

Hang-and-Go: A Smart Laundry Hanging System

by

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16012

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CERTIFICATION OF APPROVAL
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SEPT 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

(OOI WEI LYNN)

ABSTRACT

Washing clothes, drying up the clothes are the routine to the majority of the people. However, most of the people claimed that the process of drying up the clothes is the most challenging part due to the unpredictable weather in Malaysia. This project introduces Hang –and –Go: A Smart Laundry Hanging System that can automatically detect the presence of rain and sunlight and intelligently provide shelter for the clothes to protect them from the rain. This project is began with the objectives of studying people’s experience in doing the laundry process at home and small business scale, investigate existing laundry hanging system, develop a low cost laundry hanging system for household usage and lastly evaluate the performance of the developed system. In this project, a prototype is constructed using the combination of several tools which include Lego Mindstroms EV3, Tetrix, and also Arduino. On top of that, the prototype is targeted for the household usage and also for small business scale use. In order to collect the users’ experiences, problems faced and their view on the suggested solution, the research methodology uses in this project are interview and survey. Survey result shows that majority of the people agreed that the Hang-and-Go is an efficient approach that would help busy people to dry their clothes without human supervision. A series of experiment were conducted to test the functionality of the system. As a conclusion, Hang-and-Go is an unmanned robotic approach to automatically improve human on their laundry process.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Clothesline is the most eco-friendly way of drying our clothes as it reduces greenhouse gas emission. Everyone loves fresh and clean clothes, with the advancement in technology; most of the houses in the country will have at least one washing machine in their house. Although washing machine do help us in easing our washing process of sweat and dirt of the garment but somehow after taking out from the washing machine, we still need to spend some time to dry our garment back after washing it. Some of us choose to use the traditional method which is by hanging them under the sunlight, some hanging indoor, and some using dryers.

To have a better understanding on the process of drying the clothes, let have a simple view on the science behind it. The simplest way of getting rid of liquid in the garment is by turning it to vapor through process name evaporation, which basically is turning liquid into gas. Thus, human then later came out with a method to dry their garment which is by hanging them under the sun. This activity is commonly known as hanging clothes on line or on washing line.

A clothes line can be attached from a post or any wall. Generally it made up of a string, rope, cord, or twine that will be ties to two ends which is the post or wall. Then the clothes will then be hanged along the line. In most of the house, the clothes line can be seen in the backyard, balconies or garden(Mohamad, June 2008).

The main source of energy use to dry the clothes is the sunlight and the air flow in the surrounding. So basically it depends on the weather. In Malaysia, over the year are undergoing uniform temperature and with high humidity. For the rainfall distribution in

Malaysia, heavy rain pour will taken place in Peninsular Malaysia, Western Sarawak and the northeast coast of Sabah (Ministry of Science, Technology and Innovation (MOSTI), 2013).

With the increase in standard of living, the changes of the cost expenses had increase from time to time. Thus single income family will potentially unable to cover up their daily expenses. To overcome this situation, both husband and wife will have to work in order to generate more income. With the recently research done, a significant contribution towards country's economy and social development had been brought by women participation in their career. (Bakar & Abdullah, 2007).

Based on a Labor Force Report by, In the third and fourth quarters of 2007, females' labor force participation rates (LFPR) was highest at the age group 25-34 exceeding 60.0 per cent (Department of Statistic Malaysia, 2007). By comparison between LFPR of Male which is 79.2% and female 46.2%, we can clearly see that the rate of female participation is about half of the male LFPR.

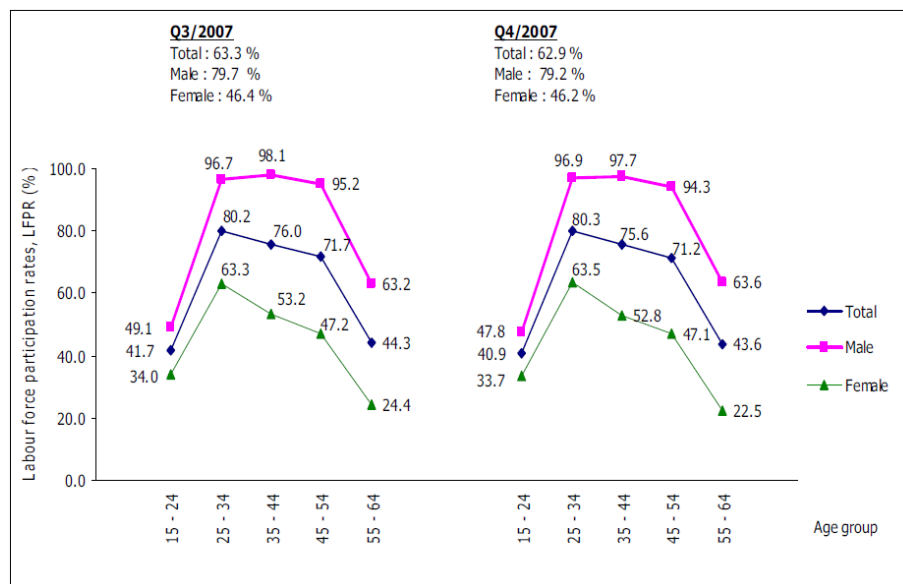


Figure 1.1: Labor force participant rate by age group.

(Source: Department of Statistic Malaysia)

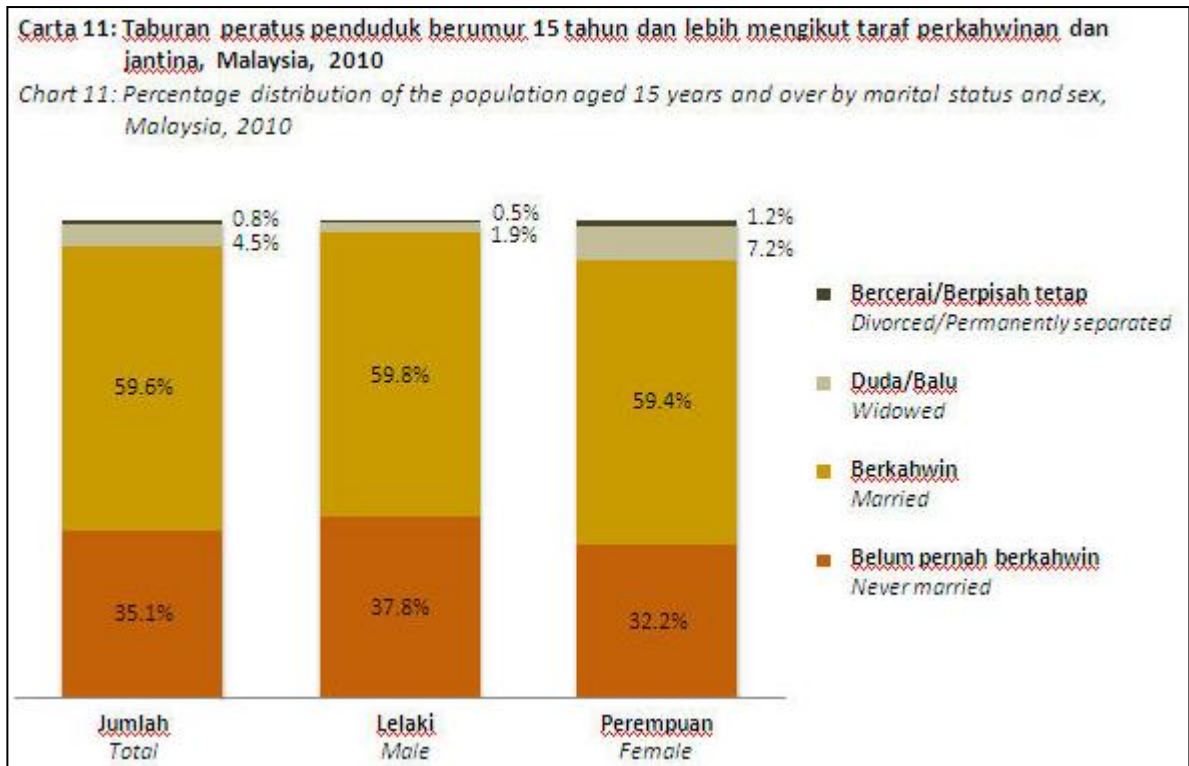


Figure 1.2: Percentage distribution of the population aged 15 years and over by marital status and sex. (Malaysia, 2010)

According to the chart by Department of Statistic Malaysia in year 2010, the percentage of female who married at 15 years old or later are about 59.4% of the population. Thus we can know that from the female who are employed 46.2% have the probability of 59.4% of getting married. So after building up a family, both husband and wife have to work in order to get more income to support the family expenses.

1.2 Problem Statements

1.2.1 Busy Lifestyle

When both husband and wife are working, during day time they would hardly be at home, thus there will be no one to be working on house hold chores for example collecting up the clothes. Even they do work from home, with the tight and busy schedule, might sometimes causes them to forget to pick up the clothes outside. If it started to rain, for those working outside will not able to get back home on time to pick it up. Thus their clothes are either exposed to rain fall or receiving excessive exposure of UV sunlight.

1.2.2 Unpredictable Weather

As mention earlier, Malaysia are country with unpredictable climate thus, the effect of rainfall on clothes is causing the clothing to collect excessive amount of water and thus it will require more time to get it dry completely. Thus if no one was home to keep the clothes, when the owner came back, there is high chances that the clothes are still wet and they will need to rewash or spin the water out from the clothes again.

What if there is no rain fall and the sunlight did their job by drying the clothes perfectly dry and clean? Yes the owner will definitely happy with it. But in long terms, later then they will start to realize that their clothes had started to fade. Now the question is why? The answer is due to photodegradation (Librarian of Congress, 2010). How does it happen? In our clothes there are some chemical bonds which present due to the chromophores in the dyes. When the clothes are exposed under excessive sunlight, the ultraviolet rays can break down the chemical bonds of the chromophores and thus fading the clothes like a bleaching process had taken in place.

1.2.3 Unhygienic Indoor Drying

When all these happen, later then more people choose to dry their clothes indoor to avoid all the above affects. Yes, indeed the clothes are now able to get rid of the sunlight and the unpredictable weather but now the family members' health are exposed against a serious threat especially for those with weakened immune systems or severe asthma. We might only think that drying clothes may cause our clothes to have unpleasant smell and

odor but we never know that it actually acts as an allergen which leads to health problems(University of Florida, 2001).

Dr Denning, a Professor of Infectious Disease in Global Health at The University of Manchester, explains: "One load of wet washing contains almost two liters of water, which is released into the room." (Medical Press, 2014). With that particular amount of water it would raise moisture level in our house up to 30 percent, and thus becoming the best breeding condition for mould spores. Other than that, there one of the type of mould which known as aspergillus fumigates are the contributors towards fatal lung infections(Medical Press, 2014). Although most of us are immune to fight back the fungus infection, but it would be a real suffer for infants, children, elderly, asthma patient, cancer patient who undergoing chemotherapy and aids patients(California Department of Health Services, 1998). The consequences would be uncontrollable coughing and wheeziest. He also advice that it is better to dry wet washing clothes outside or in a well ventilated indoor area rather than in bedrooms and living areas.

1.2.4 Expensive dryer

To overcome the infection that might bring to our family, consumer will then consider buying a dryer. However not everyone could afford it as it is very expensive (each unit is more than RM1600 (Lazada, 2015)) and consumed lots of electricity on every single usage. Based on the research made, dryer in U.S did consume up to 66 billion kWh per year and it is equivalent to 5.8% of the housing electricity usage(Paul Bendt, 2010). Other than that, each load of laundry dried will also produces carbon footprint which equivalent to 2 Kilograms of carbon dioxide (Ball, 2008). So why should we care so much about the carbon footprint produces? Will it impact us? Yes, it not just affects us, but also our planet climate (The SOPRIS Foundation) .

1.3 Objectives

There are 4 objectives which aim to be achieved at the end of the project:

- 1) To study the people's experience in handling the laundry process at home and small scale businesses.
- 2) To investigate existing laundry hanging system
- 3) To develop a low cost laundry hanging prototype for household usage
- 4) To evaluate the performance of the developed prototype

1.4 Scope Of Study

This project is focused mainly for household usage and also small scale business usage. Thus the lab scaled prototype is expected to hold up to 8 Kilograms of laundry. However due to limitation of development materials this prototype would be able to hold up to 3 Kilograms of laundry as it is mainly use to demonstrate how the idea works and how it would able to help out busy people in their daily life. Besides that the prototype is also able to hang up to 20 clothes per session, but due to the limitation of development materials in building it, the prototype is aim to demonstrate at least 6 clothes per hang.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses on existing products available in the market and also the product which are still under research. This section is divided in to three parts, which is traditional clothesline, automated clothesline system and lastly the gaps found in the existing products.

2.2 Traditional Clothesline

Traditional clotheslines are the clotheslines which require no advance technology, non-mechanical and are widely use by the people.

2.2.1 T-Poles

T-poles will have 2 pillars supporting from one edge to another. It is permanently set in the yard, or garden. Usually it will contain 4 lines attached from one pole to another and most likely to be 20 feet apart (Harriet, 2009).

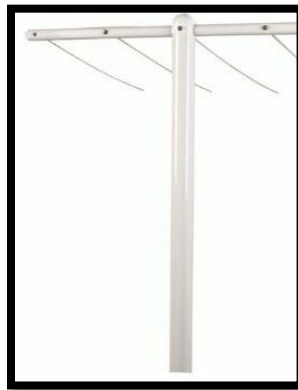


Figure 2.1: One end of T-Shape pole



Figure 2.2: String attached from one poles to another

The advantage of T-poles is that it enable user to hang a lot of clothes on the string and no matter what size are they.

However, the disadvantage is that it needs to be build and it would be the permanent structure on the ground.

2.2.2 Umbrella

Umbrella clothesline structure is having one pole which would act as the centre based. Then there would be four arms which extend outwards away from the center pole and strings are tied from one arm to another in a square (Harriet, 2009).



Figure 2.3: Umbrella clothesline when it is open (Baka Specialties LLC, 2007).



Figure 2.4: Umbrella clothesline can be close when it is not in used (Baka Specialties LLC, 2007).

The advantage of umbrella clothesline is that it can save up the space of the yard and minimize the rope stretching.

The disadvantages would be limited space compare to T-Poles clotheslines and yet it only able to hang some size of clothing. In other words, this like blanket which is big would require more space to hang it.

2.3 Automated Clothesline Systems

This section will introduce some existing clothesline system which is mainly modifying works from the traditional clothesline.

2.3.1 Versaline Disappearing Clotheslines

Versaline clothesline are basically advancement from T-Poles clothesline. It had eventually overcome the disadvantage of T-Poles clothesline which is space consuming. The modification made is by enabling each of the strings ends of the clothesline to be taken out from the poles when they are not in used, and so they name it as disappearing clotheslines.

Figure 2.5: Versaline Clothesline when it is in use.



Figure 2.6: Side view of Versaline Clothesline when it is in use.





Figure 2.7: Demo in keeping the Versaline Clothesline when it is not in use (Magento Developers , 2014).

The advantages of Versaline Clothesline are space saving, easy to install, retractable and portable. However, there are still some limitations of this product is that, user will require to find 2 poles which are perpendicular to each other in order to nail the holder of the clothesline.

2.3.2 Clever Closeline

Clever Closeline is one of the automated clothesline system can be found in the market. It is an advancement of umbrella clothesline. The clothes line system will be having a rain sensor which able to detect the rain and automatically triggers a cover to open and protects the clothes from the rain.



Figure 2.8: Clever Closeline side view.
(CleverCloseLine, 2010)



Figure 2.9: When rain is detected,
the plastic cover will expend.
(CleverCloseLine, 2010)

The advantage of the Clever Clothesline is automatically preventing the laundry to catch wet when it is raining. The disadvantages of this design are the limitation of the space to hang the laundry. Due to the cover above the clothesline, the clothes are not allow to hang exceed the square surrounding of the string as the rain cover will unable to reach the surrounding surface and thus there are chances that the clothes will get wet by the rain. Beside that as of the figure 2.9 above, we can see that there is a plastic cover surrounding the Clever Closeline in the bottom picture, this cover would need manual installation by the owner after they done hanging their laundry. If the user thinks that later it would rain then they would require covering their clothesline with that plastic.

2.3.3 Automatic Ceiling Cloth Hanger Drying Rack Cyclone Fan

This product is produced by Ozone Homz.com and it is available in the market and online. This appliance is required to be attached permanently to the ceiling. Thus the user will require fixing it indoors. The main source of heat or light is not from the sun but itself. What the user will need to do is controlling it by remote control, adjusting the bar height to their suitable height in order to hang the wet laundry. Then by pressing the remote control button, it will then back to its own position where now the clothing is ready to be dry. The user can choose to dry it with fans and also UV. Based on the statement given, clothes will need at least 3 hours to get it all dry but it still depends on the moisture of the surrounding.

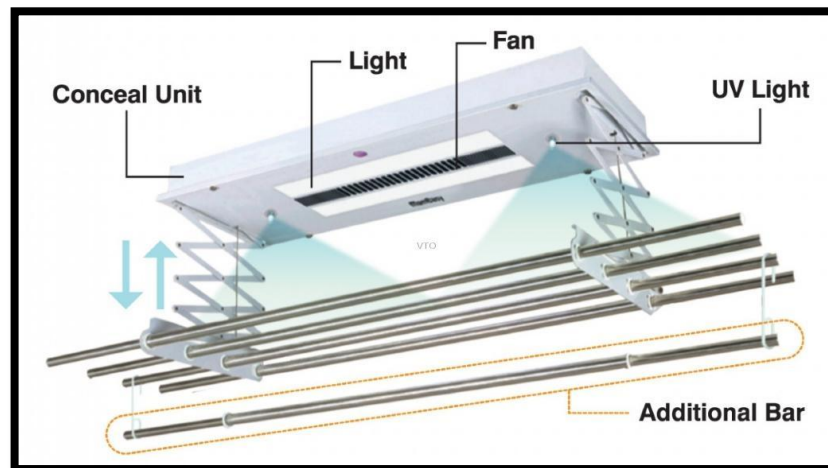


Figure 2.10: Automatic Ceiling Clothes Hanger product (OzoneHomz).

The main advantages is user do not need to hang their clothes outdoor, thus they will be worry free about their clothes whether it will caught in rain or not.

However there are some limitations found. Firstly the automatic Cloth dryer have only one choice of energy to choose in order to get their clothes dry which is electrical energy. Although this method uses less electricity than a dryer, but if we want to be eco-friendly to the environment, we should have put this appliance to the second choice.

2.4 Gaps found in the existing product

Table 2.1: Summary of existing product and Hang-and-Go prototype.

| Product Name | Source of heat | Indoor / outdoor | Methods to prevent clothes from rain. | Automated Shield extend and retrieved | Sensors used | Ease of using | Price |
|--|--|---------------------------|--|---------------------------------------|-----------------------|---------------|--------------------|
| Versaline Disappearing Clothesline | Sunlight | Outdoor | No | No | No | Easy | \$286.00 |
| Clever Clothesline | Sunlight | Outdoor | Automated plastic cover | No | Rain Sensor | Medium | \$329.00 |
| Automatic Ceiling Clothes Hanger Drying Rack Cyclone Fan | Electrical energy generating air flow and UV light. | Indoor | No, as it is indoor | No | Remote Control | Medium | RM 1,799.00 |
| Hang-and-Go: A Smart Laundry Hanging System | Sunlight and electricity | Outdoor and Indoor | Shield would be extended out to cover the clothes | Yes | Rain sensor. | Easy | ≤ RM 500.00 |

In order to get the clothes dry thoroughly, the main thing we concern the most are the source of energy. Both Versaline Disappearing clothesline and Clever Clothesline uses only sunlight as their only source of energy. Although we know that sunlight is the most environmental friendly way we can use to get our wet clothes dry, but there are also risk where it is in raining season and there would hardly be any sunlight heat during daytime.

So to overcome this Automatic Ceiling Clothes Hanger Drying Rack Cyclone Fan came out with the product which uses fans and UV light as their main source of energy to keep the clothes from wet to dry. Now the problem is this system will not be eco-friendly to the environment and will waste lots of electrical energy.

In order to make good use of the sunlight whenever it is available, and reducing the dependent on electricity, Hang-and-Go came out with a solution which is to fill in the gap by having the both sources of energy to be used. This is possible as the idea is to get the clothes exposed under the sunlight when it is there. On the other situation like raining season and the clothes are not completely dry yet, the shade will be extended to cover up the clothes, and fan would be activated to circulate the air.

The cost of Versaline Disappearing clothesline, Clever Clothesline and automatic ceiling clothes hanger drying rack cyclone fans are not easily afford by the people. To overcome this, Smart Laundry Hanging System will produce a system which would be useful and affordable to the people by using reliable and low cost materials in building the system development.

As a conclusion, Hang-and-Go uses sunlight and electricity as a source to dry up the clothes, thus this system would be placed outdoor and when it is rain, the rain sensor will able to detect the rain water and thus it will trigger the shield to cover up the clothes from rain. Then once the rain sensor had dries up, which indicating there is no more rain fall, so the shield will be retrieve back and indicating there is no more rain fall and the clothes will be able to exposed under the natural sunlight to dry.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter discusses about the methodology used for development and research processes. Quantitative and qualitative methods are used the data collection process. Quantitative method is done through surveys and interview of respondents. While qualitative method is done through market research.

3.2 Development Methodology

This project is carried out using increment development method.

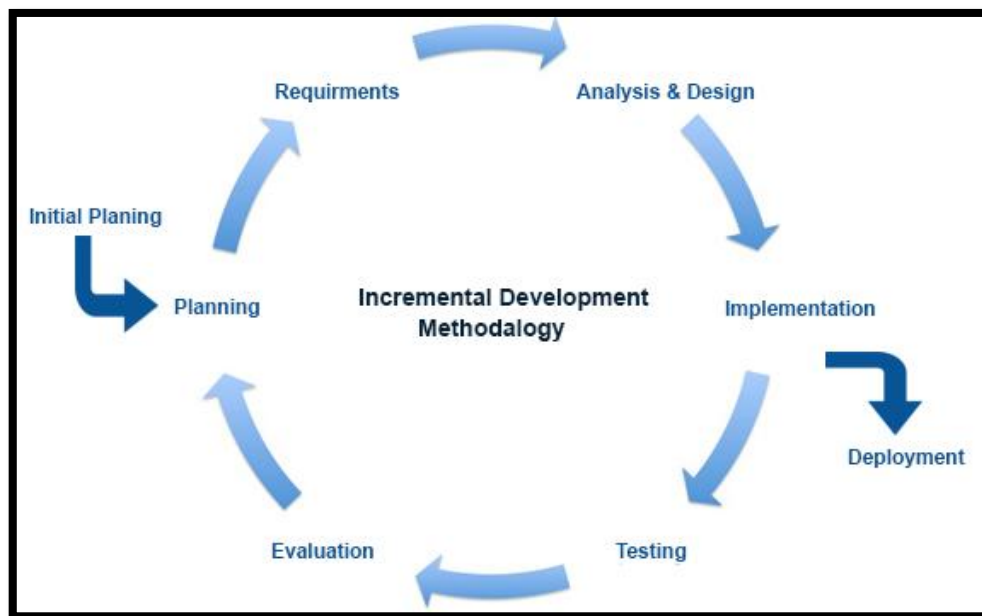


Figure 3.1: Incremental development methodology used.

From the initial planning of the project until the deployment for the project, this project is divided into few parts carrying simple goals. Analysis will be carried out from time to

time in order to achieve the goals. From planning, requirement gathering, analysis and design, testing to evaluations are the cycles which will be carried out repeatedly until the prototype reaches the goals. When the goals and the requirement had been achieved, the prototype is now ready for deployment.

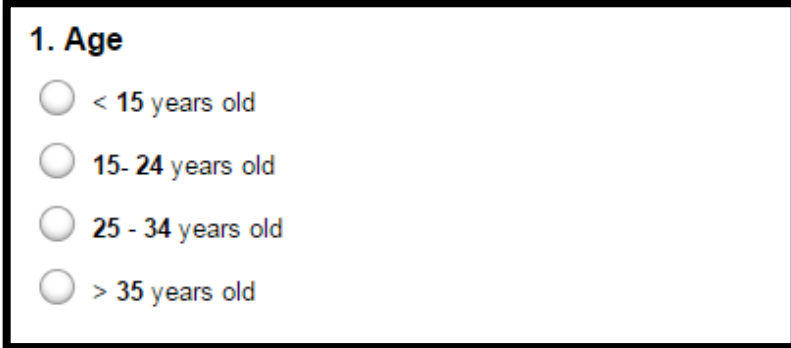
3.3 Research Methodology

This section will explain and discuss the method use to conduct the research.

3.3.1 Survey

An online survey has been performed out to gain better understanding on people's experience in handling the laundry processes at home or even by small scale businesses. Besides that, this survey also help in getting their opinions and views towards the newly develop system. In order to achieve the above mention objectives, 10 questions are posted in the online survey.

Question 1: Age



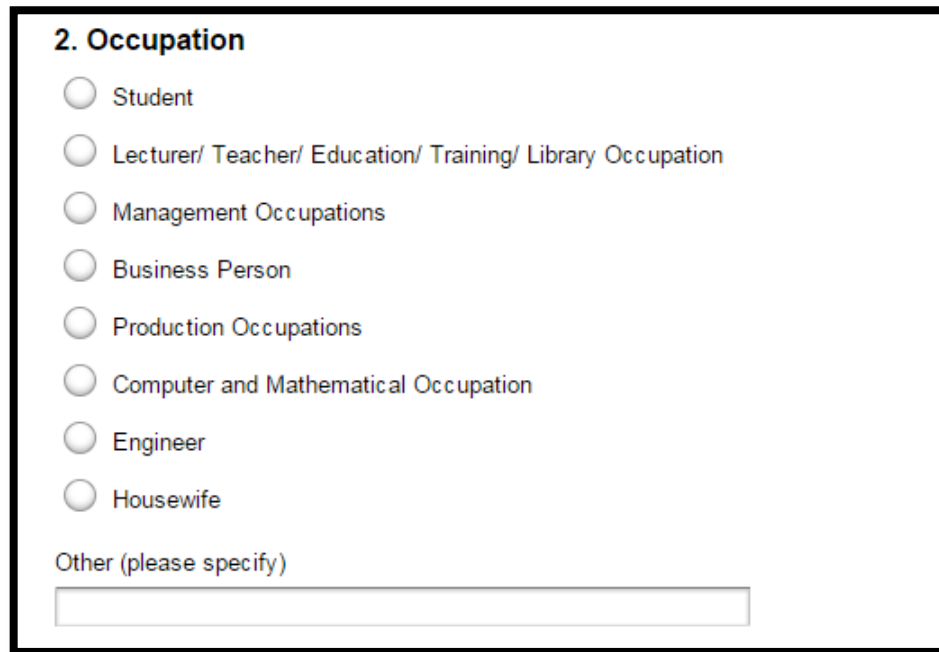
1. Age

- ☐ < 15 years old
- ☐ 15- 24 years old
- ☐ 25 - 34 years old
- ☐ > 35 years old

Figure 3.2: Question 1

This question is to determine the age group of the respondent who are interested with the idea.

Question 2: Occupation



2. Occupation

- ☐ Student
- ☐ Lecturer/ Teacher/ Education/ Training/ Library Occupation
- ☐ Management Occupations
- ☐ Business Person
- ☐ Production Occupations
- ☐ Computer and Mathematical Occupation
- ☐ Engineer
- ☐ Housewife

Other (please specify)

Figure 3.3: Question 2

This question is to determine the working group of the respondent who are interested with the system.

Question 3: Gender



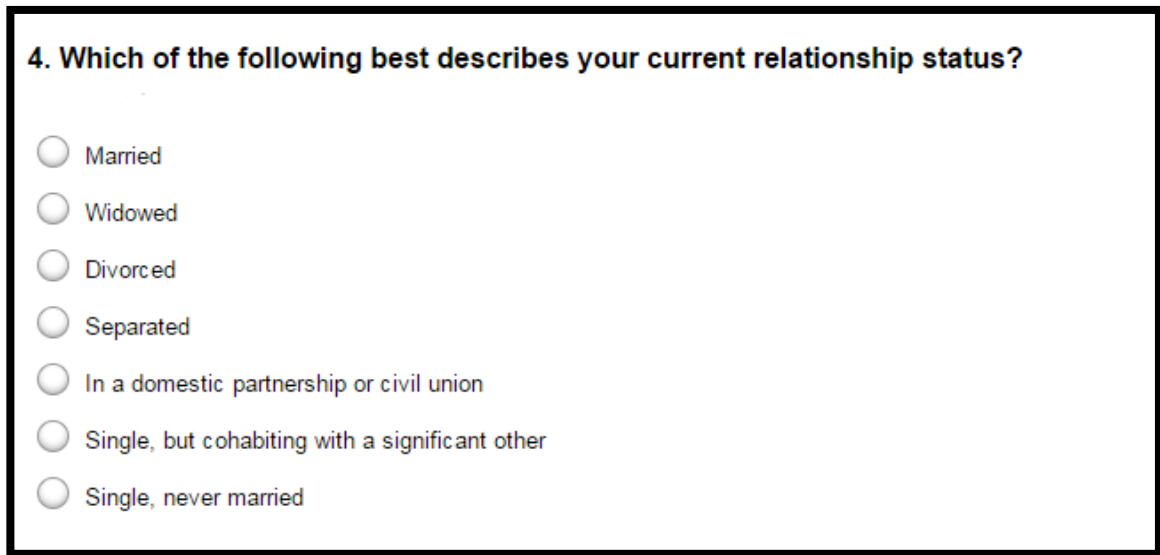
3. Gender

- ☐ Female
- ☐ Male

Figure 3.4: Question 3

This question is to determine which gender group of the respondent who are interested with the system.

Question 4: Which of the following best describes your current relationship status?



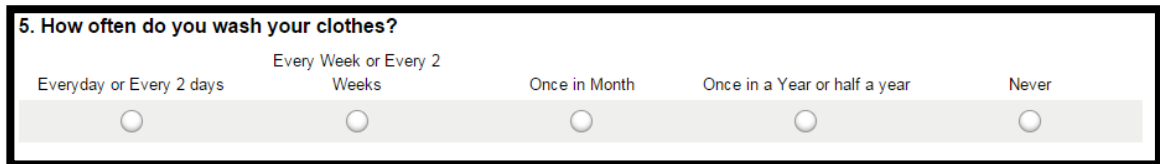
4. Which of the following best describes your current relationship status?

- ☐ Married
- ☐ Widowed
- ☐ Divorced
- ☐ Separated
- ☐ In a domestic partnership or civil union
- ☐ Single, but cohabiting with a significant other
- ☐ Single, never married

Figure 3.5: Question 4.

This question is to determine which relationship status group of the respondent who are interested with the system.

Question 5: How often do you wash your clothes?



5. How often do you wash your clothes?

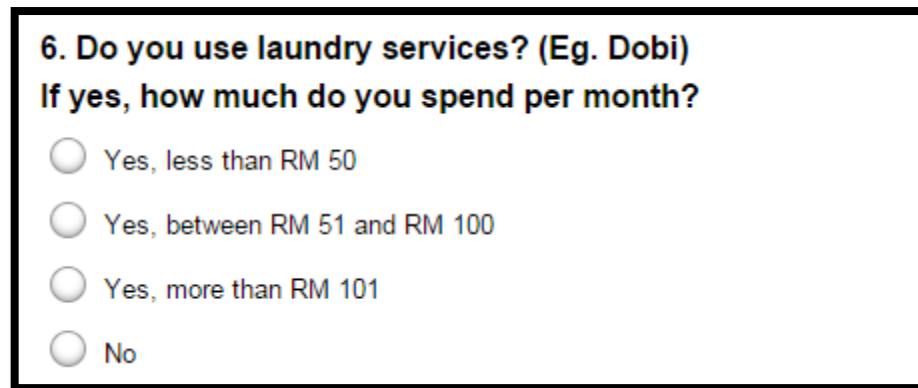
| Everyday or Every 2 days | Every Week or Every 2 Weeks | Once in Month | Once in a Year or half a year | Never |
|--------------------------|-----------------------------|-----------------------|-------------------------------|-----------------------|
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Figure 3.6: Question 5.

This question is to determine how often they wash their clothes. Choices given are Everyday and Every 2 days are in the first choice; second choice is every week or every 2 week; third choice is once in a month; forth choice is once in a year or half a year; Last choice is never wash cloth.

Question 6: Do you use laundry services? (Eg. Dobi)

If yes, how much do you spend per month?



6. Do you use laundry services? (Eg. Dobi)
If yes, how much do you spend per month?

☐ Yes, less than RM 50

☐ Yes, between RM 51 and RM 100

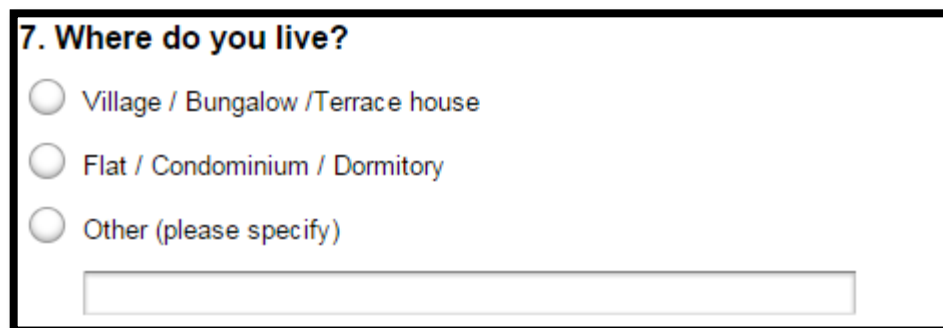
☐ Yes, more than RM 101

☐ No

Figure 3.7: Question 6.

This question is to determine how much money they usually spend to wash their laundry in a monthly basis.

Question 7: Where do you live?



7. Where do you live?

☐ Village / Bungalow / Terrace house

☐ Flat / Condominium / Dormitory

☐ Other (please specify)

Figure 3.8: Question 7.

Question 7 is to determine the area that they are living at and this question would be able to help determine how much space is needed to enable them to dry their clothes conventionally.

Question 8: How do you dry your clothes?

8. How do you dry your clothes?

☐ Outdoor/ Outdoor on clothes line

☐ Indoor

☐ Dryer

Other (please specify)

Figure 3.9: Question 8.

This question will see how users dry their clothes. Checkboxes are used to allow user to select more than one option. Choices given are outdoor/outdoor on clothes line, indoor and dryer. An “other” box is given to allow user to fill in the other way they use to dry their clothes.

Question 9: Did you ever forget to keep your clothes from outside, after drying it?

9. Did you ever forget to keep your clothes from outside, after drying it?

| | | | |
|-----------------------|-----------------------|-----------------------|------------------------------|
| Everytime Forget | Sometimes forget | Seldom forget | No, I can remember everytime |
| <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Figure 3.10: Question 9.

This question will determine how often they forget to keep their clothes from outside. 4 choices are given. First choices show that every time forget which means that they will totally forget to bring their clothes in whenever they hang it outside. Second choices are sometimes they forget which means most likely they will forget but few times they will remember. Thirdly is seldom forget, meaning that they will sometimes remember and few times they will forget. Lastly is they can remember to pick up their clothes all the time.

Question 10: If there is an Automatic Machine / Clothes Line which will help you keep your clothes from wet, Will you buy?

If yes, how much you willing to pay?

10. If there is an unmanned system that can intelligently dry and collect your clothes,
Will you buy? If yes, how much you willing to pay?

- ☐ Yes, Less than RM 500
- ☐ Yes, in between RM 501 to RM 600
- ☐ Yes, in between RM 601 to RM 700
- ☐ Yes, No matter how much, Take my money and go!
- ☐ No

Figure 3.11: Question 10.

This question is to know how much they willing to pay for the suggested system and several of range are give. If the selection of 1 range of price is high then this project will be price within the price range as it shows that the public are affording that price.

3.3.2 Flow chart of program

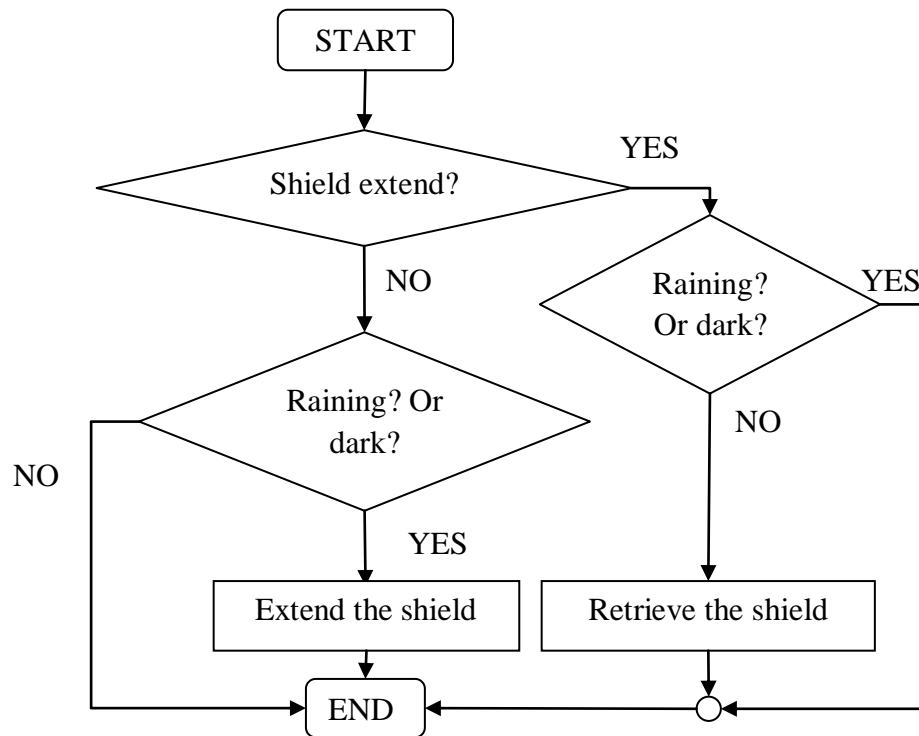


Figure 3.12: Flow chart of the overall system.

Hang –And – Go system would run as the above flowchart. The process of the algorithm is explained in the following steps:

1. Once the program started, the program will check if the current state of shield either is extended or retrieved.
2. The program will check if it is raining or it is dark.
3. If it happens to be any of the situations, the shield will automatically cover up the clothes.
4. If the shield already there then the program will do nothing and keep on looping.
5. If there is no rain or dark situation, the program will retrieve back the shield.

3.3.3 Tools

In order to develop the prototype, few tools, hardware and software are required are summarized in table 3.1 and table 3.2:

| Hardware Name | Functions |
|-----------------|---|
| Water Sensor | To detects rain drops |
| Arduino board | Act as a platform to communicates with rain sensor |
| Metal rod | To construct the framework of a clothesline |
| Light sensor | To detect sunlight intensity |
| Lego EV3 brick | To enable communication happen between the sensors |
| Lego | To hold parts of the brick and allow the shield system to move from one end to another. |
| Color Sensor | To separate between the shirt to fold and hang |
| Fan | To dry the clothes |
| Tetrix | To construct the framework of prototype |
| Tetrix DC motor | To move the clothes conveyer |
| Conveyer Chain | To construct the conveyer system for the clothes to move around |

Summarize of software needed is as Table 3.2 below:

| Software Name | Functions |
|---------------|--|
| EV3 software | To program EV3 Bricks |
| LabVIEW 2012 | To communicate between EX3 bricks and Tetrix |

3.3.4 Prototype

This section will discuss about the proposed design and the real prototype for the prototype which had been developed using the hardware as discussed earlier.

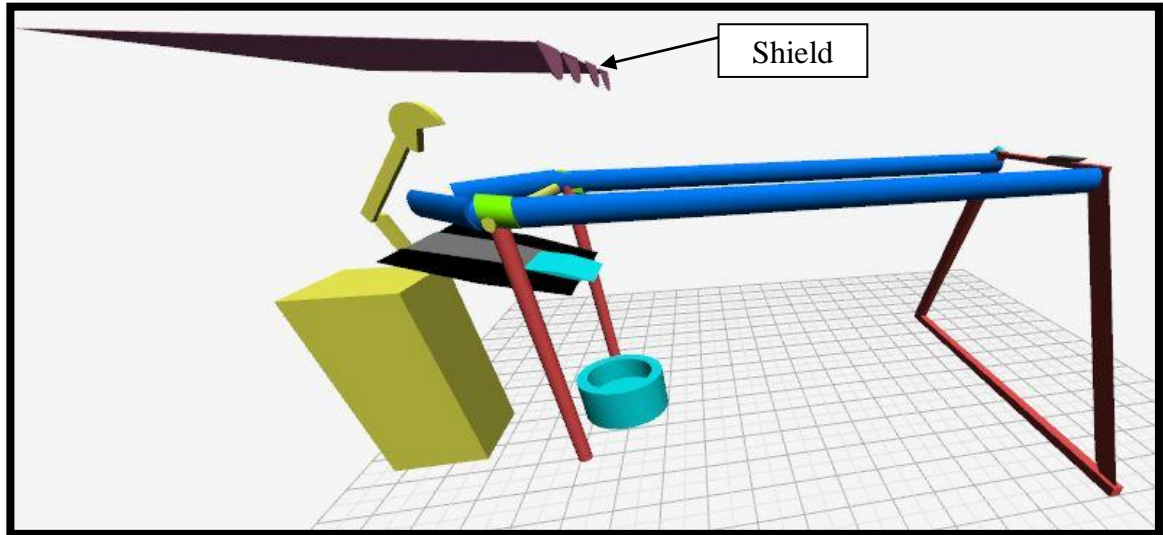


Figure 3.13: The side view of the prototype design

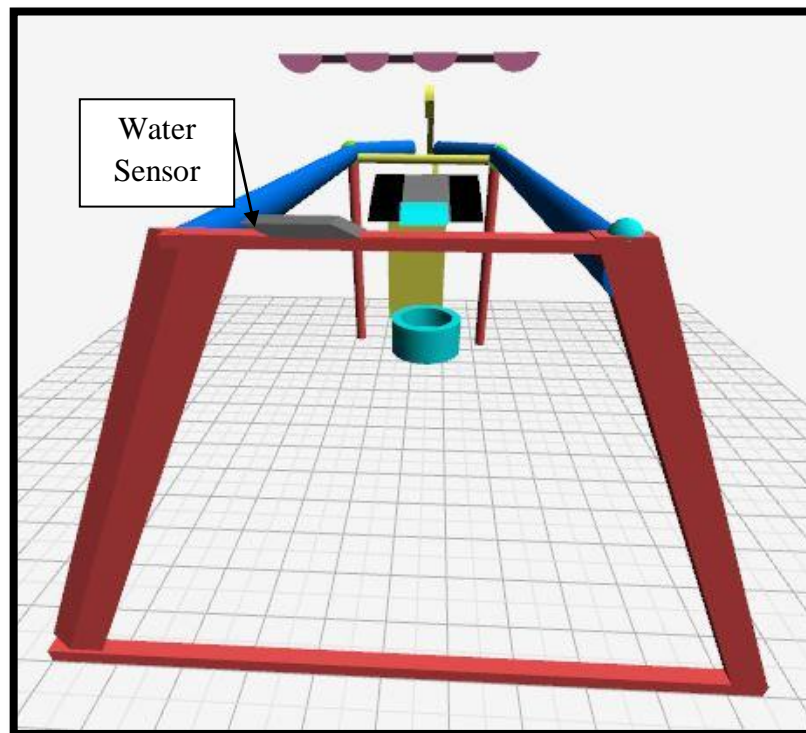


Figure 3.14: Front view of the prototype design.

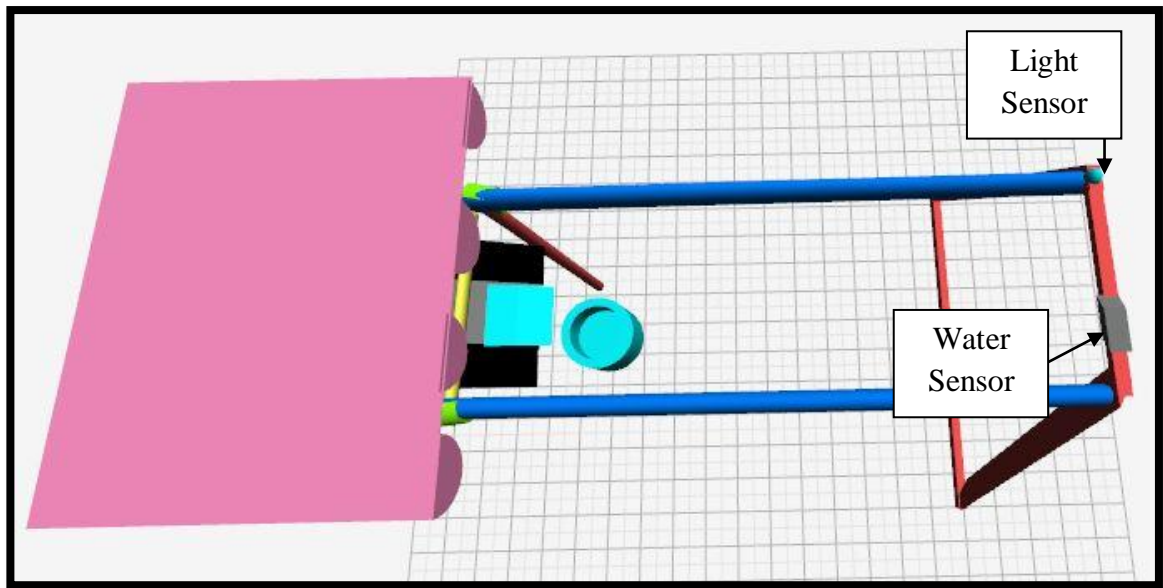


Figure 3.15: Top view of the prototype design.



Figure3.16: The initial design of prototype.

First prototype is developed using a few recycle materials which include used bicycle chain, bicycle sprocket, used clothesline frame and also Tetrix motor. However, due to

the instability of the used bicycle to act as the conveyer system to move the hanger on the rail, and other factor, this design is then suspended.

After a series of redesign and research, a new prototype is constructed and produced.

During the redesign phase, there are few items and characteristic which had been taking into considerations.

| Items | Characteristic | Justification |
|----------------|-----------------------------|---|
| Conveyer chain | Modifiable chain | Able to move by sprocket and able to hold clothes hanger |
| | 2 way chain | Able to move to and fro |
| Frame | Small and stable | To save space and promise stability while clothes being move around |
| | Removable and transportable | Able to remove and put back easily |



Figure 3.17: Second-hand conveyer chain is selected to construct the prototype.

The advantage of this conveyer chain is that it able to re-screw a tailored made hook onto it. As compared to the bicycle chain which only have an area to attach to sprocket and unable to add hook. Thus this second-hand conveyer chain is chosen.



Figure 3.18: The pathway which will use to move the conveyer chain with attached 2 sprockets at each ends.

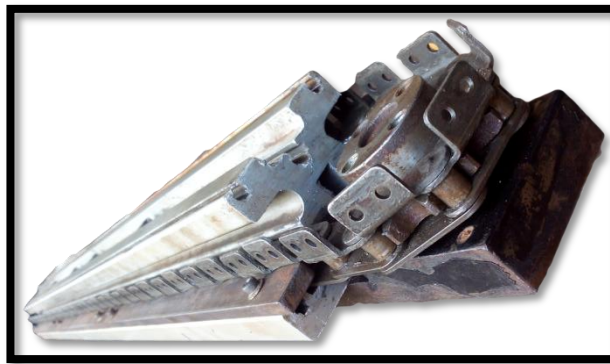


Figure 3.19: Conveyer chain is refurbish and attached onto the pathway with 2 sprockets at the end.

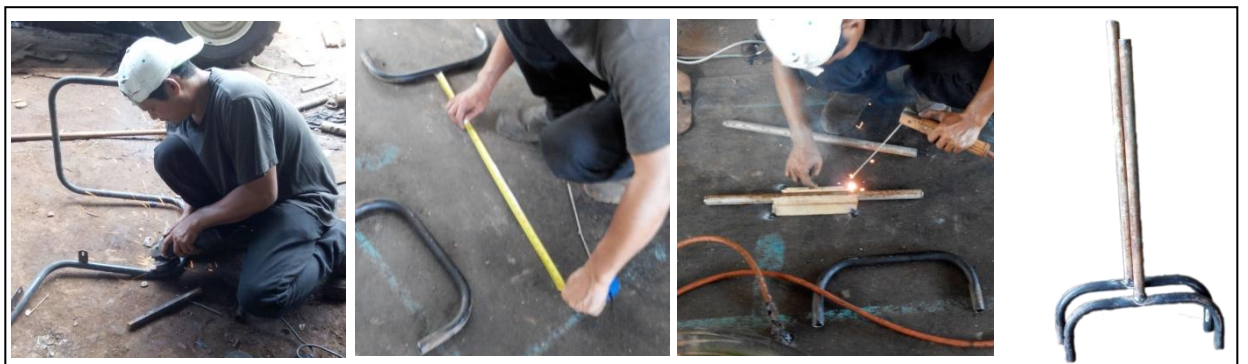


Figure 3.20: The making of stand to support the conveyer chain and the other parts.

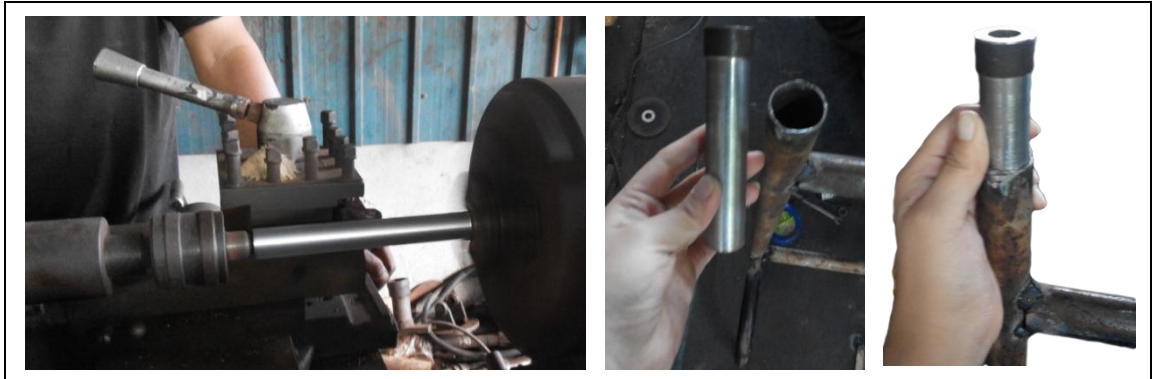


Figure 3.21: A metal is threaded to allow it to insert into a cylinder metal which would be able to remove later.

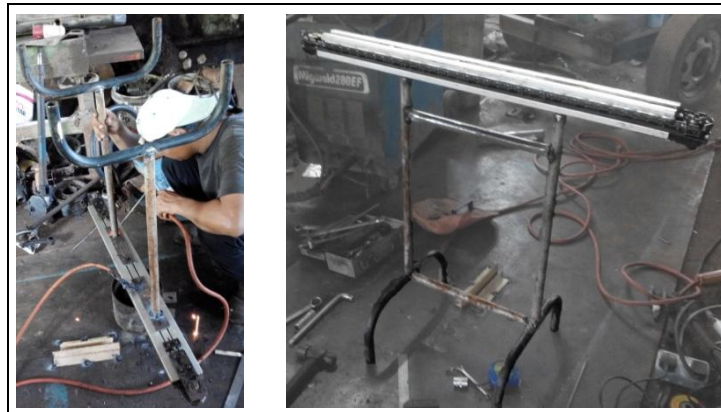


Figure 3.22: Threaded metals are then weld onto the conveyer system.



Figure 3.23: Drilling holes to enable rail of the shield to be attached.

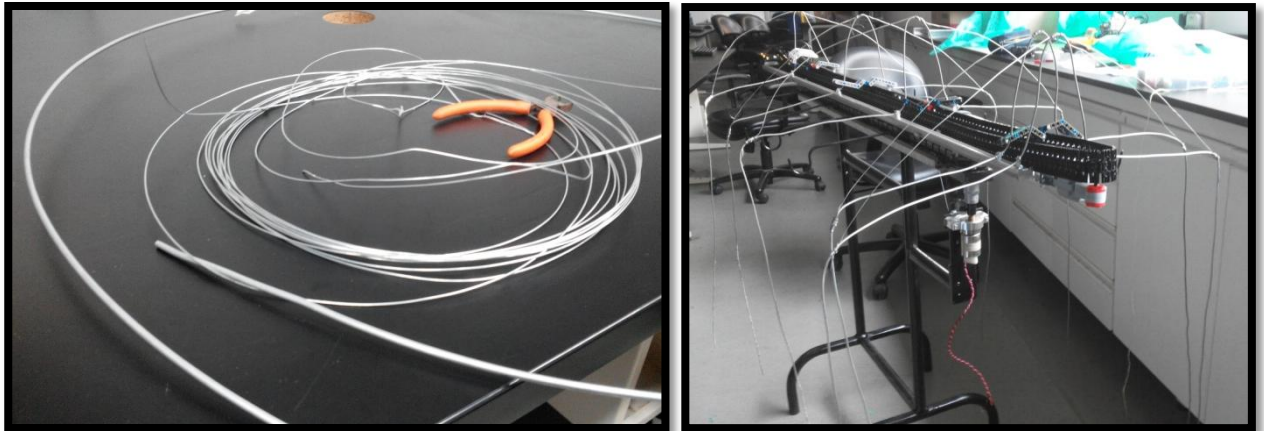


Figure 3.24: Self shaping the iron rod into the shape which would able to transporting the shield from one place to another.

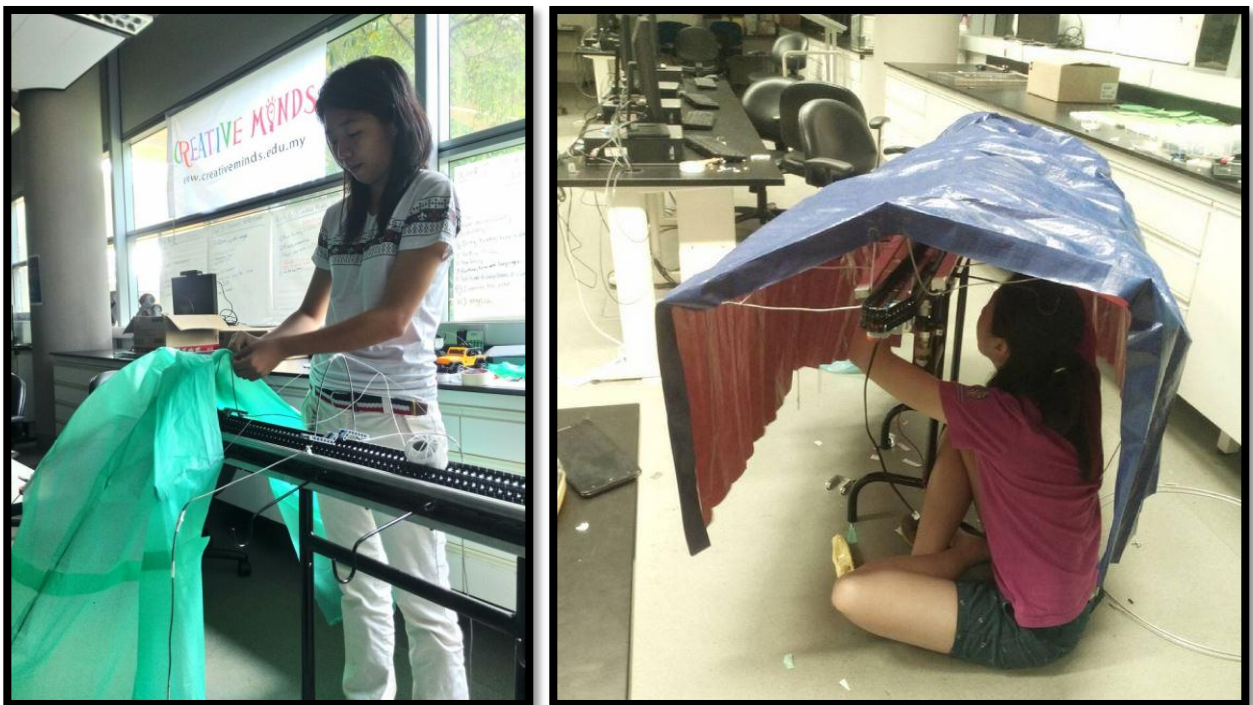


Figure 3.25: Rain coat is cut to fix onto the frame, however, due to the poor and thin material, the shield is then change to waterproof tarpaulin canvas with UV protection.

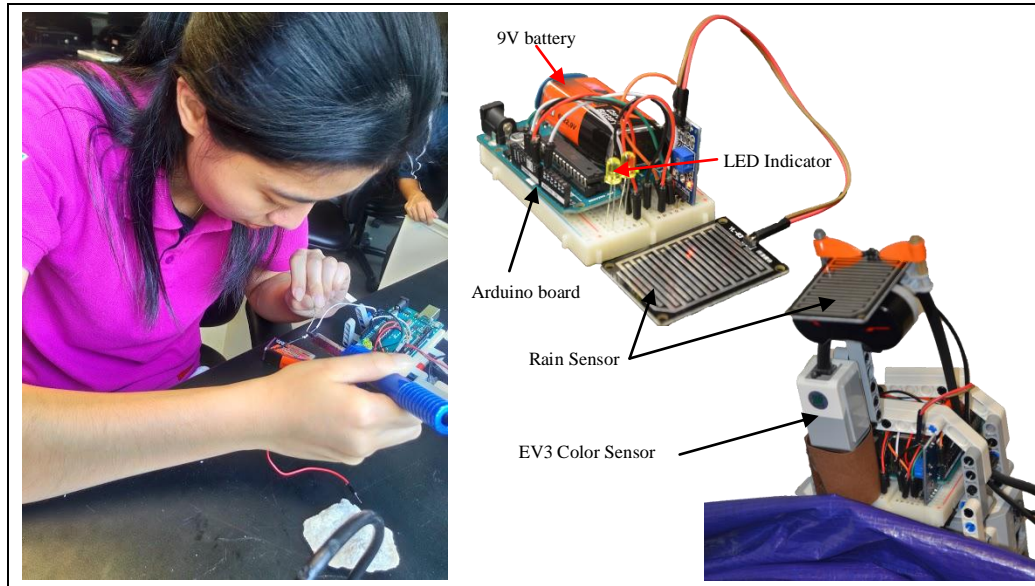


Figure 3.26: Soldering and attaching the rain sensor unit to Arduino board.

Once a water droplet with at least 0.15cc would enough to activate the water sensor and trigger the shield.

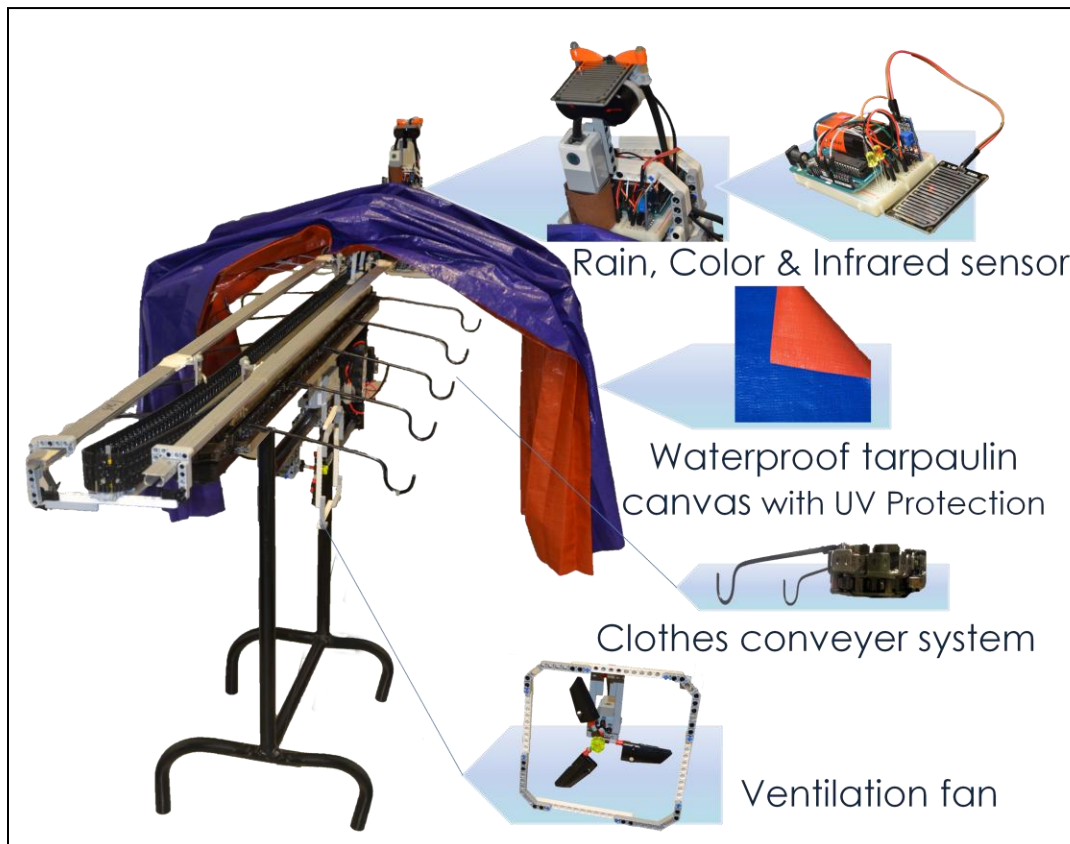


Figure 3.27: The completed prototype.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Data Gathering and Analysis

This chapter will reveal the analysis results or the outcome from the interview and also the survey made.

4.1.1 Interview

A face to face interview was conducted on 21 June 2015 in order to know more about the specific problem that they are facing.

Respondent 1:

Age : 41

Gender : Female

Occupation : Lecturer and Housewife

Family Members : 5 persons

In the interview, she claimed that she enjoy the time she washes her clothes, she likes to hang her wet clothes nicely on the clothesline. But there are two things that she does not really enjoyed while doing is that to take her clothes from the clothesline and fold them up. She also added up being a fulltime lecturer and housewife really make her busy. She told that most of the times she forget to keep her clothes outside and they even caught in rain and some of the clothes get dull. She really look forward for an affordable system that could help her keeps her clothes from rain.

Respondent 2:

Age : 21

Gender : Male

Occupation : Student

As a student, he shared that he usually go to class in during day time and do his homework. Most of the time he washes his clothes using the washing machine provided in the university facilities. So sometimes he will just hang his clothes inside his room to let it dry and sometimes he will use dryer. When he later being told about drying clothes in room will posses health issue to him or people of the surroundings then, he say he will change to drying outdoor or maybe use dryer. He added up dryer is charging based on per usage basis, thus in long term will be costly and yet shorten the life of is clothes. He also mention that the reason that he choose to dry in room or using dryer is because he do not free to come back to collect the clothes or he tend to forget about it. Thus if there were a system to help him keep his clothes from rain, he will definitely buy it. He further add on that if this works perfectly like what being told, he said the university should consider of implementing it, as it could save our mother earth as there are so many student in the university who are using dryer.

4.1.2 Quantitative Survey

In this section the analysis of the results found from the survey of 45 respondents is presented. This survey was done online and also manually. Most of the respondents are meet participated in this survey during an ITEX exhibition which held in KLCC Convention Center on 21 May 2015.

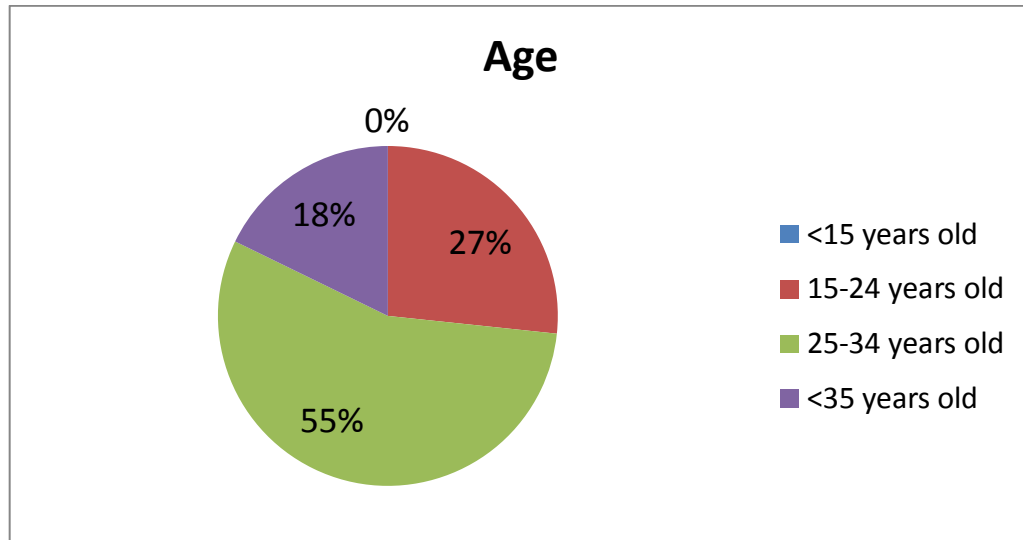


Figure 4.1: The Age of the respondent

The chart above depicts various age range of respondent respond for the survey. Out of 45 respondents, there are 55% of them are in the age between 25-34 years old and 27% are between 15-24 years old. People who age are between 15-34 are more approachable on the street and are actively online, and thus they can also easily get access to the internet as this survey is made mainly online. While people who are more than 35 are mostly approach by using manual method this is because most of them are not really good in information technology or they might not have seen this survey due to their busyness.

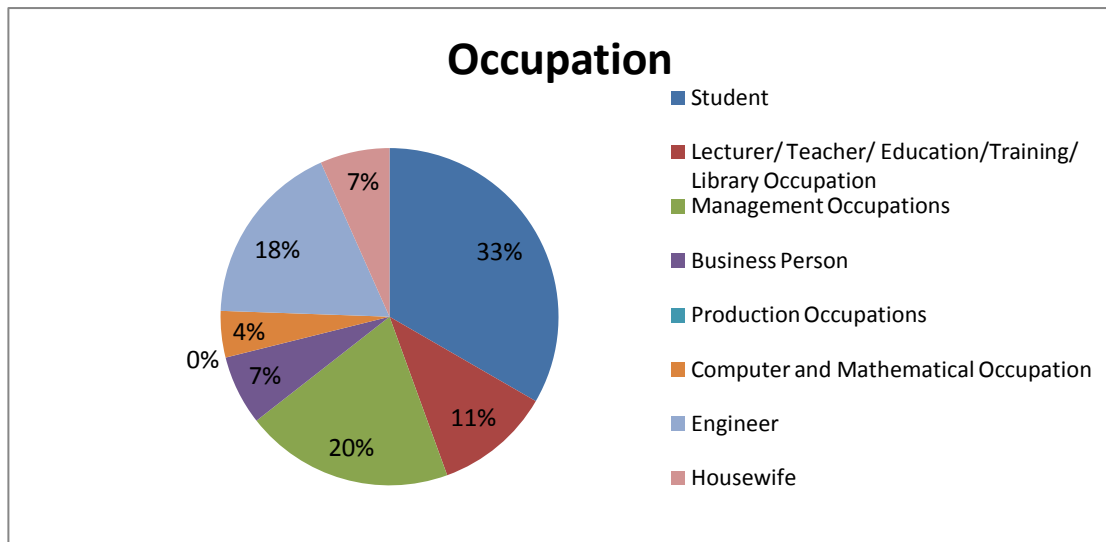


Figure 4.2: Occupation of the respondent.

There are 33% of the respondents are Students and 11% of them are Housewife. Most of the respondents are made up of students as they can easily get access to the survey form which made available online while the other working people show lesser participation as most of them hardly access to the survey due to their busy working life.

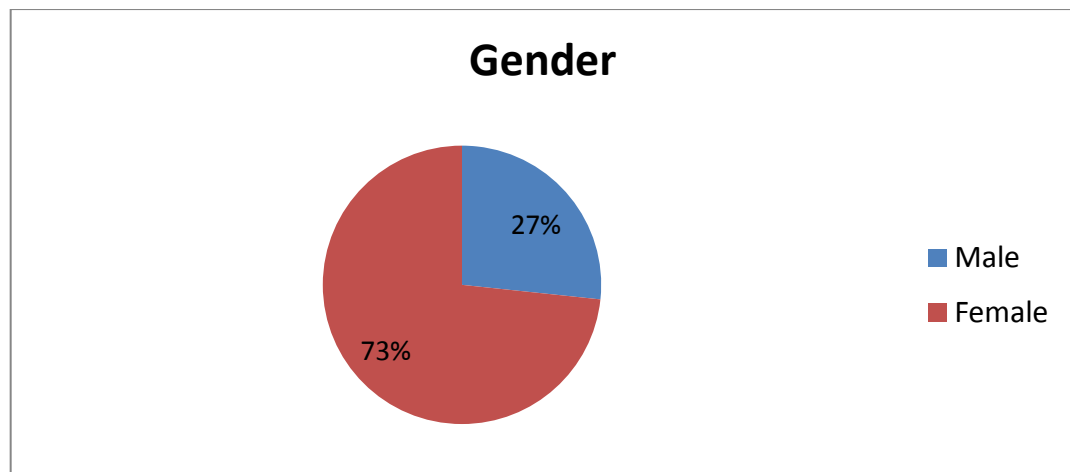


Figure 4.3: Gender of the respondent.

The Chart above show the percentage of male and female participate in the survey. 73% of them are female and the rest are male. As most of the time laundry washing and hanging process are done by female, so they show more interested in this new system rather than male do.

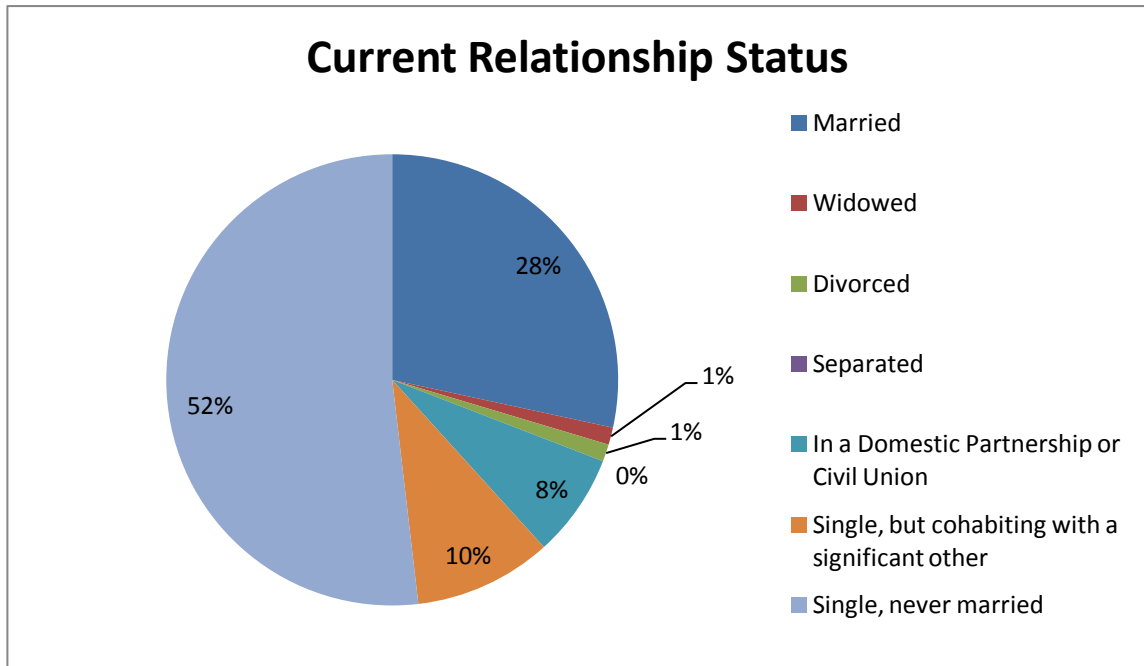


Figure 4.4: Relationship status of the respondent.

Most of the respondents are single as the age group of people who are still in between 15-24 years old are very high. Therefore the chances of them being single, never married is high.

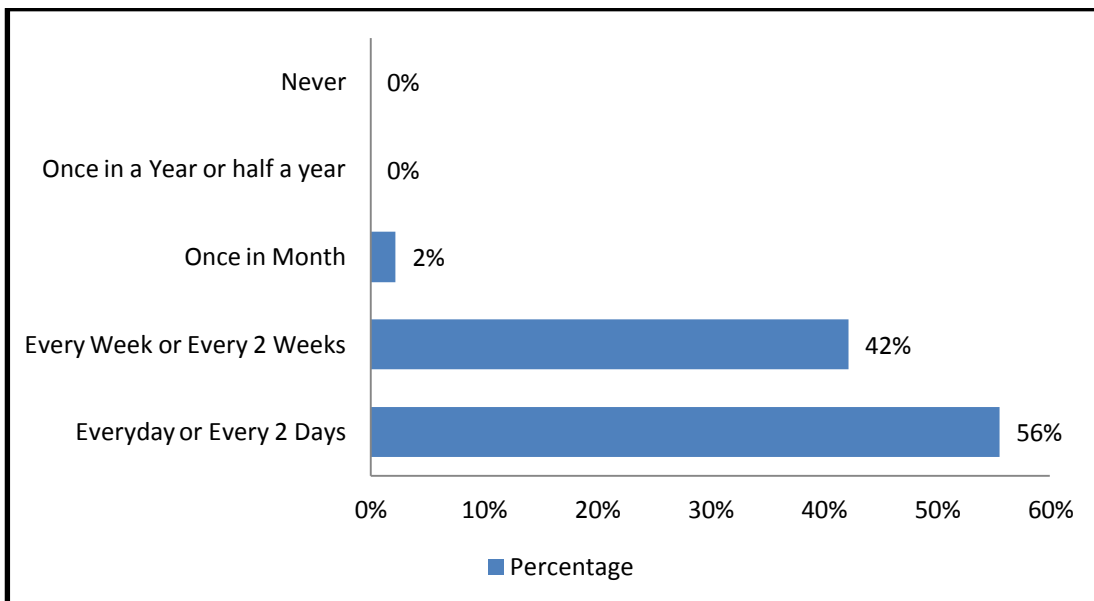


Figure 4.5: The rates of respondent wash their clothes.

56% of the respondent replied that they wash their clothes on daily basis or every 2 days. While 42% of them told that they wash their clothes every week or every 2 weeks as they are not free to wash their clothes on daily basis and it might waste water if they choose to wash it daily.

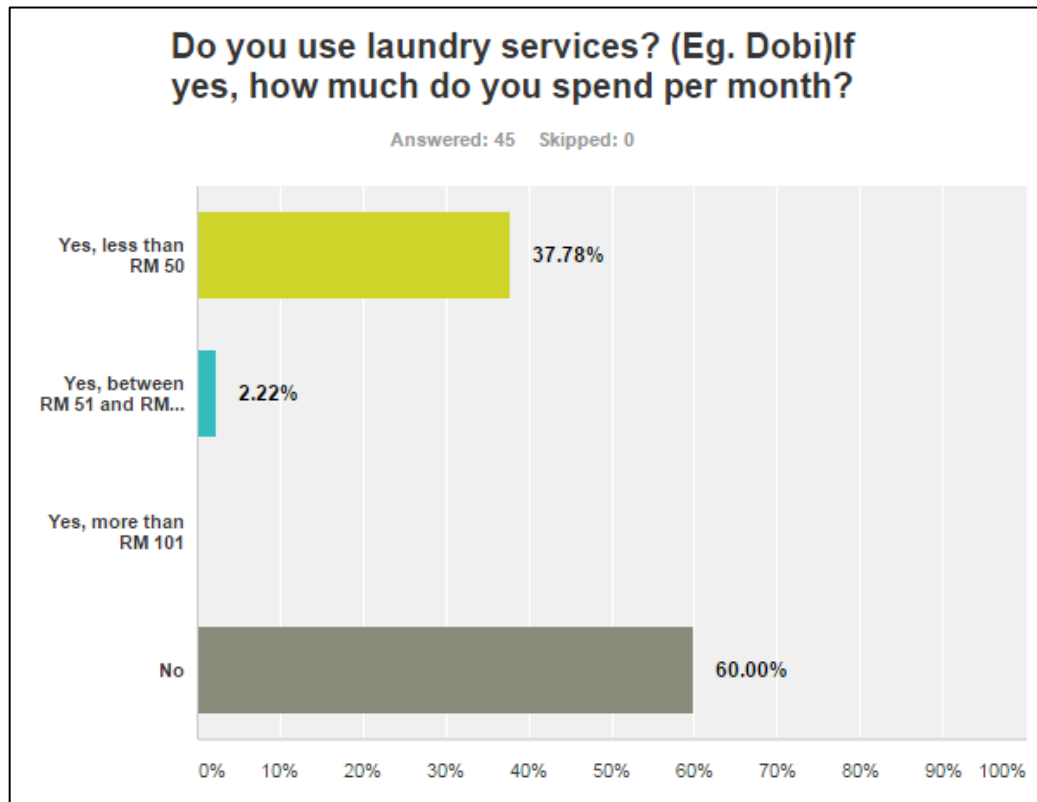


Figure 4.6: How much do they spend for laundry services in a months.

Out of the hundred percent of the respondents says that 60% of them do not use any laundry services and do it on their own. Followed by 37.78% of them did spend less than RM 50.00 for the laundry services as they do not have time to pick up clothes and do all the traditional laundry jobs. While 2.22% of them would spend in between RM 51 to RM 100 in a month for the laundry services as they would probably wash it more often.

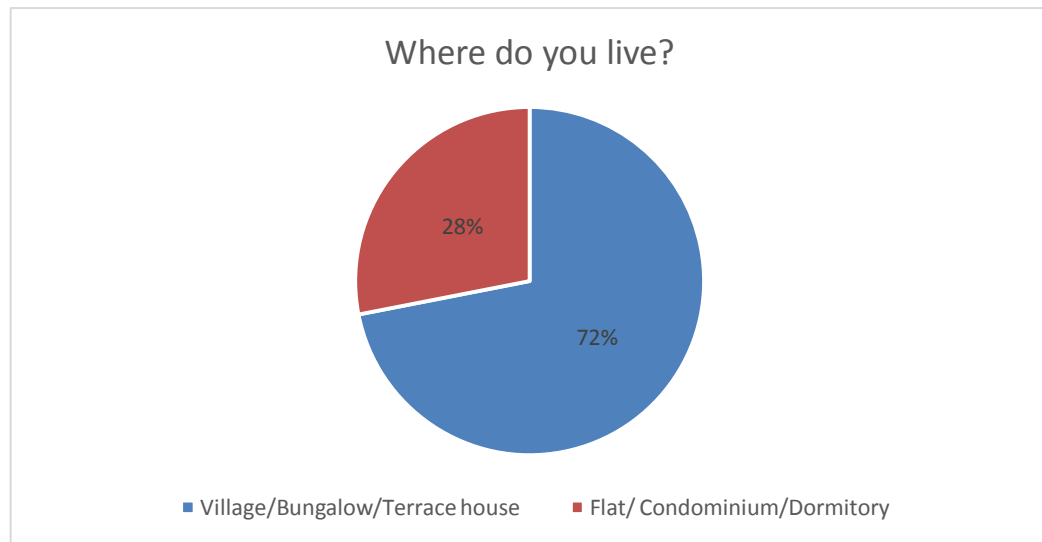


Figure 4.7: Statistic of the respondent's location of living.

Based on the question ask about type of home that respondent is living at, 72% of them do stay in village, bungalow or terrace house. Thus, it also means that most of them will have an extra small land in the area where they can place the clothesline. On the other hand, 28% of the respondents are staying in flat, condominium or dormitory. These people normally have limited outdoor spaces that are exposed to sunlight.

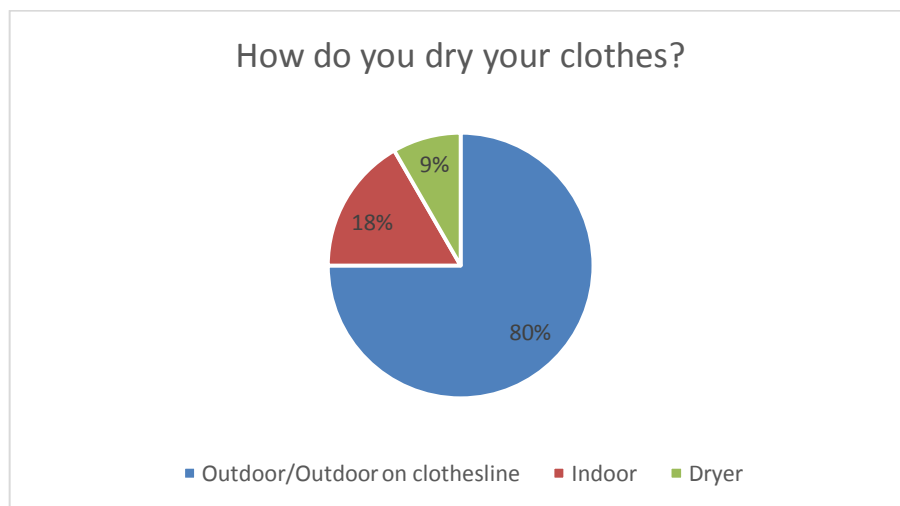


Figure 4.8: Statistic of the way people dry their clothes.

In this question, respondent are allowed to choose more than one optio. Up to 80% of the respondents still choose to dry their clothes in the conventional way which uses

clothes line. In previous statistic, we found that 72% live in the area with plenty of spaces, thus, the outdoor drying of clothes is the best option for the respondents. While 18% of the respondent who choose to dry indoor and 8.89% of them choose to use dryer.

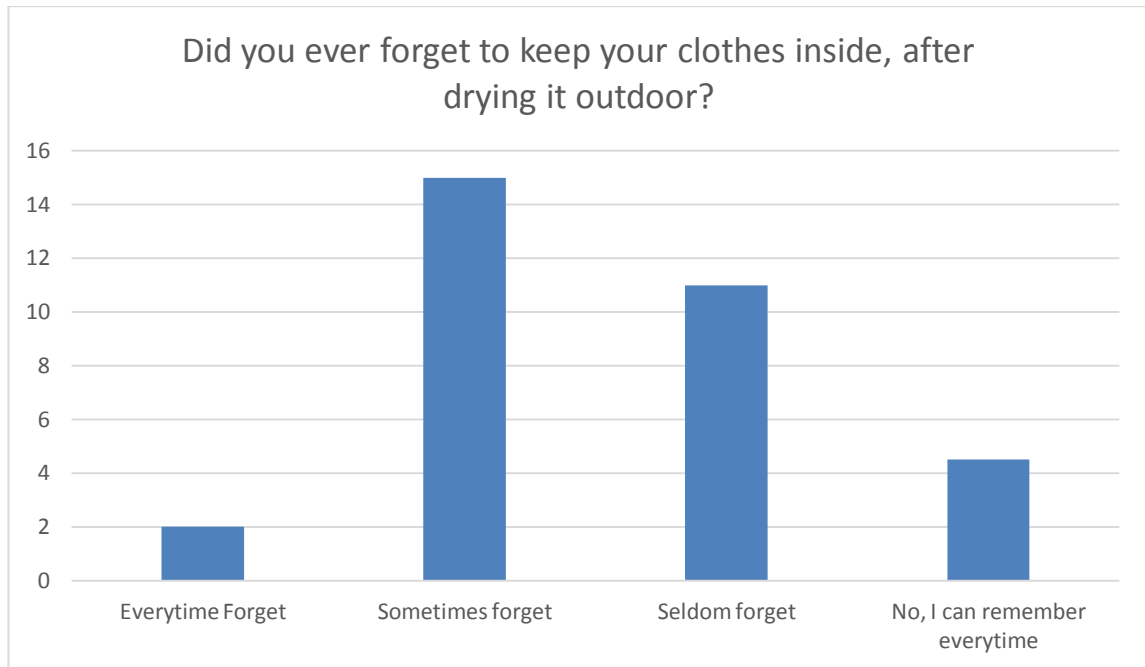


Figure 4.9: Based on the question of how often do they forget to take in their clothes from outside.

15 out of 45 of the respondent which is 33.33% of them sometimes do forget to bring their clothes in due to their busy life and their unavailability. While 11 out of 45 which made up of 24.44% tell that they seldom forget about their clothes but still there exist the chances that they forget to bring it in. This is maybe sometimes they had unpredictable and unavoidable event happen. 17 of them say that they never forget to bring in their clothes maybe they had use to the routine and can remember what to be done.

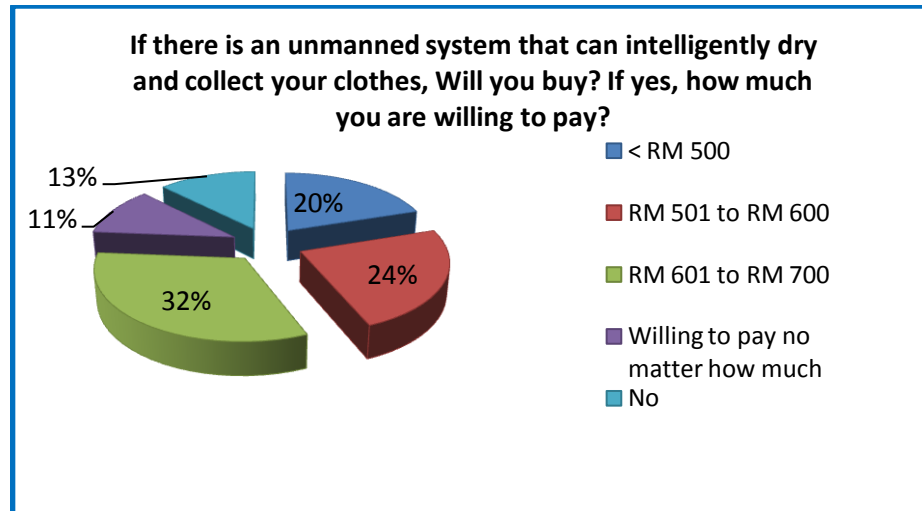


Figure 4.10: The answer that respondent gave when being ask how much so they are willing to pay if there is a system to keep the clothes and fold it up for them.

32.5% of the respondents are willing to pay between RM 601 to RM 700 to have this system. While 23.75% of the respondent willing to pay amount between RM 501 to RM 600 for the system. Since RM 601 and RM 700 is the highest vote, then the system will be price around that range in order to make it affordable for the public.

4.2 Performance Tests

This section will discuss about the performance test conducted and results from the prototype. Various kind of data were collected and the results were interpreted and analyze.

4.2.1 Functionality Tests

The testing is carried out in Machine Intelligence lab using simulated rain and sunshine environment.



Figure 4.11: Testing is carried out in lab.

Table 4.1: Type of functionality test

| No. | Test type | Main Purpose | Additional Knowledge gain | Variables | Material Tested | Output Measurement |
|-----|----------------------|---|---|--------------------------|-------------------|-----------------------------|
| 1 | Rain Drop Test | To test how much rain drop is needed to activate the system | Water droplet must at least get intact with 3 rows of sensor board printed lead | Milliliter | Rain sensor board | Activation of Arduino board |
| 2 | Shield Extended Time | To know the average time require to cover up the clothes from rain. | | Activation of the shield | Shield | Time, seconds |

| | | | | | | |
|---|----------------------------|---|--|------------------------|--------------------|---------------|
| 3 | Shield Retrieve Time | To know the average time require to retrieve back the shield. | | Activation of shield | Shield | Time, seconds |
| 4 | Brick connection | To know the success rate of the connection | Need to make sure Bluetooth is activated before hand | Bluetooth availability | Connection | Success rate |
| 5 | Ventilation Fan Activation | To know if the fan would works correctly | Bluetooth connection need to be establish first | | Fan motor rotation | Success rate |

1. Rain drop test

Table 4.2: Rain drop test is measure with milliliter and the success or failure rate of activating Arduino board.

| Test number | Milliliter | Activation of Arduino board(success/failure) |
|---------------|--|--|
| 1 | 0.5 | Success |
| 2 | 0.4 | Success |
| 3 | 0.2 | Success |
| 4 | 0.1 | Failure |
| 5 | 0.15 | Success |
| Result | Minimum 0.15 milliliter to activate Arduino board | |

Based on the table above, 5 test are carried out for the rain drop test case. From the testing we can know the sensitivity of the rain sensor and the minimum water requires activating the rain sensor. As a conclusion, a minimum of 0.15 milliliter of water is requiring to activate the rain sensor and trigger the shield.

2. Shield extended time

Table 4.3: Shield extended test is measure with unit seconds.

| Test number | Seconds |
|-------------|---------|
| 1 | 7.00 |
| 2 | 8.64 |
| 3 | 7.06 |
| 4 | 8.49 |

| | |
|----------------------------------|--------------|
| 5 | 7.94 |
| Result (average, seconds) | 7.826 |

The time is counted once the rain drop is detected and until the time when the cover reach the end of the rail of the shield. Based on the test, we can see that on average, the system will require about 7.826 seconds to activate and cover up the shield to prevent rain.

3. Shield retrieves time

Table 4.4: Shield retrieval test is measure with unit seconds

| Test number | Seconds |
|----------------------------------|----------------|
| 1 | 7.60 |
| 2 | 7.93 |
| 3 | 7.49 |
| 4 | 7.49 |
| 5 | 7.17 |
| Result (average, seconds) | 7.536 |

The time is counted once the rain drop is dry from the rain sensor and until the time when the cover retrieved back and reach the end of the rail of the shield. Based on the test, we can see that on average, the system will require about 7.536 seconds to activate and retrieve back the shield to allow the sun to penetrate.

4. Brick connection

Table 4.5: Connection between 2 bricks

| Test number | Connection (Success/Failure) |
|--------------------------|-------------------------------------|
| 1 | Success |
| 2 | Success |
| 3 | Success |
| 4 | Success |
| 5 | Success |
| Results (Average) | 100% Success |

The connection status is measured once the brick had triggered the other brick. Based on the table, we can see that the brick can successfully trigger the other when the program starts.

5. Ventilation fan activation

Table 4.6: Ventilation fan test is measured with the connection success rate.

| Test number | Activation (Success/Failure) |
|-------------------|------------------------------|
| 1 | Success |
| 2 | Success |
| 3 | Success |
| 4 | Success |
| 5 | Success |
| Results (Average) | 100% Success |

The activation is counted once the program trigger the fan.

4.3 Cost breakdown

Table 4.7: Cost breakdown for the prototype and estimated cost for mass production.

| No | Items | Cost (RM) | |
|-------------------|-------------------------------------|---------------|-----------------|
| | | Lab Prototype | Mass Production |
| 1 | Conveyer with chain and hanger hook | 450 | 200 |
| 2 | Removable conveyer based | 80 | 30 |
| 3 | Painting | 10 | 2 |
| 4 | Shield and frame | 30 | 18 |
| 5 | Arduino UNO | 96 | 38 |
| 6 | Rain Sensor | 19.50 | 6 |
| 7 | Fan | 45 | 8 |
| 8 | Curtain rail and wheeling system | 20 | 8 |
| 9 | Wheels | 80 | 32 |
| Total (RM) | | 830.50 | 342.00 |

The lab scale prototype cost RM 830.50 while estimated mass production cost for each of the product would be around RM 342.00 which is lot more lesser than lab prototype cost. For the pricing or selling price of the system, it would be at the range of RM 500 to RM 650 which estimates to yield 68.4% to 190% of the profit margin. With this price range, we could still sustain 67% of the respondent as they are still willing to by the system with the above price range.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Achieved Objectives

It can be summarized that, unpredictable weather and busy lifestyle has turn the clothes drying and collecting process become more challenging but with the advancement of the technology, this will definitely lighten up the task. By helping people to make sure the rain would not able to reach the clothes and still able to allow sunlight to come in once it is sunny day.

By studying people's experience in handling the laundry process at home and small business scale and the existing laundry hanging system, therefore we come out with this new Hang-and-Go: A Smart Laundry Hanging system to enable the task to be carried out easily by automated the laundry drying process.

With the special selected sensor which is reliable and affordable had help lowered down the development cost by more than 50% and therefore making the whole system affordable to the public.

The objectives that had been achieved are as follows:

- 1) Study the people's experience in handling the laundry process at home and small scale businesses.
This is achieved through the survey and interview which had been carried out.
- 2) To investigate existing laundry hanging system
This is achieved through the research and study had been made on the existing laundry hanging system.
- 3) To develop a low cost laundry hanging prototype for household usage

This is achieved by using simple, affordable and reliable tools and development materials to develop.

- 4) To evaluate the performance of the developed prototype

This is achieved by carried out various kind of testing to the developed prototype.

5.2 Future Works

Since this is the first phase of the project, the project would only able to achieve the main function which is to prevent the rain from the clothes. Then for the second phase this prototype would still able to support later extension which is to allow the clothes to be transport from one end to another and then to detect the wetness of the clothes and later do the clothes folding work by using the conveyer chain which had been developed and add on with dampness sensor and also the Perspex board.

5.3 Summary

In conclusion, Hang-N-Go: Smart Laundry Hanging system is a system which helps to retrieve and extend the shield to cover up the clothes whenever it is necessary. By having this system, it will lighten the household chores as nowadays people are having hectic and busy lifestyle. It is built with Lego Mindstorm EV3, Arduino board and also Tetrix. By using the low cost and reliable software and hardware, will definitely be an affordable system to everyone.

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