ceiling fan blade by attach to the extension hose of a vacuum.
2. To determine a suitable and the best material for wiping the dust.
3. To reduce the consumption of time for cleaning process and ease movement of user.

1.4 PROJECT SCOPE

- Design the nozzle for ceiling fan blade cleaner using software NX 10.
- Fabricate the nozzle for ceiling fan blade cleaner using 3D printer.
- Determine the efficiency of material for dust, thermal comfort, energy and time taken to clean the fan blades.

CHAPTER 2

LITERATURE REVIEW

2.1 Ceiling fan cleaner with rotatable cleaner

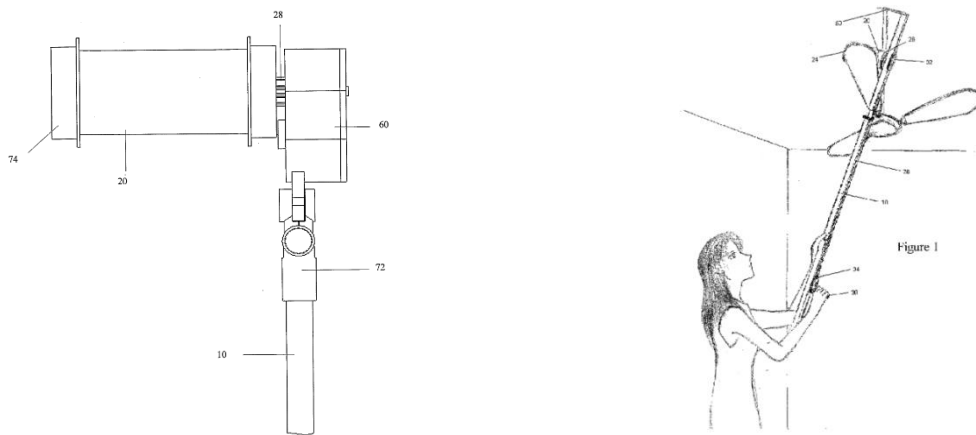


Figure 1: Ceiling fan cleaner with rotatable cleaner and its procedure during cleaning (Chew, 2009)

The present invention is a ceiling fan cleaning apparatus comprising a roller cleaner enveloping a central hub and rotatable with respect to the central hub, the central hub attached at one end to an elongated member, and a first pulley connected fixedly to one end of the roller cleaner and such that rotation of the first pulley causes an equal rotation of the roller cleaner, and a second pulley located close to a second end of the elongated member and a chain connecting the first and second pulleys. A hand crank is connected to the second pulley so that a user is able to rotate the roller cleaner by turning the hand crank. The roller cleaner has a width substantially equal to the standard width of a ceiling fan blade. There is provided a pair of circular protrusions at each end of the roller cleaner that restricts the lateral movement of the roller cleaner to a path substantially within the area of the ceiling fan blade (Chew, 2009).

In one embodiment of the present invention, there is also provided a mirror attached at the top end of the elongated member such that during operation, a user will be able to view the top surface of the ceiling fan blade being cleaned. The length of the

elongated member is adjustable to accommodate differing heights of both the ceiling fan and the user. The roller cleaner may be disposable or removable to facilitate changing of a used cleaning surface. Alternatively, only the cleaning surface of the roller cleaner may be removed and changed, leaving the bulk of the roller cleaner unchanged, thus lowering the cost of changing the cleaning surface (Chew, 2009)

2.2 Vac+Dust Ceiling Fan Tool with SWIPES™ Washable Microfiber Pad vacuums and dusts ceiling fan blades



Figure 2: Vac+Dust Ceiling Fan Tool with SWIPES™ Washable Microfiber Pad vacuums and dusts ceiling fan blades (Olivia, 2018)

- 4-in-1 versatile bagless stick vacuum - Go from floors to ceilings to couches in seconds
- Cyclonic Filtration cuts through any mess with powerful suction
- Vac Dust Tools with SWIPES pick up heavy dirt and debris while the SWIPES microfiber pad captures the dust
- Bottom empty dirt cup with MaxFill Technology prevents dirt and hair from getting stuck in the dirt cup
- Powered Stair and Upholstery Tool adjusts to cover every part of each step
- Extended reach stretches from floors to ceilings and catch everything in between
- 27' power cord let you easily clean your couch then your stairs without unplugging
- Includes reusable quick-rinse filter, crevice tool and pivoting extension tool

2.3 Ceiling fan cleaner for domestic purposes

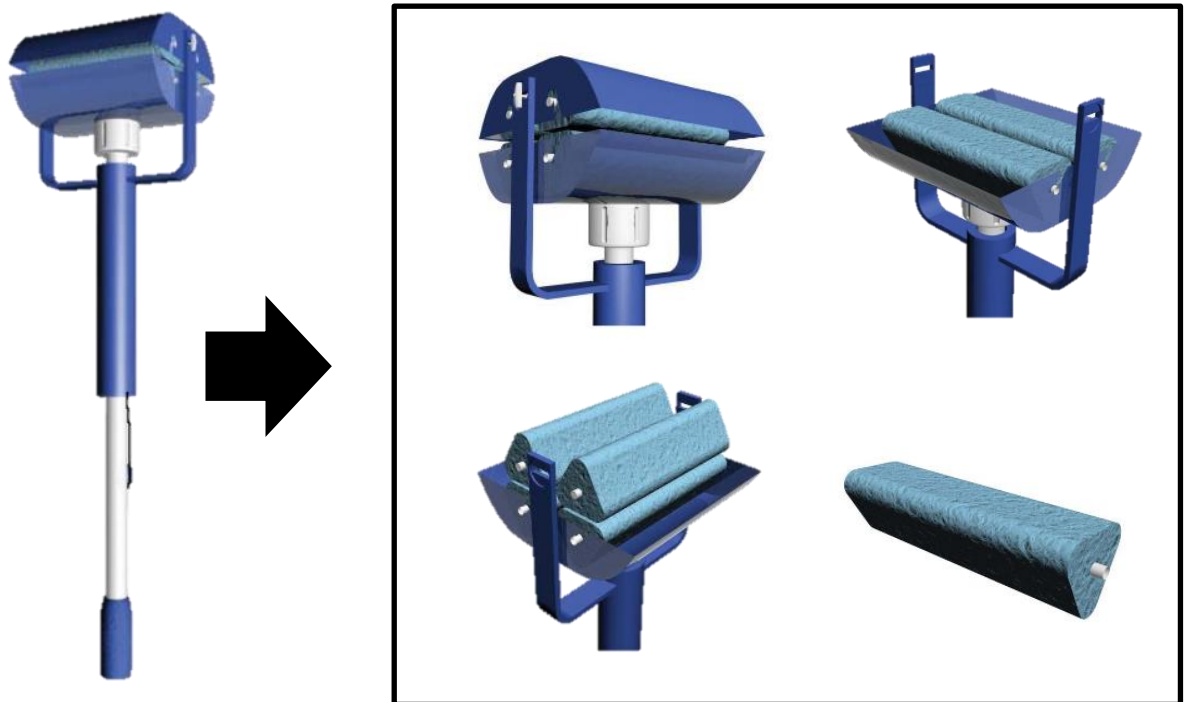


Figure 3: Ceiling fan cleaner for domestic purpose (Jain, n.d)

Basic principle was to sandwich the fan blade between two cleaning surfaces and enables slide cleaning. Various alternatives to provide ample compactness and friction for cleaning were tried out. (Jain, n.d)

Addressing all major issues of:

1. Overhead cleaning, fatigue reduction
2. No climbing on stools, covering of household objects required
3. Ergonomically sound position of person while cleaning
4. Compact cleaning and friction scrub clean.
5. Neat management of dirt into see thru tray (visual feed-back)
6. Easy cleaning and storage of product after use

The outer pipes lock at a certain distance, providing optimum distance between the two cleaning surfaces. After one blade is scrub cleaned (as it snugly fits between the blades), the cleaning sponges are rotated to bring over fresh cleaning surfaces. Thus, each of the three blades has a clean surface to start with. The cleaner is completely dis-manta-able and is easily assembled, ensuring proper cleaning and convenient storage.

2.4 11 inch Microfiber Ceiling Fan Duster Connect and Clean Locking System (Unger Ceiling Fan Duster)



Figure 4: Unger Ceiling Fan Duster (Depot, 2018)

Clean ceiling fans without getting hands dirty with the Unger Ceiling Fan Duster. It was made out of microfiber and has a 10 in. handle for reach without straining. With a long, curved head, you can clean both sides of the fan blade with just one swipe. (Depot, 2018)

- Long fibers to attract and trap dirt and dust
- Microfiber for deep cleaning into tight crevices
- 3 in. wide head
- Lightweight and easy to use

2.5 Shark Multi-Angle Dusting Brush 146FLI480



Figure 5: Shark Multi-Angle Dusting Brush (ClickReason, n.d)

It is easy to dust with this brush, but it is also useful as universal micro tool kit. A multi-position soft dusting brush for cleaning blinds, ceiling fans, walls, books, and

tops of furniture. It has two (2) packs of HEPA filter and 2 packs of foam. It is also fits with 1 and 1/4 inches friction-fit wands. With this dusting brush, to walls, ceiling fans, a user can clean all-throughout the house which are from blinds, books, and furniture. It is recommended for washing the filter every 1 to 2 months for best performance. Next, it also can be used to clean a variety of household items, books, including blinds, ceiling fans, walls, and tops of furniture. Multi-position so a user can make it a perfect fit to any objects. With the Shark Ninja Multi-Use Dusting Brush, a user can easily clean his/her home without needing to constantly switch out brushes. Lastly, it can fits to all vacuums that accept standard 1 1/4 inch; inside diameter attachments hence it can stiff front and back bristles help to create a more aggressive clean that eradicates stubborn dust. (ClickReason, n.d)

2.6 Automated Cleaning of Ceiling Fan

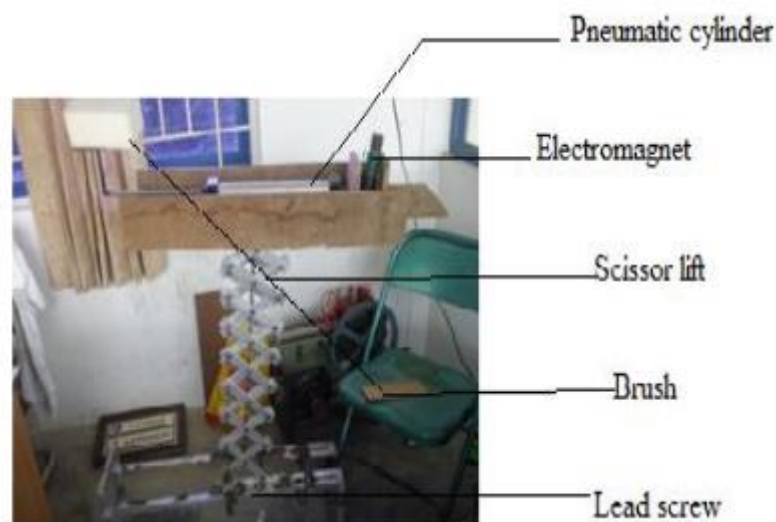


Figure 6: Mechanical section (P, C.S, & K, 2017)

The main objective of the project is to reduce the human effort and sluggishness of human when the operation is in large scale and to avoid the risk in case of any accidents. The proposed system is a portable to ensure regular cleaning of the ceiling fan using some mechanical setup such as scissor lift, lead screw whose movements are controlled by microcontroller which controls a pneumatic control and some cleaning mechanisms. (P, C.S, & K, 2017)

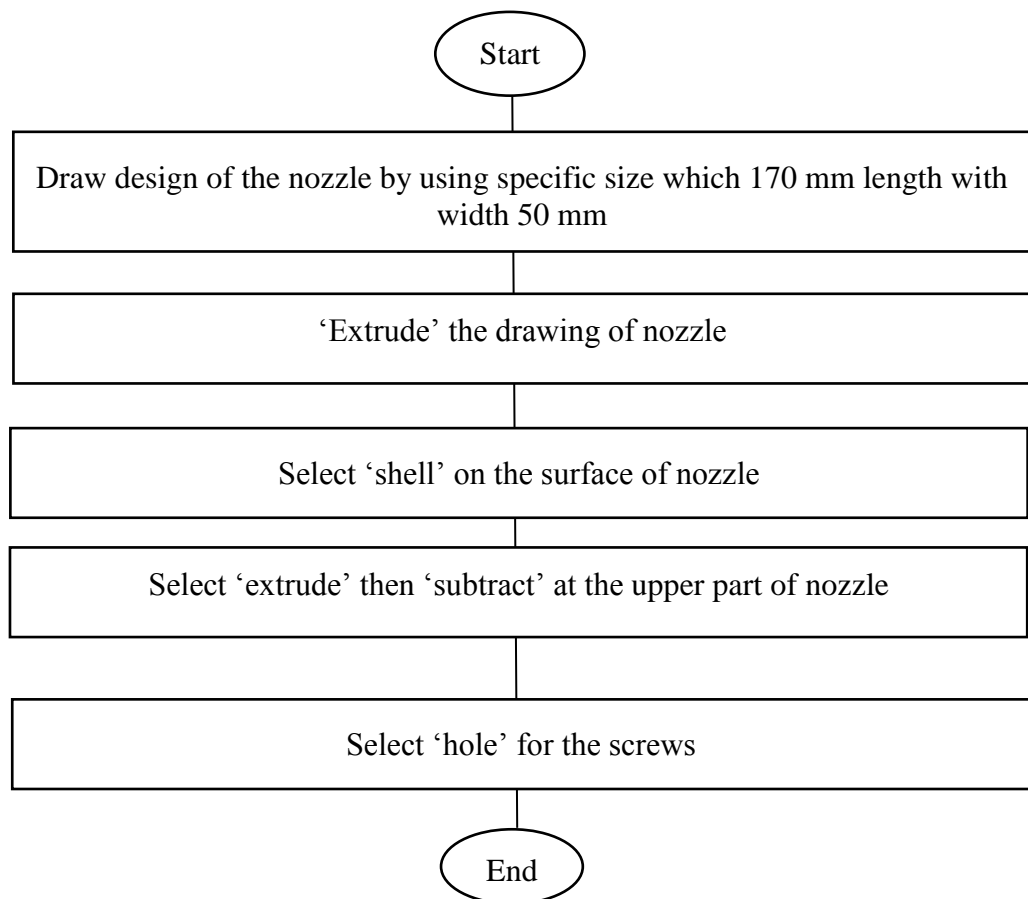
The project involves the methodology of cleaning the fan blades individually one after the other. Microcontroller forms the heart of the system and carries out the sequence of operation as per the programming. The system involves a total of three (3) motors and the system is completely electrically actuated. The system carries a scissor lift that forms the mounting of the actuating system to the close proximity of the fan from ground. The scissor that consists of linkages is electrically operated so that the linkages in which the linkage that consists of one fixed ends and free end is lifted upwards. This electrical actuation is assisted by the action of ac synchronous motor and a lead screw mechanism to lift the ladder. As the scissor lift gets in close proximity with the fan, the centre of the fan, described as the switch cup, is sensed by the proximity sensor placed in the base made of wood where the actuation system with other components is being placed. The electromagnet, included in the list of various components in the base that is coupled to a motor is attracted towards the switch cup and comes in contact with the switch cup. The purpose of an electromagnet is to rotate the fan every time after one of the blades is cleaned. So, as the scissor lift reaches the proximity of fan, the other proximity sensor being placed at the other side of base senses for the blade and as the blade reaches the required position, it is programmed such a way that the pneumatic cylinder actuates the cleaning brush to clean the fan blade. There were several methods applicable for the cleaning mechanism of the blade. Some of them are vacuum cleaner system that is being mounted on the place of the brush, usage of sponge system coupled with the robotic arm but for an economical as well as effective setup we have chosen the sponge setup for the cleaning process. (P, C.S, & K, 2017)

CHAPTER 3

METHODOLOGY AND MAIN OF MATERIALS

This methodology will cover the details explanation of steps that is being used to make this project succeed. This method is used to achieve the objective of the project that will accomplish. To evaluate this project, the methodology is based on Design, 3D Printing, Fabrication and Maintenance and Testing.

3.1 Flowchart of Design Project with Software NX10



Flowchart 3.1.1 shows that procedures that had been design in Software NX 10. In the design process, there are two design which part 1 and part 2. After the process of brainstorming the desired design, the shape of nozzle had been draw with 170 mm length and 50 mm width in a rectangular shape. Then, the shape of the nozzle was 'extrude' to give effect 3D. The setting of extrude must insert with 25 mm. The next step is press 'hole' in the top menu at the NX 10 then make four hole for nozzle's screws.

3.1.1 Overview design

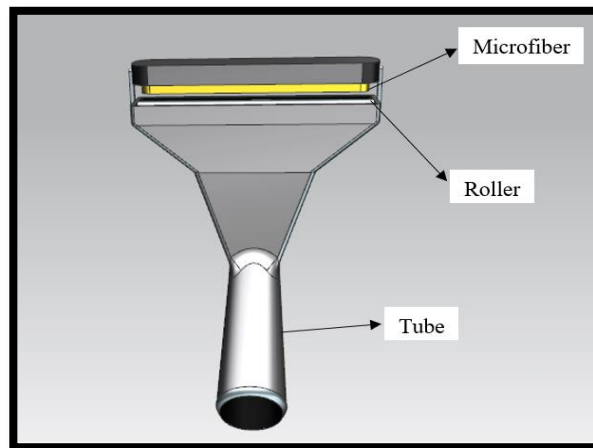


Figure 7: Front view of vacuum nozzle

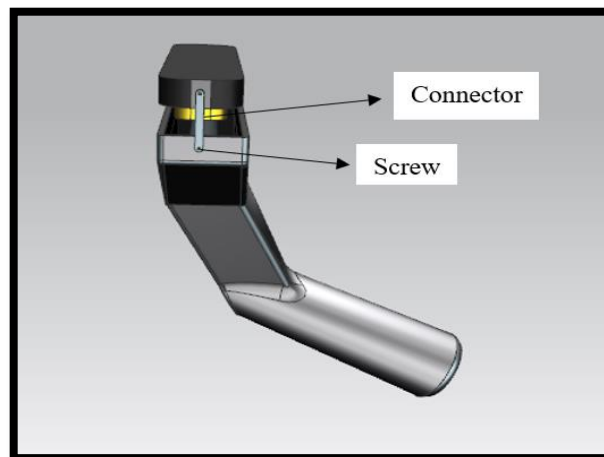


Figure 8: Right side view of vacuum nozzle

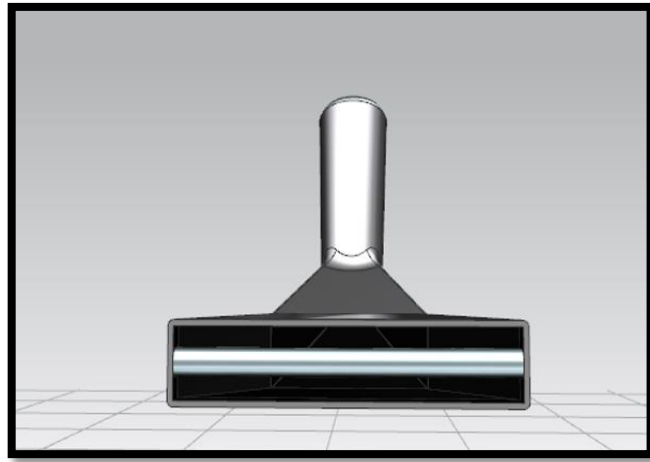


Figure 9: Lower part view of vacuum nozzle

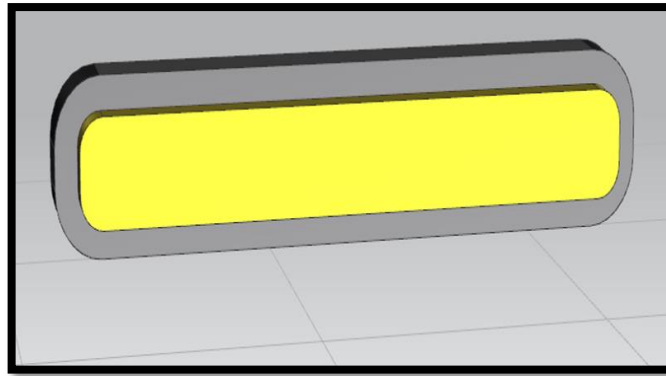


Figure 10: Upper part view of vacuum nozzle

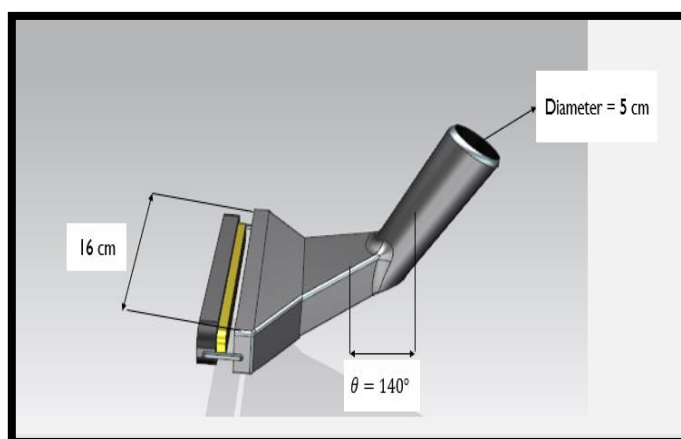
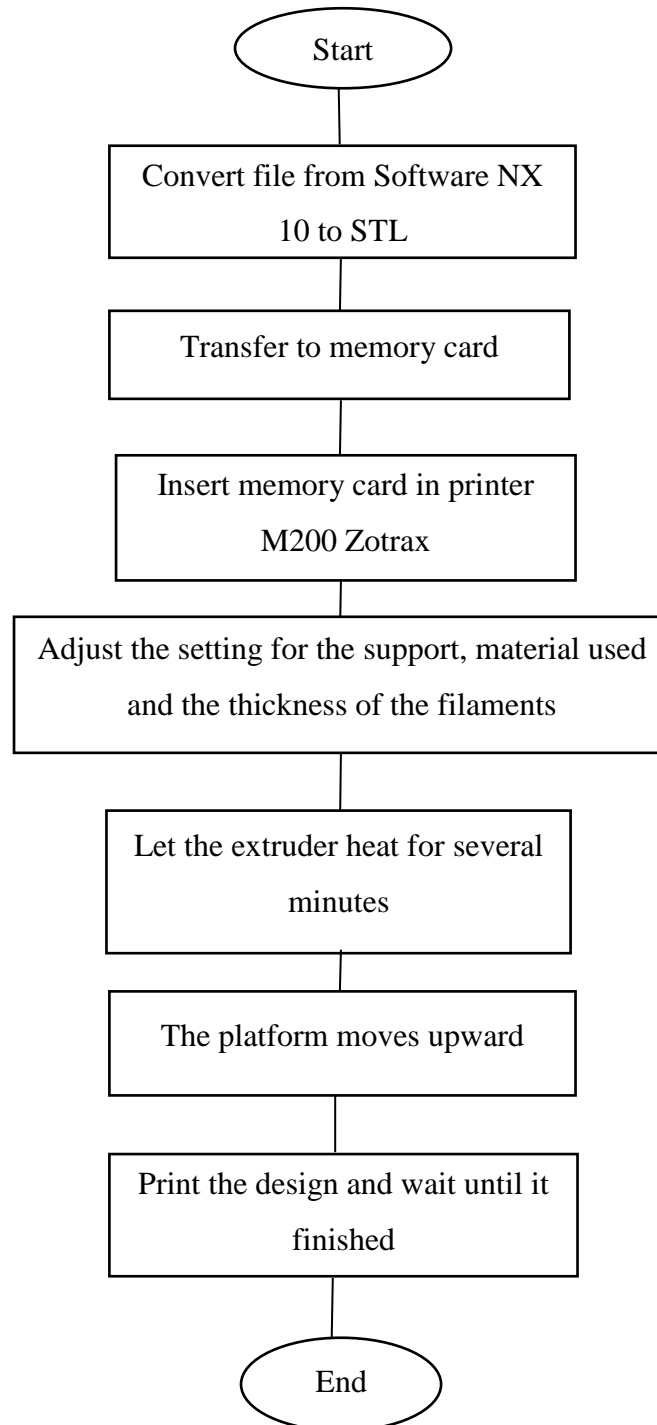


Figure 11: Dimension of vacuum nozzle

3.2 Flowchart of 3D Printing



Flowchart 3.2 shows that procedures to print the design by using Zotrax M200 with filament material ABS Plastic. First of all, the file must be converts from Software drawing NX 10 to STL then transferred it to memory card. The memory card then will

be inserted into the printer Zotrax M200, the setting must be adjusted with the thickness of filament and the angle of support. After that, press button saved and print then the extruder will be heated for a several minutes. The platform will move upward and started to print the desired design until finished.

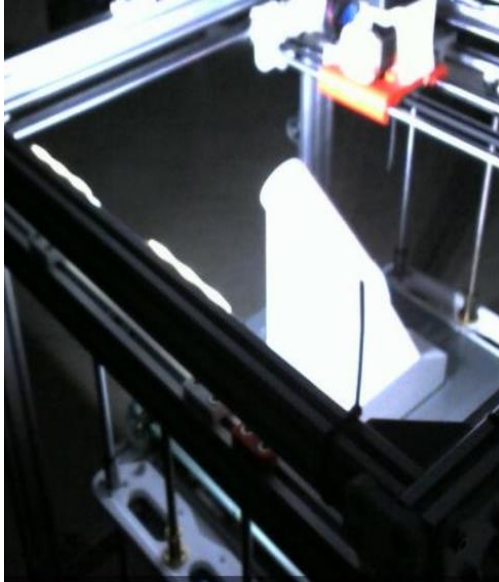


Figure 13: 3D printing progress for lower part and upper part



Figure 12: A final result from 3D printing process using white color of ABS Plastic

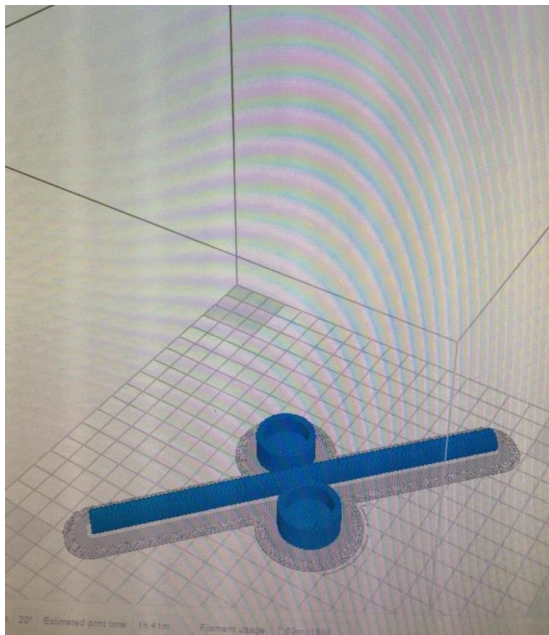


Figure 15: A roller 3D printing for lower part nozzle attachment

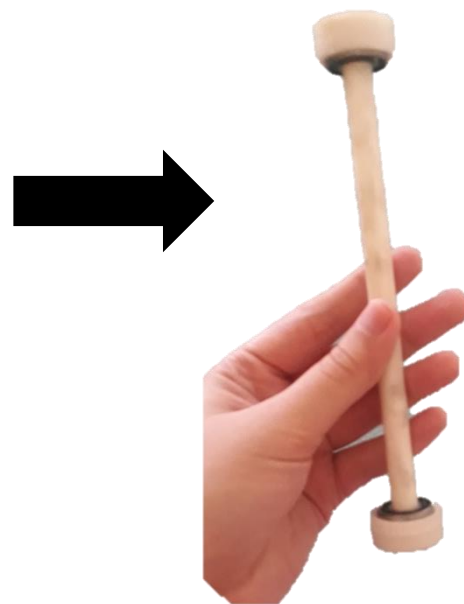
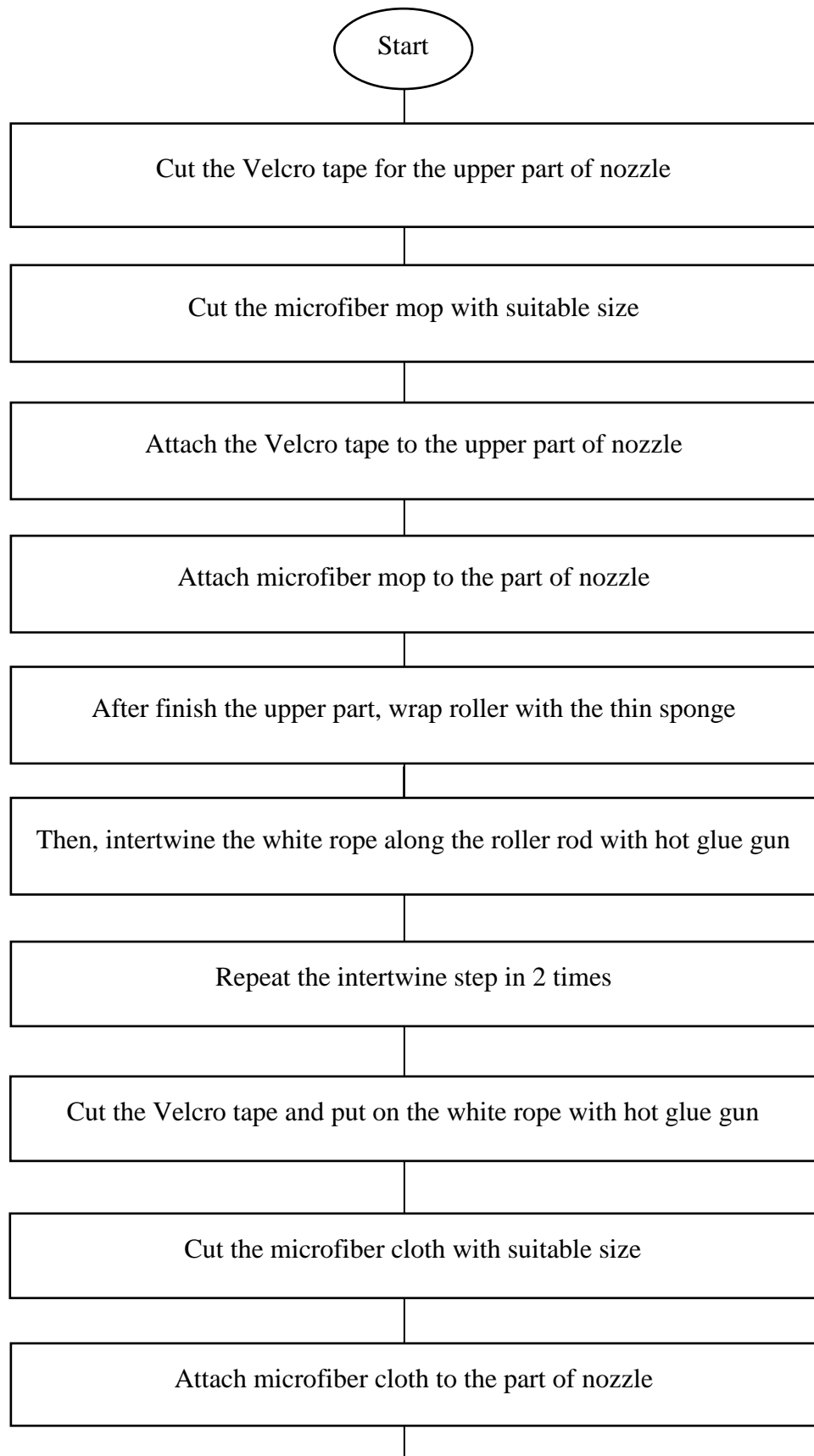
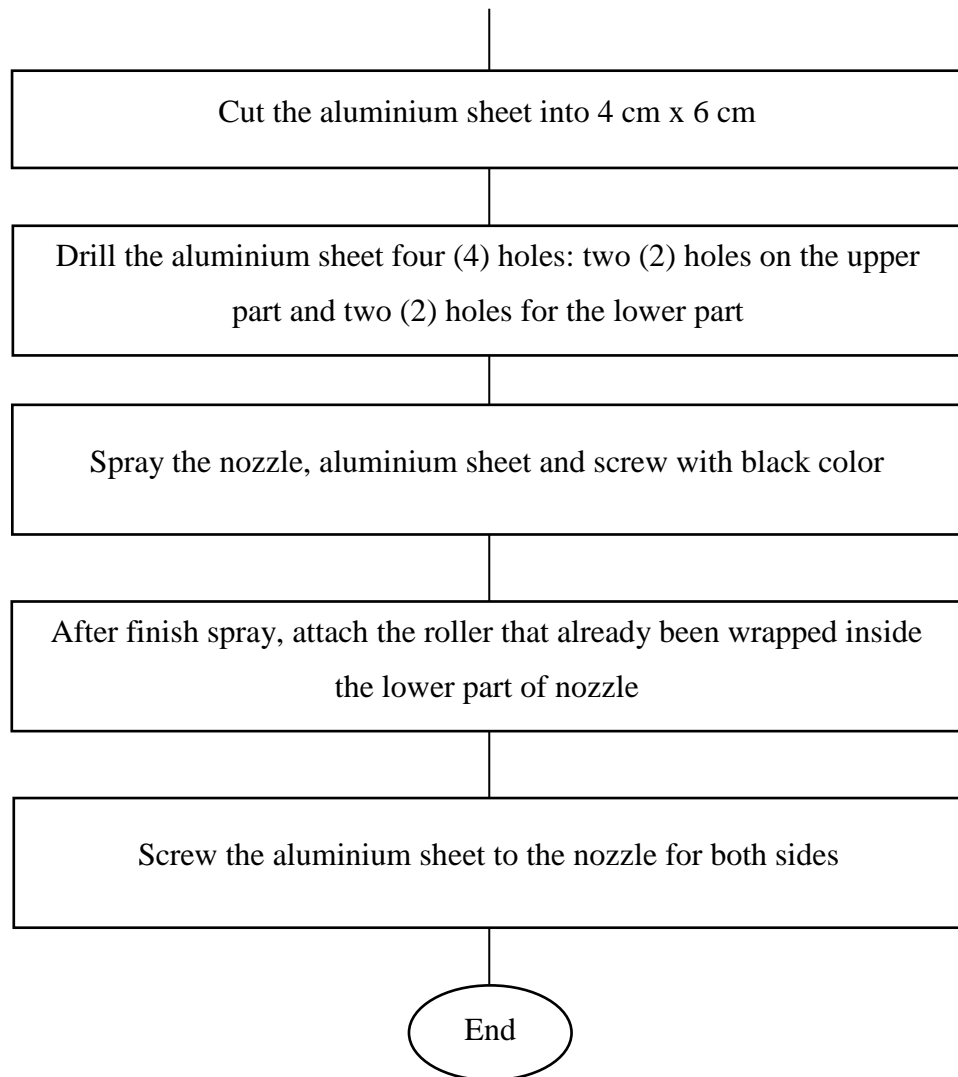


Figure 14: A final result of roller with two (2) bearings from 3D printing process

3.3 Flowchart of Fabrication and Maintenance





Flowchart 3.3 shows the procedures for the fabrication and maintenance that had been done in FTEK workshop. After getting the both parts of nozzle, the Velcro tape was cut 15 cm and attach to the upper part with hot glue gun. The microfiber mop was cut into 17 cm of length and 6 cm of width, hence attach other 15 cm of Velcro tape to the microfiber. After finish the upper part, cut the thin sponge to the size that can fit for roller then the roller was wrapped by thin sponge with hot glue gun. Next, a white rope was intertwined on the thin sponge and this method repeated for two (2) times to make sure it was thick and can touch the surface of blade to get the roll as its function. When the thickness of roller was achieved, the microfiber cloth was cut to the suitable size of roller. Two (2) aluminium sheets were cut into 4 cm x 6 cm, and scraped at the corner of the plate by using scraper to make a curve which burr and sharp were removed.

Therefore, the aluminium plates were drilled four (4) holes to insert the screw. The nozzle, two (2) aluminum plates and eight (8) screws were sprayed with black and shiny color to look elegant. Lastly, the aluminium plates were screwed for both sides by using screwdriver.



Figure 17: Wrapping and intertwine progress for the roller

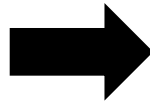


Figure 16: A final result of roller with sponge, white rope and Velcro tape



Figure 18: Two (2) aluminium plate were drilled eight (8) holes to insert screw

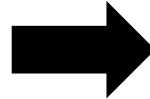
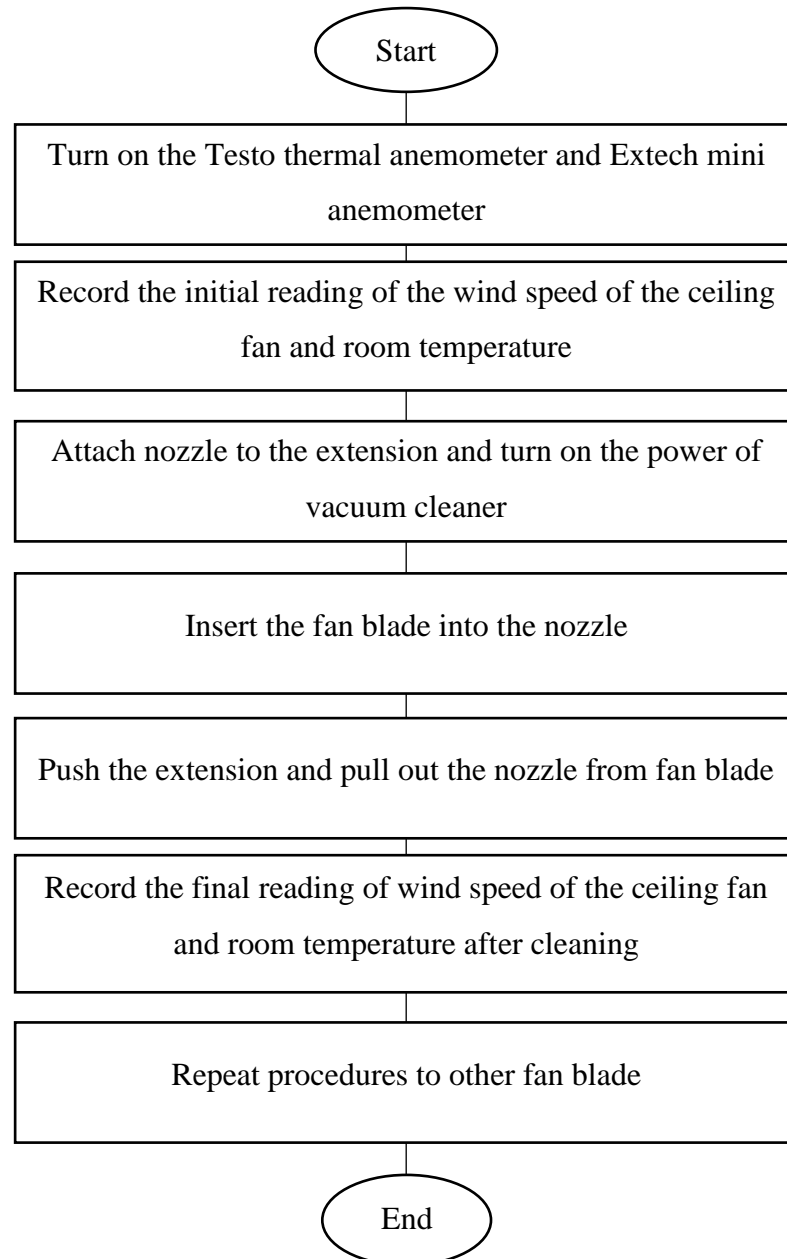


Figure 19: A final result of aluminium plate as fan and nozzle holder



Figure 20: Spray the nozzle and aluminium plates with black and shiny color

3.4 Flowchart of Testing



Flowchart 3.4 shows the testing step that has been done in room and living room with the same place. The efficiency of NX15 was tested based on four (4) parameters which were the wind speed, the room temperature, the time taken to clean fan blade and the weight of dust collected by using Testo thermal anemometer and Extech mini anemometer (Figure 34) as before and after the cleaning process. Besides microfiber, sponge and rubber material were also tested to compare the dust trap efficiency which material was the best in all types of dust.



Figure 22: TESTO 425-Thermal anemometer



Figure 21: EXTECH 45118 - Mini anemometer



Figure 24: Testing NX15 to ceiling fan blade before spray



Figure 23: Testing room temperature after using NX15



Figure 25: Testing wind speed after using NX15

3.5 Main of Materials

3.5.1 Microfiber



Figure 26: Example of microfiber pad (MW, 2018)

Microfiber cloth has been developed for cleaning smooth surfaces in order to ensure the surface are clean properly without any dust left. Microfiber material is intended to pull in tidy and expel oil on contact with the smooth surface. Microfibers can connect themselves to even the littlest, most infinitesimal earth particles which ones that ordinary fabric strands roughly brush past. On the off chance that powers were unmistakable, there are cement powers amongst microfibers and soil. In this design of ceiling fan cleaner, the microfiber will be at the upper and lower part of the ceiling fan blade cleaner. At the lower part, the microfiber will wrap the roller cleaner in order to make the cleaning process in rolling motion. For the upper part, the microfiber cloth will be attached at the case of ceiling fan cleaner. To increase the efficiency of cleaning the blade of ceiling fan, user can simply use the microfiber cloth by itself with a little water. In this way, the microfiber will attract all the dust better.

3.5.2 ABS Plastics

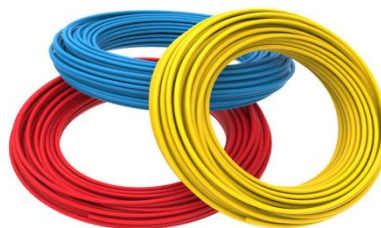


Figure 27: ABS Plastic (Scribbler, 2017)

Acrylonitrile Butadiene Styrene (ABS) is an opaque thermoplastic and amorphous polymer (Creative Mechanism, n.d) .Thermoplastic turn into liquid when it reached certain point of temperature for ABS plastic it will turn to liquid when the temperature is 221 degrees Fahrenheit. The first heating causes thermoset materials to set resulting in a chemical change that cannot be reversed. Heat a thermoset plastic to a high temperature a moment time it would essentially consume. 3D printer uses an ABS production process of the present invention to provide a wire by increasing toughened in the raw materials, to reduce the brittleness and improve impact resistance can be prevented when printing from the lump, broken line, and improving print quality.

There are innumerable applications for ABS. Among the most broadly identifiable are keys on a PC console, control instrument lodging, the plastic face-monitor on divider attachments and LEGO toys. ABS plastic allows that there will be no major hold-ups due to material when transitioning from prototype to production. It is often chosen because it is a good middle-ground option for a huge number of applications. ABS is easily machined, sanded, glued and painted. This makes it a great material for prototyping ABS can also be coloured relatively easily, unlike some other plastics, so the final product will present in a good condition with ABS. This is a reason it is often used for enclosures especially in housing that might have different textures or glossy surfaces. ABS is very structurally sturdy, which is why it is used in things like camera housings, protective housings, and packaging. An inexpensive, strong, stiff plastic that holds up well to external impacts product, ABS is a good choice.

3.5.3 Aluminium sheet

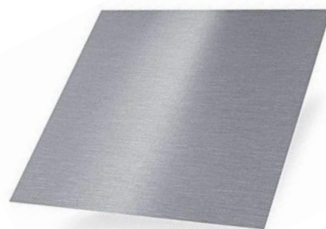


Figure 28: Shiny and smooth Aluminium sheet (Ltd., 2018)

Physically, chemically and mechanically aluminium is a metal like steel, brass, copper, zinc, lead or titanium. It can be melted, cast, formed and machined much like these metals and it conducts electric current. In fact often the same equipment and fabrication methods are used as for steel.

Aluminium is a very light metal with a specific weight of 2.7 g/cm^3 , about a third that of steel. For example, the use of aluminium in vehicles reduces dead-weight and energy consumption while increasing load capacity. Its strength can be adapted to the application required by modifying the composition of its alloys. Aluminium naturally generates a protective oxide coating and is highly corrosion resistant. Different types of surface treatment such as anodising, painting or lacquering can further improve this property. It is particularly useful for applications where protection and conservation are required. Aluminium foil, even when it is rolled to only 0.007 mm thickness, is still completely impermeable and neither light aroma nor taste substances out. Moreover, the metal itself is non-toxic and releases no aroma or taste substances which make it ideal for packaging sensitive products such as food or pharmaceuticals (AZoM, 2002).

3.6 Comparison of Existing Product

For another step for gaining information, there are comparison between Innovative Ceiling Fan Cleaner and a Normal Ceiling Fan Cleaner. The following shows the comparison. It is safe to say that it is more futuristic and ergonomics.

Characteristic	NX15 Innovative Ceiling Fan Cleaner	Normal Ceiling Fan Cleaner
Movement	Control using connecting rod of vacuum cleaner	Wipe manually
Cleaning progress	Double sided cleaning	One sided cleaning
Cleanliness	Direct suck the dust into filter bag of vacuum cleaner	Manually clean the dust that spread all over the area
Time taken to clean	Less time to clean	Take time to clean

Table 1: The comparison of innovative ceiling fan cleaner and normal ceiling fan cleaner

Next, there is also an observation and research to compare the other similar ceiling fan cleaner that exist at the market. The results of comparison of three (3) types of design are shown below:


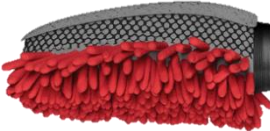

	NX15 Innovative Ceiling Fan Cleaner	Extended Wand	Vac+ Dust Ceiling Fan Tool with Washable Microfiber Pad
Figure		 (Devil, 2015)	 (Devil, 2015)
Price	Estimate: RM 40-60	RM 150	RM 215.00
Weight	Estimate: ~ 400 g	550 g	700 g
Dimension	5 cm x 17 cm	3 cm x 9 cm	6 cm x 10 cm
Type of material for cleaning	Microfiber	Microfiber	Microfiber
Rate of cleanliness	Excellent	Moderate	Excellent
Specification	<ul style="list-style-type: none"> – Clean upper part and lower efficiently – High quality of material in cleaning 	<ul style="list-style-type: none"> – Clean one surface only – No dust suction to vacuum 	<ul style="list-style-type: none"> – Fit most of ceiling fan – Capture dust very well but the lower part use brush to wipe dust

Table 2: The comparison of 3 types of design

3.7 Ideas of Design for Innovative Ceiling Fan Cleaner

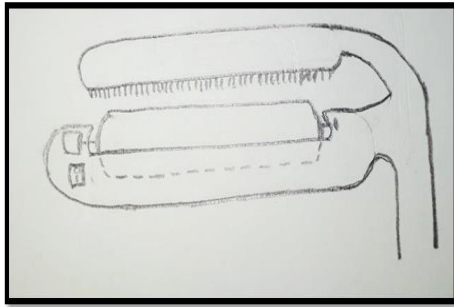


Figure 29: First idea of design

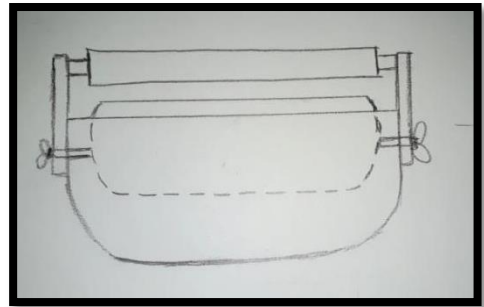


Figure 30: Second design

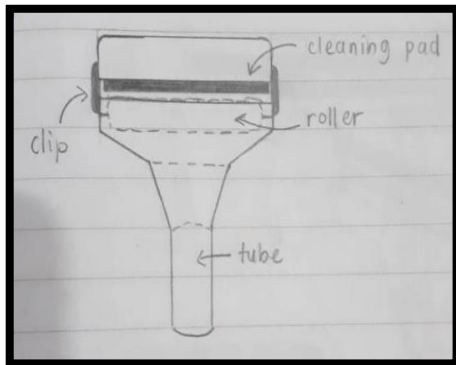


Figure 32: Third design

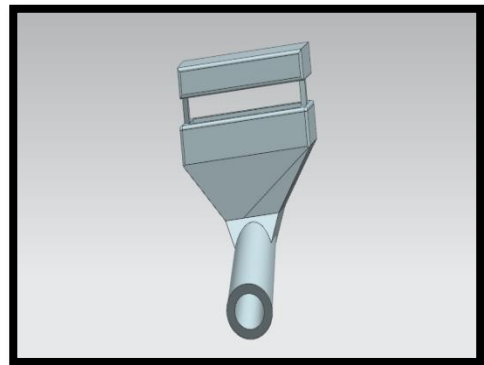


Figure 31: Fourth design

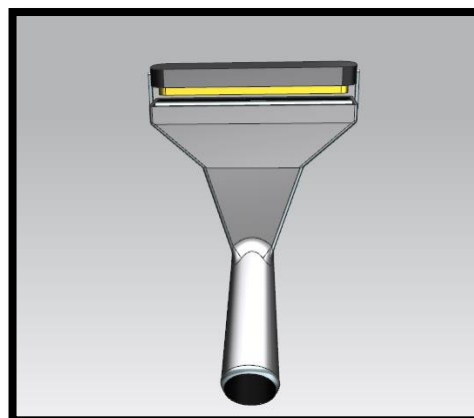


Figure 33: Final design

CHAPTER 4

RESULT AND DISCUSSION

4.1 Efficiency of design

Before the design proposed, many aspect has been considered to produce an efficient NX15 which are shape of nozzle, ergonomically of the nozzle and most important the function itself which is to clean ceiling fan blades. The brainstorming for proposed design started from March 2018 with the new innovation to design an efficient and safe nozzle for cleaning the ceiling fan blades. After the design was approved by the supervisor, the project moved to the design phase. The design phase was completed in 30 days by using the Software 3D Drawing NX10. The shape of the NX15 is rectangle and has an extension which is the most suitable shape for insertion of ceiling fan blades at the middle of it. The edge of the nozzle was design with 4 mm of edge blend to reduce the acuity after the process of printing. The hose of the nozzle designed at the middle of the nozzle and 140° bend to avoid user from standing right below the ceiling fan blades and bend the head too long. It was design ergonomically to avoid difficulties to user when doing the cleaning process especially at higher places and feeling tired of neck. The hole of suction designed at the lower part of nozzle to make sure the dust from the fan blades suck up well to vacuum cleaner. The upper part needs not the suction because the dust will stay in between the roller and cloth. The fan blades holder also was designed to hold the blades after had been inserted. The width of the nozzle designed up to 50 mm to ease the process of fabrication of materials attached and the maintenance process.



Figure 34: Front view of NX15 Innovative Ceiling Fan Cleaner

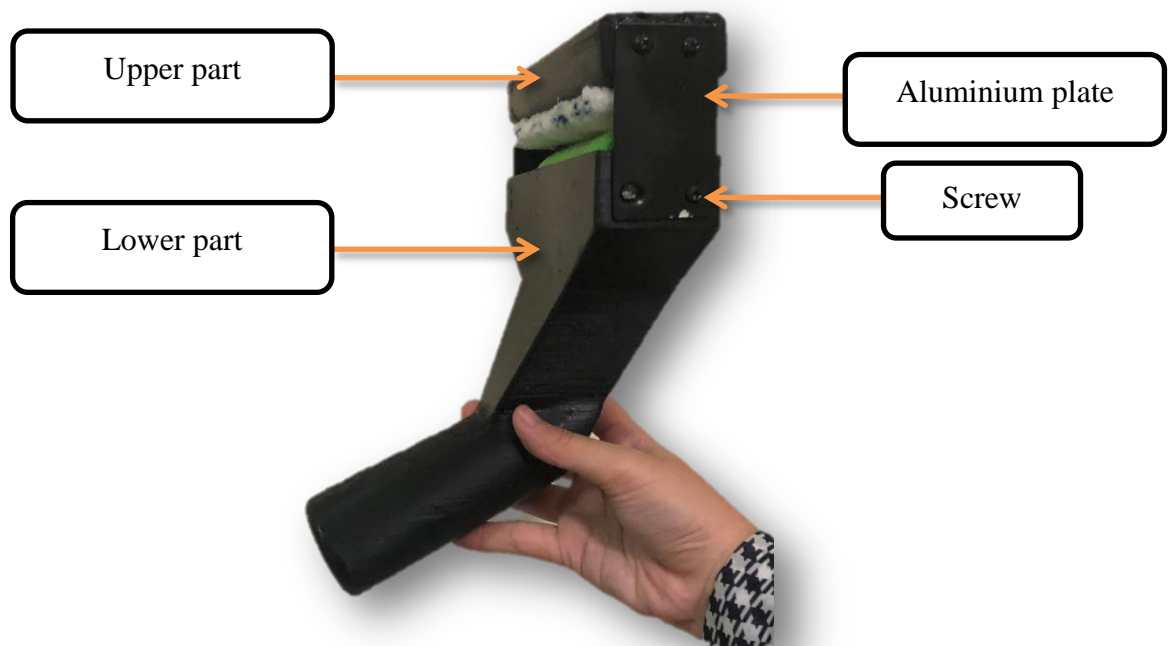


Figure 35: Side view of NX15 Innovative Ceiling Fan Cleaner



Figure 36: Removable parts which upper part can separate from the lower part by remove the screws



Figure 37: Roller with microfiber in the lower part



Figure 38: Upper part with microfiber

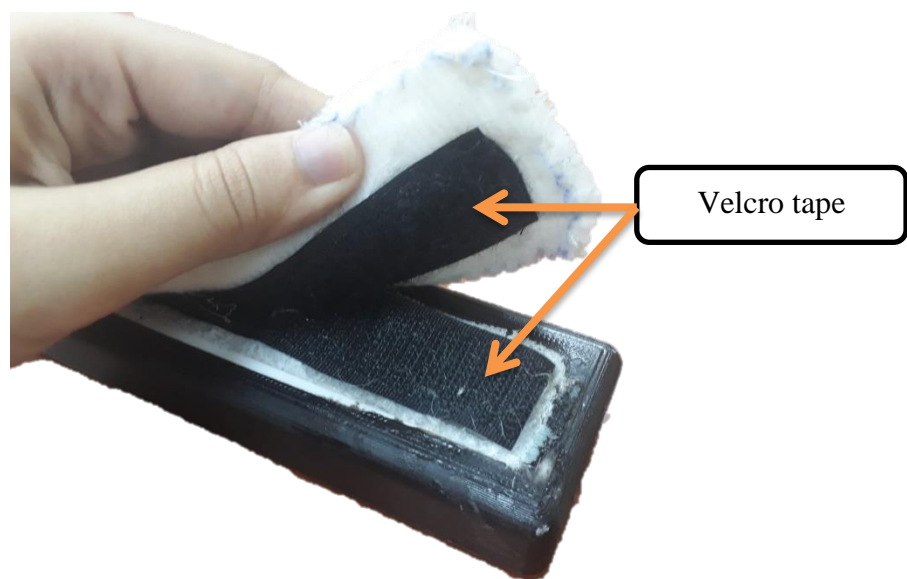


Figure 39: Velcro tape attached to the microfiber and NX15

4.2 Efficiency of material

In this project, three (3) types of materials are used to clean the ceiling fan blade's surface which is microfiber cloth, rubber and sponge. The result of dust weight, time taken, room temperature and wind speed are recorded.

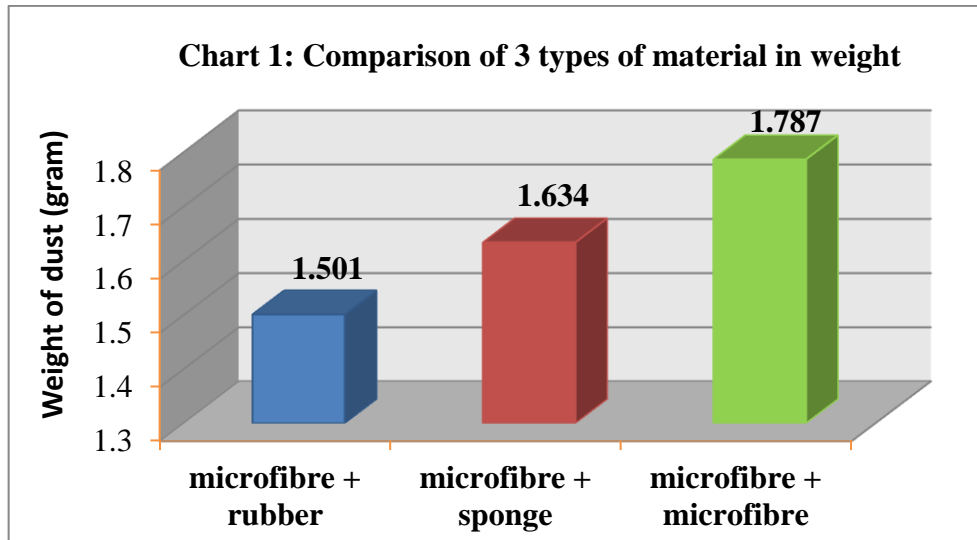


Figure 40: Comparison of 3 types of materials in dust weight collected (gram)

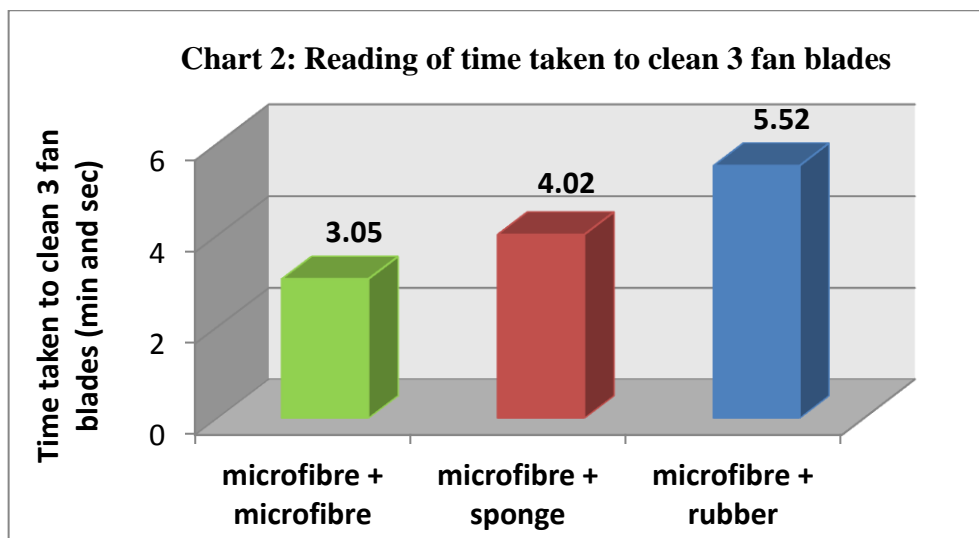


Figure 41: Comparison between 3 types of material for the time taken (minutes and second) to clean 3 fan blades

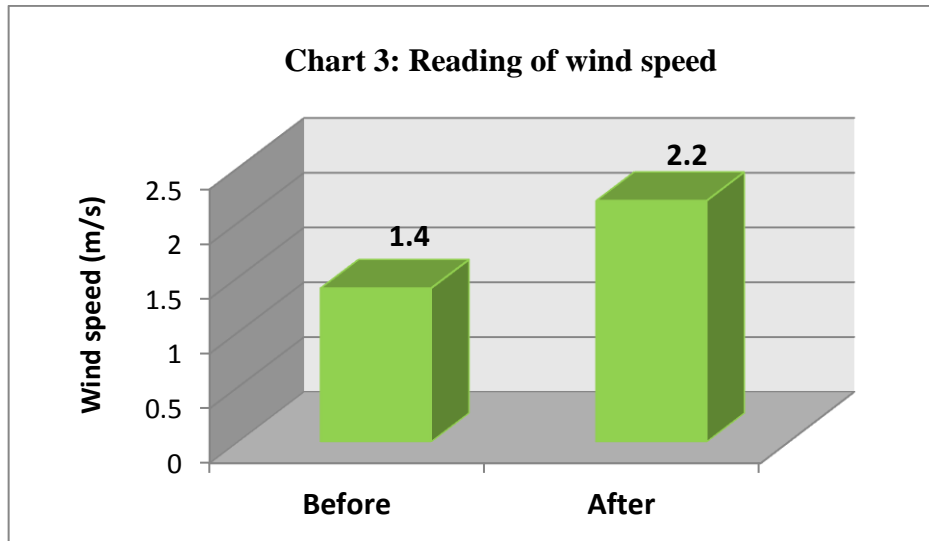


Figure 42: Wind speed (m/s) before and after cleaning ceiling fan by using NX15

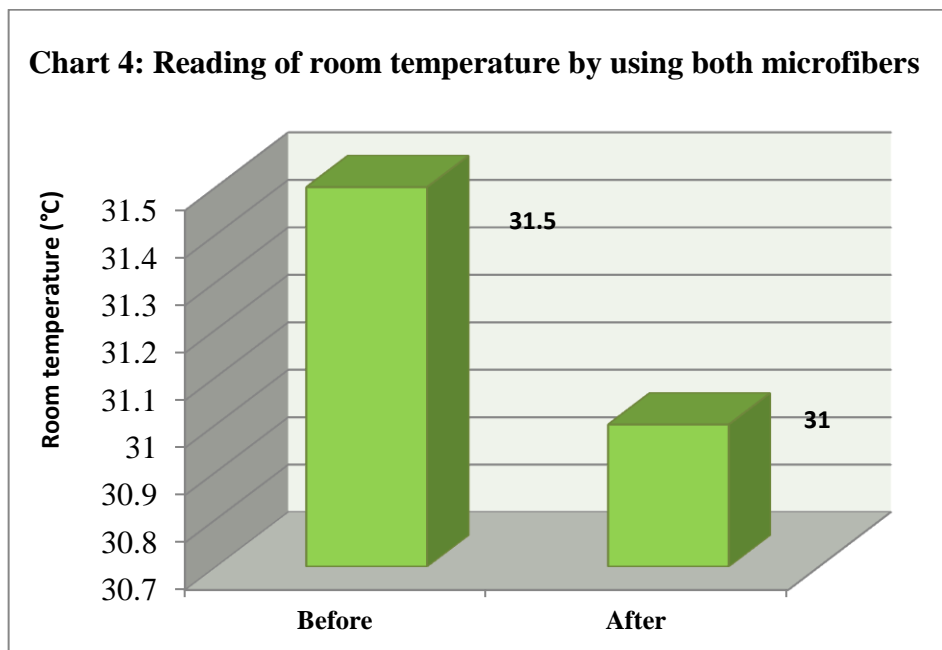


Figure 43: Room temperature (°C) before and after cleaning ceiling fan by using NX15

As Figure 34 and Figure 35, either Testo thermal anemometer or Extech mini anemometer, the reading speed of the wind and temperature in the room record the same pattern as the speed of the wind in the room will increase for both material and room temperature will decrease after fan cleaning.

Material attached to the upper part and roller part is microfiber-microfiber, microfiber-sponge and microfiber-rubber. Based on these three pair of material, pair of microfiber-microfiber is the most efficient since microfiber picks up debris rather than pushing it. Figure 39 show that dust collected by material microfiber-microfiber is higher compared to material microfiber-sponge and microfiber-rubber.

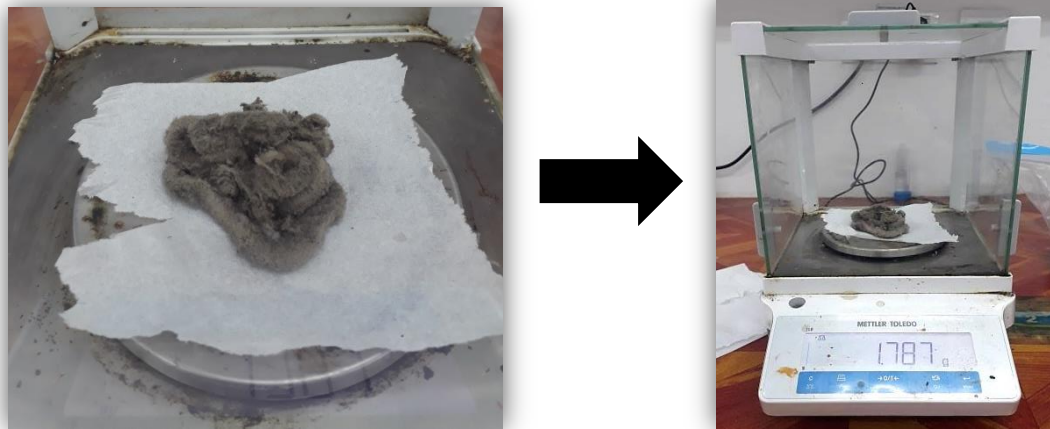


Figure 44: The weight of dust collected by microfiber-microfiber

According to Figure 40, microfiber material also show that 3 minutes and 5 seconds as the shortest in duration of time to clean 3 fan blades while sponge takes 4 minutes and rubber takes almost 6 minutes. This is proven that the microfiber structure can trap more dust compared to the rubber and sponge. This is because the microfiber has a more surface area to hold or collect the dust efficiently. Sponge can be used in cleaning the surface of ceiling fan blade, but it has abusive surfaces unless the sponge is wet. After finish cleaning the ceiling fan by using microfiber cloth, ceiling fan has been tested by using Extech mini anemometer for the wind speed of fan which is increases from 1.4 m/s to 2.2 m/s and at the same time, the room temperature measured by Testo thermal anemometer, decreases for 0.5 °C which is from 31.5 °C to 31.0 °C. Overall, microfiber is the most efficient material to wipe the dust on fan blade compared to sponge and rubber.



Figure 45: Ceiling fan blade before using NX15



Figure 46: Ceiling Fan blade using NX15

4.3 Energy performance of ceiling fan and time consumption

NX15 are quite efficient to suck up dust and grimes stick at the side and on the surface of ceiling fan blade. The high power of the vacuum which it has 2000W of suction power can suck up the dusts that have been picked by the material attached. However, the ceiling fan blades' surface cannot be cleaned one hundred percent because somehow the blade's surface need to be clean by wet cloth so the blade can look more shine. The user also can handle the NX15 easily as it has light weight. It only weighed 0.36 kg and if the nozzle is attached with the vacuum hose, it will become 0.80kg which is less than 1 kg. The user will not be too tired to hold the NX15 to clean the ceiling fan blade and it will reduce the risk of or avoid the user from using ladder for cleaning process. Besides the weight issue, 140° of hose is also one of the important factor need to be consider because the eye will use between range 30° and 45° to see the fan blade while cleaning process. This can reduce the tiredness of neck and shoulder as well as energy of human body during cleaning the fan blades.

Before cleaning ceiling fan blade by using NX15, the ceiling fan are switch to speed 5 which means the blade are loaded with the dust and grimes at the side and on the surface. This can effect to the motor fan which need to give more energy to move the blade. Therefore, NX15 are created to remove the dust and grimes at the fan blade. After finish cleaning the ceiling fan blade, in the speed of 5, the wind speed increases than before and at the same time the room temperature become decrease. Hence, the room become cold so that, the speed of ceiling fan can switch to 3 to keep the humidity and temperature in a comfort condition for human, besides to reduce the energy supply to the ceiling fan.

Since the NX15 can remove all the dust on the ceiling fan blade, it can increase the health safety for the consumer which the user will not too expose with the dust contain in the circulating air in the user's space. When a dirty ceiling fan runs, dust and dust mites can spread throughout the room, especially onto surfaces such as carpets and bedding. These effects can be detrimental, especially if users are allergic to dust mites. With less than four minute, the user can clean the ceiling fan blade frequently and will not worry about getting allergic to the dust or air that breathed in the user's living space.

4.4 Thermal comfort in a room

Thermal comfort depends on many factors, in which, temperature, humidity, and air speed are among the most important ones. In cooling scenarios, although low temperature is the first choice for comfort control, moderate air speed as a breeze can enhance thermal comfort at higher temperature by “wind chill” effect. (Ho, Rosario, & Rahman, 2008) In the urban environment, a thermally comfortable indoor condition is essential for a healthy indoor living environment and quality of life. Human thermal comfort is found to be related with several factors such as air temperature, air movement, amount of clothing worn, and activity level including a human body itself (Jamaludin, Mohamed, Khamidi, & Wahab, 2014). From figure 51 and figure 52, the wind speed increases for 0.8 m/s and room temperature decreases for 0.5°C.

Sampling sites	No of sampling	Description of sampling site	Testing by using	Type of dust collected
Appendix A1	3 fan blades	<ul style="list-style-type: none"> – Kitchen – Laundry – Living room 	Microfiber	<ul style="list-style-type: none"> ✓ Dust ✓ Grimes ✗ Dirt
Appendix A2	3 fan blades (each blade for one material)	<ul style="list-style-type: none"> – Medium size – 3 cupboards 	<ul style="list-style-type: none"> – Microfiber – Sponge – Rubber 	<ul style="list-style-type: none"> – Microfiber cloth: Dust, dirt and grimes – Sponge: Dust, dirt and grimes – Rubber: Dust
Appendix A3	3 fan blades	<ul style="list-style-type: none"> – Small size – 2 cupboards 	Microfiber	<ul style="list-style-type: none"> ✓ Dust ✓ Grimes ✓ Dirt
Appendix A4	3 fan blades	<ul style="list-style-type: none"> – Living room – Door always open 	Microfiber	<ul style="list-style-type: none"> ✓ Dust ✓ Grimes ✓ Dirt

Table 3: Detail of the testing by using NX15 on sunny day

Based on the table above, the dirt is difficult to remove by the cloth especially when there has a kitchen. Sampling site can refer to Appendix A1. The surfaces of the ceiling fan blade are greasy and a little bit sticky causes the fan is not look glow after cleaning the fan blade. As a result, it still has the bacteria on the surfaces and low air velocity. This problem can be overcome by spray water to both microfiber cloths to attract the sticky dust on the surface. Water is pretty good at cleaning most things all by itself. This is because its molecules have two very different ends. They are electrically unbalanced, so they stick to all kinds of things including lumps of dirt like tiny magnets and break them apart. Water is sometimes called a universal solvent because it can dissolve so many different things. Where water alone cannot help, it can turn to a detergent such as a soapy chemical that clings to dirt and grease, breaks it apart, and

makes it easier for water molecules to flush it away. But, many people do not like using detergents because expensive, can cause allergic reactions and skin complaints, undermining the way our bodies' immune system. Another complaint is that detergents contain chemicals that flush down to drains into rivers and seas, where they gradually build up and cause water pollution. Detergents or soaps might be making home cleaner, but at the same time they are making the environment dirtier in the process. For all these reasons and a few more, many people would love to be able to clean their homes without chemicals and that is where microfiber cleaning cloths can help (Woodford, 2018).

Next, for the comparison of three (3) materials, this is proven that microfiber cloth and sponge can collect all the dust from the blades compared to the rubber which is collect the dust only. But, the microfiber is still as the most efficient material in dust collected because the weight of dust is higher than sponge and the time taken to clean the blades is the shortest duration. This is because its ingredients are 50 percent polyester and 50 percent polyamide. Microfibers vary widely in the size of the fibers and cleaning effectiveness. Based on figure 44, in average cloths, the fibers are 10 to 50 times thinner than a human hair, so each one is only about 3 to 5 micrometers in diameter and about 50 times lighter than the fiber in a pair of stockings. It is roughly the same size as “typical” bacteria (1 to 5 microns), but still bigger than most viruses (which tend to be smaller than 0.5 microns). Since microfibers do not effectively remove anything smaller than they are, it would be accurate to describe average microfiber cloths as “antibacterial” (Woodford, 2018).

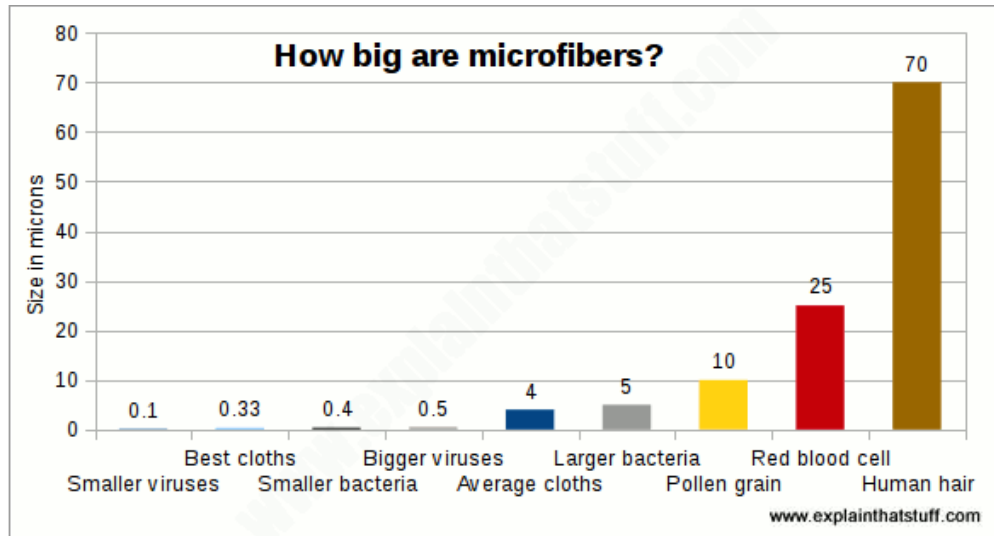


Figure 47: Comparison of microfiber size with other stuff (Woodford, 2018)

Lastly, it can say that the microfiber can collect the dust but when there is a greasy mix with the dust or dirt, there has difficulties to wipe all the dirt by the microfiber without water. Therefore, to increase the efficiency of the product, the water also needs to remove all types of dust include dirt.

CHAPTER 5

CONCLSUION AND RECOMMENDATION

5.1 Conclusion

Most Malaysian still depend on ceiling fan as their priority equipment as cooling system at their home. The main reasons to design new vacuum nozzle extender for ceiling fan blades are to fabricate the new innovative nozzle to reduce the risk in health and safety aspect and to design an efficient and safe nozzle for cleaning the ceiling fan blades. It will give big impact if people not taking seriously about the cleanliness of their home and the ergonomic of their cleaning tools. Hence, the vacuum innovative nozzle cleaner is the efficient ways for solving all the issues. However, the design of vacuum innovative nozzle still need improvement such as the design should consider more about how the ceiling fan blades can enter easily in the vacuum nozzle, the hose of the nozzle can be fit to certain brands of vacuum, the size of nozzle extender should be more variable for the most brands of ceiling fan. With this innovative nozzle all the cleaning process can be easier as the upper part and lower part of ceiling fan blades can be clean at the same time. This project is done by showing some observations, research and survey from the Malaysian's people.

5.2 Recommendations

Recommendations are required to improve efficiency of NX15 especially on the design. First, the design requires an indicator or special holder to hold the ceiling fan blade to facilitate the insertion of the ceiling fan blade. For current design, it do not achieve 5S concept which the cleaning process need to wipe back and forth and do not clean fully in one wipe. Besides must insert the nozzle at the front, this repeated moving shows the design is not as an efficient product. If the design of nozzle can be insert at the side of blade and have push button to adjust the diameter of gap between the lower part and upper part, then place the blade in between two part and flank to wipe the dust for one direction only. Lastly, the size of hose need to meet the size of varies vacuum.

Currently, the design only fit with the hose of Panasonic brand and for ceiling fan blade, the roller can fit with two standard types of ceiling fan which are KDK brand. If the hose and the roller of the nozzle can fit with varies brand, it can be more efficient to anyone to use. All the recommendations are need to be considering for the better future.

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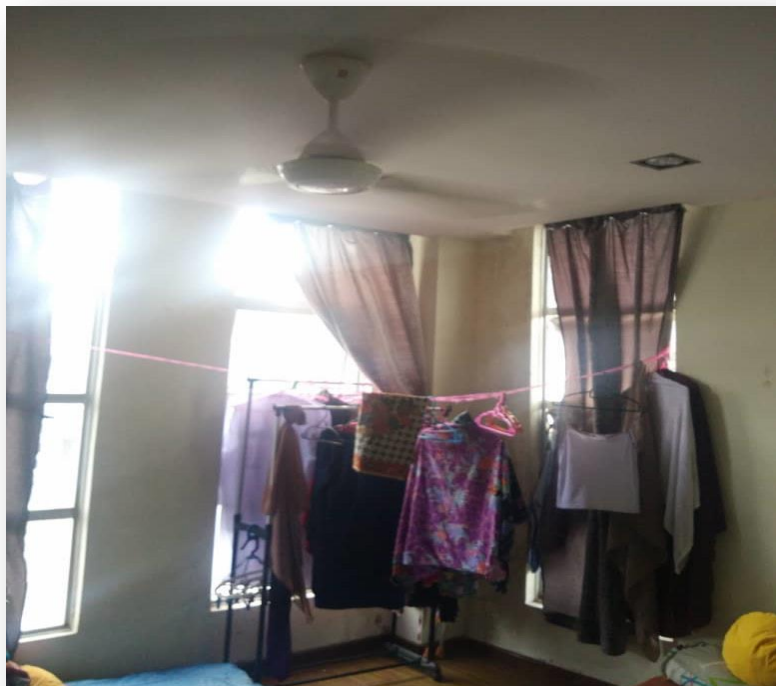
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APPENDICES

Appendix A1: Kitchen (Sampling site 1)



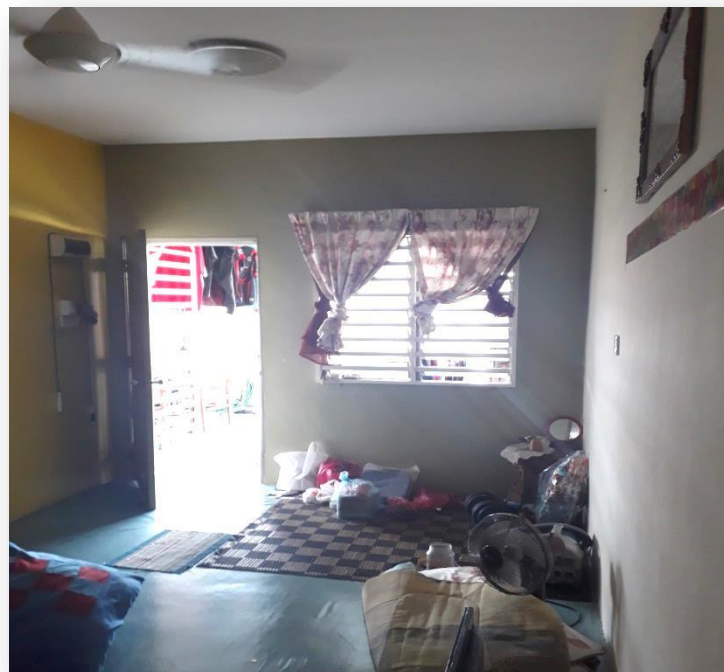
Appendix A2: Medium room (Sampling site 2)



Appendix A3: Small room (Sampling site 3)



Appendix A4: Living room (Sampling site 4)



Appendix B: Time management

GANTT CHART																											
ACTIVITIES	MONTHS	SDP I												SDP II													
		FEB			MAR			APR			MAY			SEPT			OCT			NOV			DEC				
TOPIC UNDERSTANDING																											
BASIC DESIGN																											
DETAIL DESIGN																											
MATERIAL SELECTION																											
DRAFT PROJECT PROPOSAL																											
PRESENTATION																											
FULL PROJECT PROPOSAL																											
REDESIGN PROJECT																											
3D PRINTING																											

Appendix C: Cost analysis

No	Material	Quantity	Price per unit	Total	Sources/Shop
1	3D Printing	1 times	RM400.00	RM400.00	FKM, Pekan
2	Bearing	2	RM10.00	RM20.00	Hardware
3	Microfiber Cloth	1	RM3.00	RM3.00	MR.DIY
4	Microfiber mop	1	RM5.57	RM5.57	MR.DIY
5	Black spray	1	RM8.00	RM8.00	Hardware
6	Aluminim sheet	2	RM1.00	RM2.00	Hardware
7	Velcro tape (black)	1 meter	RM3.50	RM3.50	Wedding shop
8	Thin sponge (sheet)	1m x 1m	RM2.00	RM2.00	Wedding shop
9	Rope (White)	1	RM 4.00	RM4.00	Book shop (Popular)
Total :				RM 448.07	

Table 5: Analysis cost for NX15

NX15 have potential to be in market and if it will be on the market, the expected selling price for this nozzle is from RM 40 to RM 60 of mass production.