UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS♦

JUDUL: **A NEW MULTIPURPOSE SOAP DISPENSER PROTOTYPE USING DESIGN FOR MANUFACTURING (DFM) APPROACH**

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A NEW MULTIPURPOSE SOAP DISPENSER PROTOTYPE USING DESIGN FOR MANUFACTURING (DFM) APPROACH

MOHAMAD HAFIZ BIN MOHAMAD

A report submitted in partial fulfillment of the requirements
for the award of the degree of Bachelor of Manufacturing Engineering

Faculty of Manufacturing Engineering
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JUNE 2012

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We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Manufacturing Engineering.

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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DEDICATION

To my parent and those who made it possible

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ABSTRACT

Soap Dispenser is a personal care product which includes liquid soap and dispenser. This product generally use to washing a hand where can be found at the most toilet or restaurant. There has a lot of soap dispenser design and shape can be found in the market. The functions of the entire soap dispenser are almost same which is to dispense a liquid soap. The main objective of the project was to design and develop a multipurpose soap dispenser prototype. An additional function may be adapted to the current soap dispenser to enhance the ability of the soap dispenser in order to meet the current demand. The process of development may be conducted based on several tools of idea and concept generation such as New Product Development (NPD) and Design for Manufacturing (DFM). The development was focused on the additional functions and performance of the product. Another wish was to increase consistency and reliability of the prototyped product. An initial pre-study gave insight in how to come out with multipurpose functions that can be adapted into the soap dispenser. A wide variety of soap dispenser and the other hygiene care product were studied to obtain complete understanding. Next phase was to generate ideas and new concepts which after the product and concept evaluation resulted from the analysis. These concepts were made as functional mock-ups for further testing and evaluation and finally built as a fully prototype. A new multipurpose soap dispenser prototype finally produced by using Fortus 360mc prototype machine. The recommended additional functions from the customer's survey for a new multipurpose soap dispenser prototype are mini dustbin and tissue compartment. The product can be assembled and functions as expected. Thus, objective of the project is achieved successfully.

ABSTRAK

Dispenser sabun adalah produk penjagaan diri yang terdiri daripada cecair sabun dan detergen. Produk ini secara amnya digunakan untuk mencuci tangan di mana boleh didapati di kebanyakan tandas atau restoran. Produk ini boleh didapati di pasaran dengan pelbagai jenis bentuk dan rekabentuk. Fungsi produk-produk tersebut hampir sama iaitu digunakan untuk mengeluarkan cecair sabun detergen. Objektif utama projek ini adalah untuk membangunkan dan merekabentuk sebuah prototaip dispenser sabun serbaguna. Fungsi tambahan akan disesuaikan dengan produk untuk meningkatkan keupayaan dan memenuhi kehendak semasa. Proses untuk membangunkan boleh dijalankan berdasarkan beberapa alat idea dan dan penjanaan konsep seperti Pembangunan Produk Baru (NPD) dan Reka Bentuk untuk Pembuatan (DFM). Pembangunan telah memberi tumpuan kepada fungsi-fungsi tambahan dan prestasi produk. Hasrat lain adalah untuk meningkatkan keseragaman dan kebolehpercayaan produk yang diprototaip itu. Kajian pra-awal memberi gambaran tentang bagaimana untuk keluar dengan fungsi pelbagai guna yang boleh disesuaikan ke dalam dispenser sabun. Pelbagai dispenser sabun dan lain-lain produk penjagaan kebersihan telah dikaji untuk mendapatkan pemahaman yang lengkap. Fasa seterusnya adalah untuk menjana idea dan konsep baru yang selepas penilaian produk dan konsep adalah hasil daripada analisis. Konsep-konsep ini telah dibuat sebagai percubaan berfungsi untuk ujian lanjut dan penilaian dan akhirnya dibina sebagai prototaip sepenuhnya. Sabun baru pelbagai guna dispenser prototaip akhirnya dihasilkan dengan menggunakan mesin prototaip Fortus 360mc. Fungsi baru bagi produk seperti yang dicadangkan oleh pengguna adalah bekas sampah mini dan bekas tisu. Produk boleh dipasangkan serta berfungsi seperti yang diharapkan. Maka objektif projek telah berjaya dicapai.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Soap Dispenser is a device which is use to dispense amount of liquid soap for hygienic purposes. A liquid soap dispensing system includes housing and a discharge mechanism for dispensing repeated doses of liquid soap from an associated cartridge. Soap dispenser in washrooms commonly require a user to depress a nozzle or lever in order to dispense a quantity of soap. The design of the soap dispenser is generally adopted and extensively used in public places for users to clean their hands and the structure of soap dispenser usually includes a housing containing a liquid soap and one end of the bag is connected to an appropriate flexible soap dispensing tube. The soap dispenser tube adopts the design of a one-way check valve, and thus the liquid soap can be squeezed out in one direction and its backflow to the body can be prevented.

This invention relates to a multipurpose soap dispenser, particularly to a liquid soap dispenser with a several function and can be used for other purpose. The new design and improved soap dispenser is very useful, for example in toilet, where users may have difficulty to get a several accessories during hygienic activities. Multipurpose Soap Dispenser obviously would help user and the most important thing is improving their function much better. So, this design will be going on many processes before it will end up with prototype in order to achieve the objective and of course the customer need.

This final year project invention relates to improve currently soap dispenser structure, and more particularly to develop a new soap dispenser prototype that having multipurpose functions rather than only providing liquid soap. The design and development process will be conduct based on several idea and concept generation tools which are use to analyze the effectiveness of new product outcome.

1.2 PROJECT PROBLEM STATEMENT

Soap dispensers are generally installed in public toilets and deliver small amount of liquid soap when operated. Mostly current soap dispenser only serves the soap liquid detergent to the user. There is no more function that can soap dispenser used for other purpose. Commonly people think that soap dispenser use for liquid soap purpose only. Actually there has a lot of function that we can integrate to the soap dispenser such as tissue dispenser mechanism, mini-dustbin mechanism and also box compartment mechanism.

Those functions can be as a value added purpose to the soap dispenser. Besides that, current soap dispensers are not flexible and commonly placed at the wall. Multipurpose Soap dispenser also can be design as the portable soap dispenser for the traveler or medical and hospitality purpose.

Therefore the problem statements of this project are:

1. The soap dispenser design and appearance almost same at the market. There is no variation on the product specifications type.
2. Current soap dispenser more focuses on to serve the liquid soap only rather than integrate with other purpose. Soap dispenser need to come out with a new multi functional purpose to give value added function on the product and make it more useable.
3. The mounting mechanisms of the soap dispenser commonly fail and always break during or after refill the liquid soap.

1.3 PROJECT OBJECTIVES

The primary objectives of this invention is to provide a multipurpose soap dispenser which is capable of supplying a predetermined amount of liquid soap when used and which can prevent the leakage of liquid soap effectively. This project also can be as a long term practice for student in order to facing a real problem solving world and come out with a solution for each problem. The objectives of the projects are:

I. **To design and develop a new multipurpose soap dispenser that can meet current customer and market demand**

   To design a new multipurpose soap dispenser that can meet current user and market needed. Nowadays design is almost same of all soap dispensers at the market. This new multipurpose soap dispenser will be design as better looks.

II. **To research the tools of idea and concept generation on developing a new multipurpose soap dispenser**

   The process of design and development a new multipurpose soap dispenser product need to be study based on idea and concept generation tools such as New Product Development (NPD) and Design for Manufacturing (DFM).

III. **To enhances the ability and effectiveness of multipurpose soap dispenser that can suit to the usage environment**

   To enhances the ability of soap dispenser that suit to the usage environment such as Tissue Dispenser mechanism, Mini-dustbin mechanism or Box Compartment mechanism. Those mechanisms will give value added to the soap dispenser and make it more useable.

1.4 PROJECT SCOPE

The scope of the project is more particularly focusing on the multipurpose soap dispenser for hygienic purpose. There are not many product of soap dispenser at market equipped with some additional function. This project will introduce a new multipurpose soap dispenser which is consisting of tissue dispenser mechanism, dustbin mechanism

and mini-brush mechanism. Therefore for the final product, we expected that this product will come out with at least 4 functions which are soap dispenser mechanism, tissue dispenser mechanism, dustbin mechanism and mini-brush mechanism. The multipurpose soap dispenser will be developed in 3D CAD software (SolidWork or CATIA) environment.

These are scope of work in this project. Literature review about the design from any possible resource:

1. Design and Develop Multipurpose Soap Dispenser for hygienic purpose.
2. The Idea and Concept Generation will be developed by using following tools:
    a. New Product Development (NPD).
    b. Product Process Design.
    c. Design for Manufacturing (DFM).
3. Virtual Product Design and analysis will be developed in 3D modeling software (CATIA & SolidWork).
4. Finalized Virtual Product Design will be prototyped by using Rapid Prototyping (RP) machine.

1.5 PROJECT FLOW CHART

The figures 1.1 show the overall flowcharts of the projects. The project start with discussion about the project title with the supervisor and prepare a complete proposal for the project. This consists of the project background discussion, the problem statement, the objective and the scope of the project.

The project continues with the literature review research. This chapter consists of all the data and information related to the development project and idea concept. After gathering all the required data and information, the project undergoes on apply the design tools. The design tools consist of New Product Development (NPD), product design process and Design for Manufacturing (DFM).

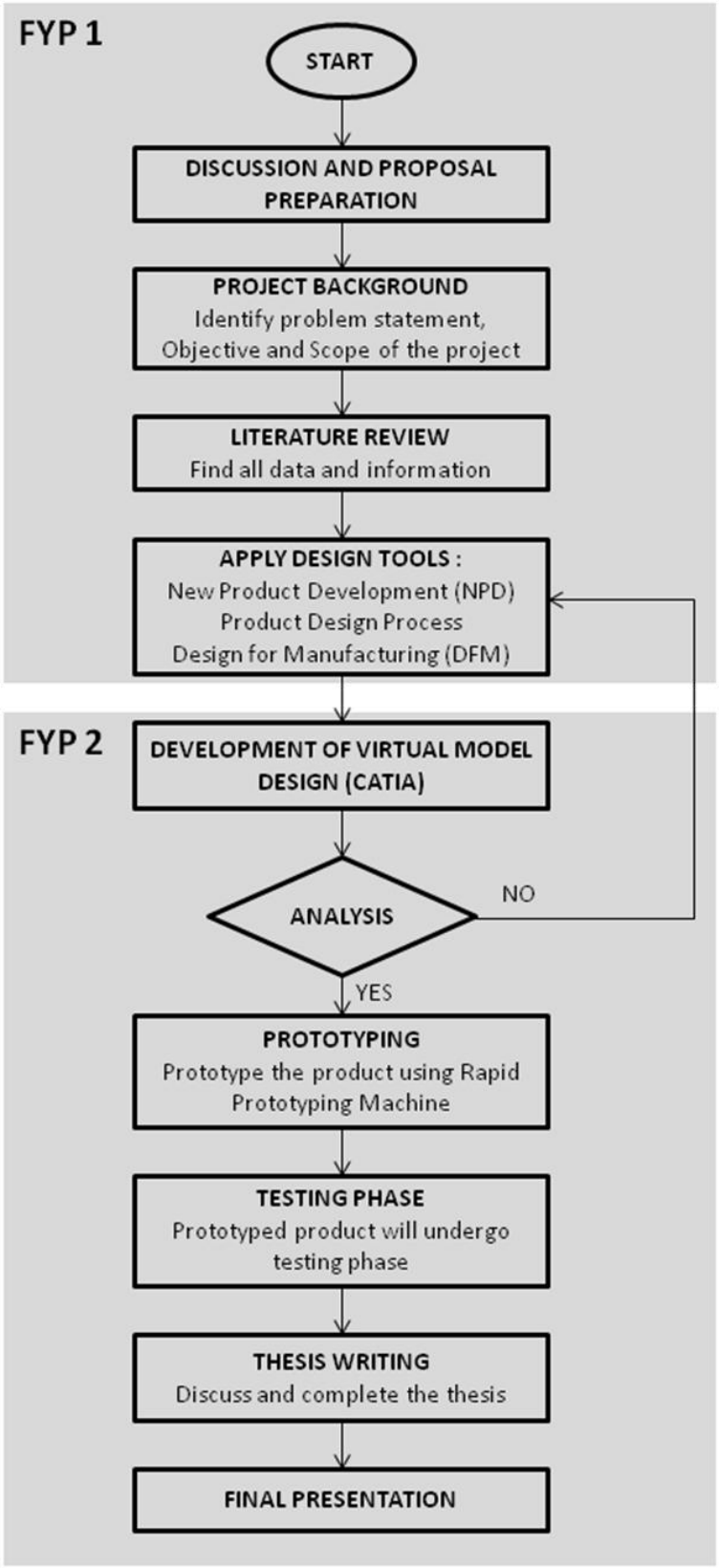

Figure 1.1: Project Flowchart

After the design and development of the product concepts has done, the next step is to develop and design virtually the product using 3D software, CATIA. The product designed based on the specifications and concepts that have been chosen. The design started with the roughly sketching of several concepts, then chooses the best concept as the final design. The selected design then constructed to 3D solid modeling.

The 3D solid then will undergoes analysis process by using Finite Element Analysis (FEA) that can be done using CATIA software. This stage is important in order to ensure the product can be use for long lasting. If the analysis fails, then the design tools must go through under the design tools process again to troubleshoot the failure. If the analysis is good, then the project will go for the prototyping process by using Rapid Prototyping (RP) machines.

The prototyped product then will be tested to validate the strength and the function whether it is good or need some improvement. If there is need any changes then the mockup process will be conduct due to the changes. After the product has been validated, the last step is to discuss and preparing the final thesis before go for the final presentations.

1.6 PROJECT SCHEDULE

The overall project schedule has been detailed in the Gantt chart. (Appendix A).

1.7 PROJECT EXPECTATION

At the end of this project, student must be able to describe as much as possible about the manufacturing process that has been involve during project. The outcome product should be able to functions and meet the objective. This product design and concept project should be able to improve the current product and enhances the ability of the product due to the customer demand.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews about literature review of some recent project or experiment or journal that related to the title of the project. In this chapter, there will be explanations on the New Product Development (NPD) process, the product design process, factors impacting product design and Rapid Prototyping (RP).

2.2 NEW PRODUCT DEVELOPMENT (NPD) PROCESS

New Product Development (NPD) process is the term used in engineering to describe the complete process in order to develop a new product in the market. Commonly, the product development process is involves in the idea generation and product design. The designer and inventor typically see new product development as the first step in generating an idea and commercializing new products. Product development is the process of inventing new product to be sold and used by the customers (Baralla, J.G, 1988).

Design refers to the activities which creating the styling, look and feel the product, design the mechanism to make the product work. Development is refer to make reference to the whole procedure for determining a market chance, developing a product in order to attract the actual recognized marketplace and finally, testing, modifying as well as refining the product until it is ready for production (Baralla, J.G, 1988).

In the New Product Development (NPD) process, Idea generation is also known as “fuzzy front end”. The idea for the new product can be generate from a several tools such as SWOT analysis which are stand for Strength, Weakness, Opportunities and Threats. A great idea improvement is essential (Baralla, J.G, 1988). The needs of the target market usually are identified, reasonably competitive products are reviewed, solution specifications are defined, a product concept is selected, an economics analysis is finished and this development project is outlined. The idea generation activities are usually organized based on Figure 2.1 (Baralla, J.G, 1988).

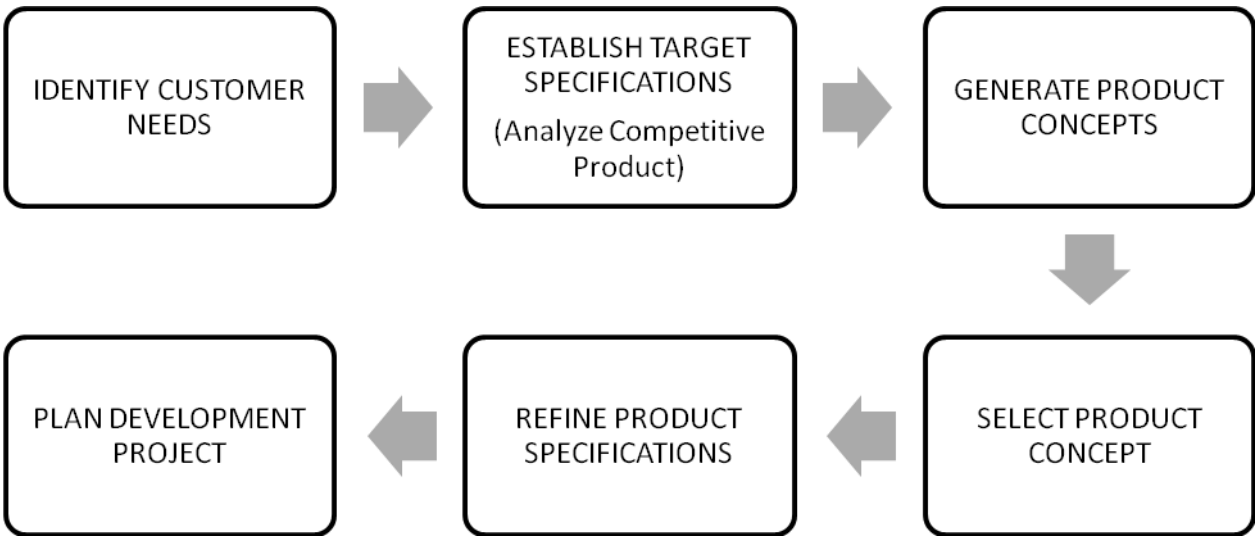

Figure 2.1: Idea Generation activities

2.2.1 Identify Customer Needs

The customer needs could be identify via interview or questionnaire survey with potential customers, focus group, through observing comparable product being used and researchers to identify customer requirements. The listing of need includes *hidden needs*, which are actually needs which customer might not be aware with the problems they merely accept without having question. Researcher develops the required information which bases the overall performance, size, weight, service life along with other specifications from the product. Customer requirements and product specifications

tend to be organized right into a hierarchical list having a comparative rating value given to each need and standards specifications (Baralla, J.G, 1988).

2.2.2 Establish Target Specifications

Depending on customers' requirements and evaluations of competitive product, the designer establishes the target specifications from the prospective brand new product. The process of identifying customer's needs is entirely a function of marketing, designer and engineers become involved in establishing target specifications. After designer have generated preliminary product concepts, the target on specifications usually are refined to be the reason for technical, manufacturing and economic realities. An analysis of competitive products is part of the process of establishing target specifications (Baralla, J.G, 1988). Other products may exhibit successful design attributes that should be improved in the new product. By understanding the shortfalls of competitive products, a list of improvements can be developed that will make the new product clearly superior to those of others.

2.2.3 Generate Product Concepts

Designers and engineers develop many product concepts to illustrate what sorts of product are generally feasible along with would best meet the requirement of the target specifications (Baralla, J.G, 1988). Engineers develop preliminary concepts to the architecture in the product, then industrial designer develop renderings to demonstrate styling along with layout alternatives. After narrowing the selection, non-functional visual appearance models are built of candidates designs.

2.2.4 Select Product Concept

From the process evaluation and also tradeoffs among attributes one last concept will be selected. The selection process could be confined for the team and also key executives inside company or perhaps customer could be polled for their input. Candidate appearance models are often used for additional market research, to receive

feedback coming from certain important customers or being a centerpiece regarding focus teams (Baralla, J.G, 1988).

2.2.5 Refine Product Specifications

Product specifications tend to be refined based on input in the foregoing activities. Final product specifications are resulted by tradeoffs made between technically feasibility, expected service life, projected price value and the actual financial limitations from the development project. With a new soap dispenser product for example, consumers may want a product that is lightweight, inexpensive, attractive, and with the ability of multi-purpose which has many function rather than dispense a liquid soap (Baralla, J.G, 1988). However, the mechanism needed for the multi-purpose feature will raises the selling price, add weight on the product along with introduce a new mechanism containing the risk of failure. Therefore, the designer must make a choice from a heavier, higher priced product as well as one it does not have multi-purpose features. Whenever product attributes have been in conflict, or once the technical challenge or more selling cost of specific features outweighs its benefits, the specification might be dropped or even modified in support of other advantages.

2.2.6 Plan Development Project

In this final phase of idea generation, the designer prepares detail development plan with a list associated with activities, the required resources as well as expenses, along with a development schedule with milestones with regard to tracking progress.

2.3 THE PRODUCT DESIGN PROCESS

Certain steps are typical in the development on most product designs. They are idea generation, product screening, preliminary design and testing, as well as final design (Ullman, D.G, 1997). These types of steps are shown in Figure 2. Product designs will never be finished, but tend to be always updated along with new ideas. Let’s take a look at these steps within more detail.

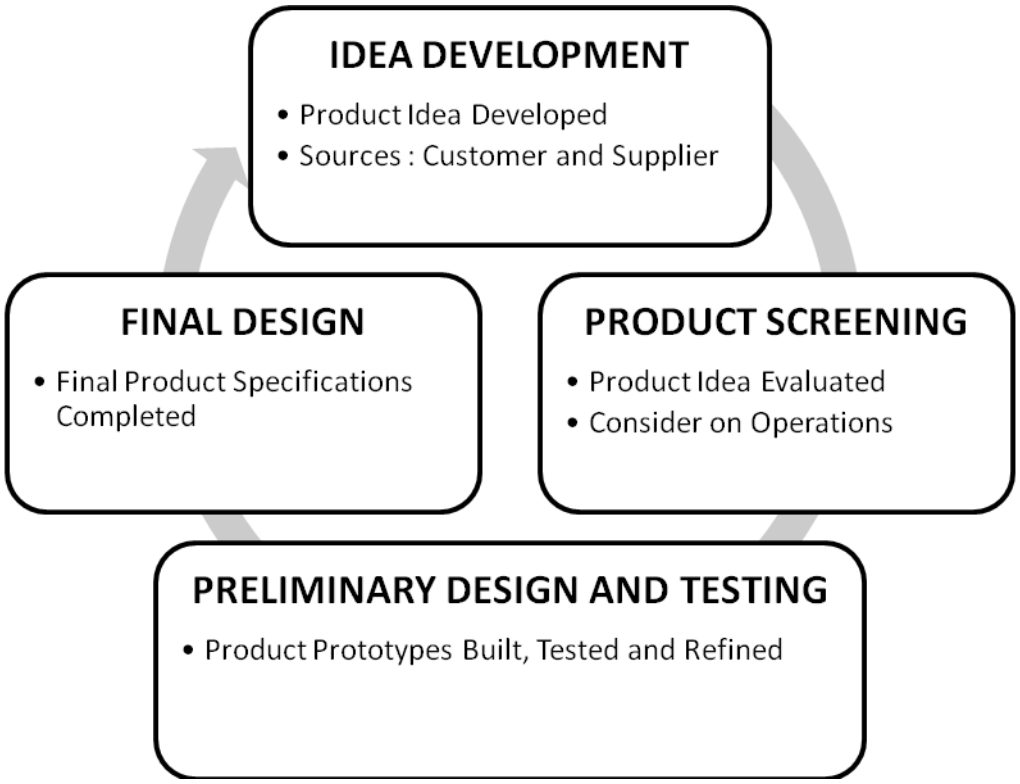

Figure 1.2: Product design process

2.3.1 Idea Development

All product designs start with an idea. The idea concept might come from a product designer that spends time with customers and it has a sense of what customers want, from an engineer with flare for innovations, or from anyone else in the organization. To remain competitive, designer must end up innovative and enhance new products regularly. In some industries, the cycle of new product development is predictable. We see this in the plastic industry, where new soap dispenser product come out every year, or the retail industry, where new fashion is designed for every season (Ullman, D.G, 1997).

In other industries, new product releases are less predictable but just as important. The body shop, retailer of plant-based skin care products, periodically comes up with new ideas for its product lines. The actual timing often is due to the market for any product, and whether product sales are declining or continuing to develop.

2.3.2 Product Screening

After a new product idea has been developed it will be evaluated to determine its possibility of success or we called as 'Product Screening'. The product screening activities are evaluates the product design idea according to the needs of the major customer demand (Ullman, D.G, 1997). The *Break-even-Analysis* is a technique that can be useful when evaluating a new product. This technique computes the quantity of good a company needs to sell a product just to cover its cost or break even called the 'break-even' point. When evaluating an idea for a new product it is helpful to compute its break-even quantity. An assessment can then be made as to how difficult or easy it will be to cover costs and make a profit. A product with a break-even quantity that is hard to attain might not be a good product choice to pursue.

2.3.3 Preliminary Design and Testing

Once a product idea has passed the screening stage, it is time to begin preliminary design and testing. At this stage, design engineers translate general performance specifications into technical specifications. Prototypes are built and tested. Changes are made based on test results, and the procedure of studying, rebuilding a prototype, and testing proceeds (Ullman, D.G, 1997).

2.3.4 Final Design

Using extensive design testing the products moves to one more design stage. It is where final product specifications are drafted. The final technical specifications are then translated into specific finalizing instructions to manufacture the product, which include picking out equipment, outlining jobs that need to be performed, identifying specific materials needed and suppliers which are to be used, and all the other aspects of organizing the process of this product production (Ullman, D.G, 1997).

2.4 FACTORS IMPACTING PRODUCT DESIGN

There is an important thing that needs to be highlighted in order to design a new product. There are several factors that should be considered during the product design stage (Ullman, D.G, 1997) which are Design for Manufacturing (DFM), product life cycle, Concurrent Engineering (CE) and remanufacturing. Design for Manufacturing is a series of guidelines that need to be follow in order to produce a product easily and profitably. The product life cycle consist of a stage to ensure the product pass through in their lifetime and characterized by changing product demand over time. An approach that brings together multifunction teams in the early phase of product design in order to simultaneously design the product and the process is known as concurrent engineering. A remanufacturing is a term for the concepts of using components of old product in the new ones production.

2.4.1 Design for Manufacture (DFM)

Once we think of product design we generally first consider how to please the customer. However, we should consider how quick or difficult it is to manufacture the product. Otherwise, we might have the better plan that is difficult or too costly to manufacture. Design for Manufacture (DFM) is several guidelines that we need to follow to make a product easily in addition to profitably (Ullman, D.G, 1997). Design for Manufacture (DFM) guidelines focus on two issues:

i. **Design simplification**

   Design simplification means reducing the number of parts and features of the product whenever possible. A simpler product is easier to make, costs less, and gives us higher quality.

ii. **Design standardization**

   Design standardization refers to the use of common and interchangeable parts. By using interchangeable parts we can make a greater variety of products with less inventory and significantly lower cost and provide greater flexibility.

There have a several guidelines in Design for Manufacturing (DFM) that need to be considered to produce new products before the product goes to the market. The guidelines consist of reduce the total number of parts, use standard components parts and materials, design for ease of fabrication, design of tolerances within manufacturing capabilities and use CAD software to evaluate the design. Figure 2.3 shows the overall guidelines of Design for Manufacturing (DFM).

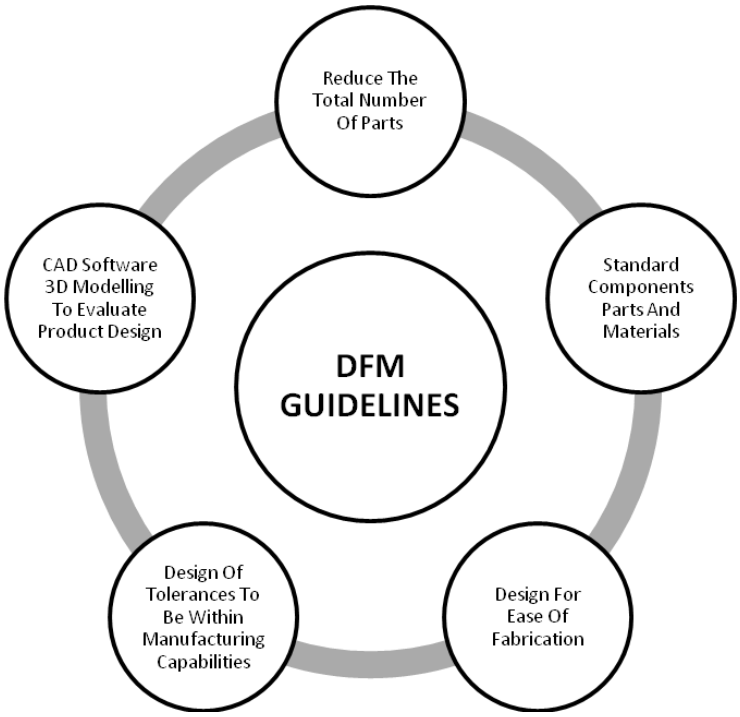

Figure 2.3: Guidelines of Design for Manufacturing (DFM)

i. Reduce the Total Number of Parts

By reducing the number of parts in a product design, this provides the best opportunity for reducing manufacturing costs. Fewer parts mean less engineering development time, purchases, inventory, work-in-processing time, fabrication and assembly steps, inspection, etc. Overall it reduces the level of intensity of all product-related activities. The design team's focus is to evaluate each part to see if it can be eliminated, combined with another part or its function can be performed in a simpler way.

ii. Standard Components Parts and Materials

Design using standard components that are less expensive than custom-made items and they simplify the design. Common parts and materials will reduce inventory, costs and product lead times.

iii. Design for Ease of Fabrication

Select processes compatible with the materials and production volumes. Select materials compatible with production processes that reduce processing time but meet functional requirements. Final surface requirements such as painting, polishing, finish machining, should be clearly understood and design intent accurately defined .

iv. Design of Tolerances to Be Within Manufacturing Capabilities

Continually designing for manufacturing will improve product quality and reduce fabrication costs. After completion of preliminary drawings, meet with manufacturing and review design intent, requirements and determine manufacturing process requirements. Manufacturing to review tolerances and determine process capabilities to meet dimensional limits. In general, the design to avoid unnecessarily tight tolerances that are beyond the natural capability of the manufacturing processes. Tolerance stack-ups should be considered on mating parts. Overall assembly tolerances should be calculated, and interface as well as clearance requirements understood.

v. CAD Software 3D Modeling to Evaluate Product Design

With today's advances in PC & software power, using CAD software for example Solidwork or CATIA is a very powerful tool to evaluate your product design. This is a good time to pull the design team and manufacturer together to demonstrate and evaluate the product parts, subassemblies & assemblies. This will allow the review of the majority of the above DFM guidelines and most importantly how the physical-relationship of the parts work together when viewed as a 3D model.

2.4.2 Product Life Cycle

Another aspect in product design is the stage of the life cycle of the product. Most products go through some stages of transforming product demand called the product life cycle. There are typically four stages of the product life cycle: introduction, growth, maturity, and decline.

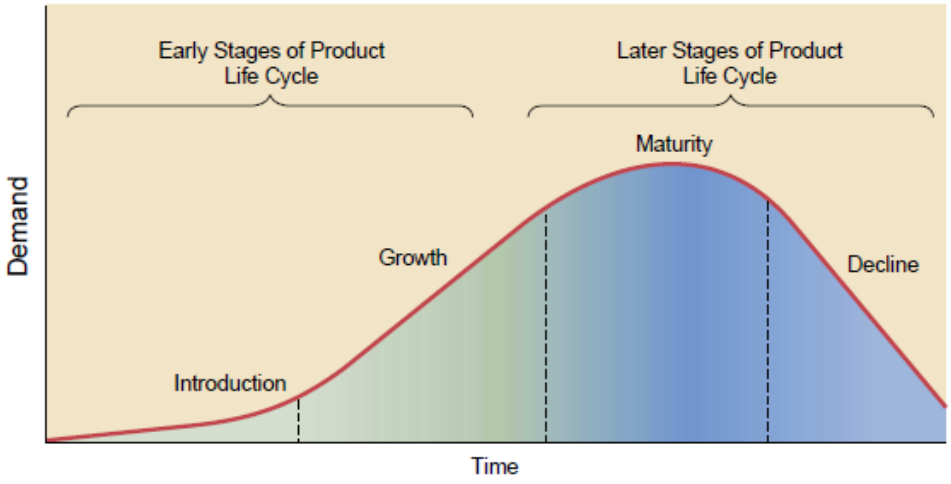

Figure 2.4: Product life cycle (Ullman, D.G, 1997)

Based on Figure 2.4, Products in the introductory stage usually are not well defined and also neither is their particular market. In the growth stage, the product takes maintain and each product as well as market continue being refined. The third stage is that of maturity, where demand levels off and there are usually no design changes: The product and its market are predictable at this stage (Ullman, D.G, 1997). Many products, such as soap dispenser, can stay in this stage for many years. Finally, there is a decline in demand, because of new technology, better product design, or market saturation.

The first two stages of the life cycle can generally be called as the early stages of the product life cycle because the product is still being improved and refined, and the market is still in the process of being developed. The last two stages of the life cycle can be referred to as the later stages because here the product and market are both well defined.

Understanding the stages of the product life cycle is important for product design purposes, such as knowing at which stage to focus on design changes. Also, when considering a new product, the expected length of the life cycle is critical in order to estimate future profitability relative to the initial investment. The product life cycle can be quite short for certain products, as seen in the computer industry. However, almost all products do, and some may spend a long time in one stage

2.4.3 Concurrent Engineering (CE)

Concurrent engineering is an approach that brings many people together in the early phase of product design in order to simultaneously design the product and the process. This type of approach has been found to achieve a smooth transition from the design stage to actual production in a shorter amount of development time with improved quality results (Ullman, D.G, 1997).

The old approach to product and process design was to first have the designers of the idea come up with the exact product characteristics. Once their design was complete they would pass it on to operations that would then design the production process needed to produce the product. This was called the “over-the-wall” approach, because the designers would throw their design “over-the-wall” to operations then had to decide how to produce the product.

There are many problems with the old approach. First, it is very inefficient and costly. For example, there may be certain aspects of the product that are not critical for product success but are costly or difficult to manufacture, such as a dye color that is difficult to achieve. Since manufacturing does not understand which features are not critical, it may develop an unnecessarily costly production process with costs passed down to the customers. Because the designers do not know the cost of the added feature, they may not have the opportunity to change their design or may do so much later in the process, incurring additional costs. Concurrent engineering allows everyone to work together so these problems do not occur. Figure 2.5 shows the difference between the “over-the-wall” approach and concurrent engineering.

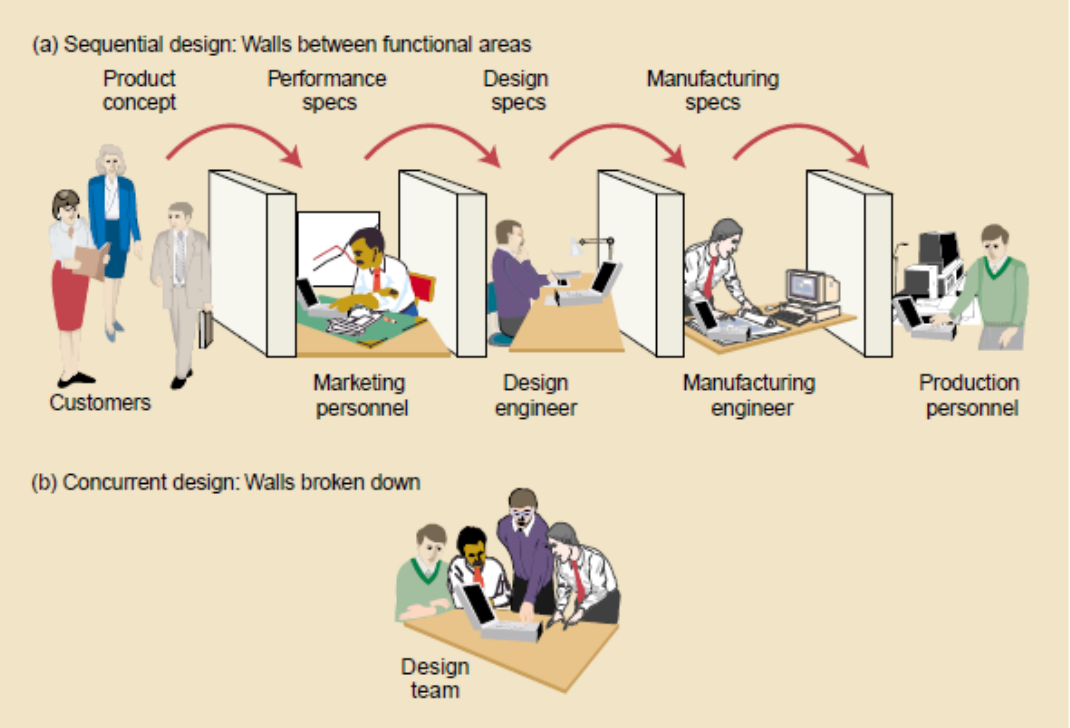

Figure 2.5: The differences of over-the-wall and Concurrent Engineering (CE) (Ullman, D.G, 1997)

A second problem is that the "over-the-wall" approach takes a longer amount of time than when product and process design are performed concurrently. As you can see in Figure 2.5, when product and process design are made together much of the work is done in parallel rather than in sequence. In today's markets, new product introductions are expected to occur faster than ever. They may eventually get a great product, but by then the market may not be there (Ullman, D.G, 1997).

The third problem is that the old approach does not create a team atmosphere, which is important in today's work environment. Rather, it creates an atmosphere where each function views its role separately in a type of "us versus them" mentality. With the old approach, when the designers were finished with the designs, they considered their job done. If there were problems, each group blamed the other. With concurrent engineering the team is responsible for designing and getting the product to market. Team members continue working together to resolve problems with the product and improve the process.

2.4.4 Remanufacturing

Remanufacturing is a concept that has been gaining increasing importance, as our society becomes more environmentally conscious and focuses on efforts such as recycling and eliminating waste. Remanufacturing uses components of old products in the production of new ones. In addition to the environmental benefits, there are significant cost benefits because remanufactured products can be half the price of their new counterparts (Ullman, D.G, 1997). Remanufacturing has been quite popular in the production of computers, televisions, and automobiles.

2.5 RAPID PROTOTYPING

Rapid prototyping (RP) is an additive process used for building physical models, prototypes, tooling components, and finished production parts from 3D computer-aided design (CAD) data. Its additive systems join together liquid, powder, or sheet materials to form parts that may be impossible to fabricate by any other method. Based on thin, horizontal cross sections taken from a 3D computer model, RP processes produce plastic, metal, ceramic, or composite parts layer upon layer (Jacobs, P.F, 1992). A prototype is an important and vital part of the product development process. In any design practice, the word “prototype” is often not far from the things that the designers will be involved in.

2.5.1 Fundamental of Rapid Prototyping

Most manufacturing industries are involved in product development, a process wherein the product concept must be transitioned from virtual drawings (3D Software) to a working physical product. Producing the first physical model, or prototype, of the product is called prototyping. Prototyping is important because it is the ultimate means for verifying the form, fit, and function of a product. Prototypes are made in low volume at high unit cost because all the tooling costs (fixed costs) associated with making the prototypes are spread over a small number of parts. Rapid prototyping methods assist in making the product development process cheaper and faster, which can ultimately impact customer satisfaction and requirement (Jacobs, P.F, 1992).

A component or product is modeled on a Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) system. The model which represents the physical part to be built must be represented as closed surfaces which unambiguously define an enclosed volume. It means that the data must specify the inside, outside and boundary of the model. This requirement will become redundant if the modeling technique used is solid modeling. This is by virtue of the technique used, as a valid solid model will automatically be an enclosed volume. This requirement ensures that all horizontal cross sections that are essential to RP are closed curves to create the solid object (Jacobs, P.F, 1992).

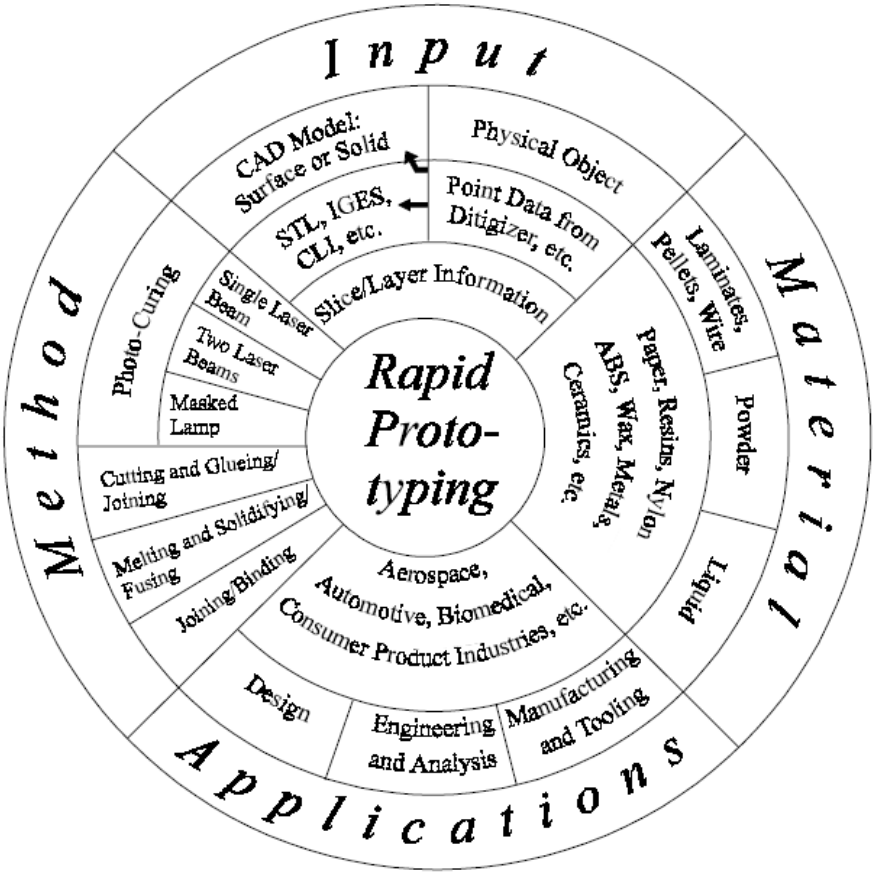

Figure 2.6: The four major aspects of Rapid Prototyping
(Kochan, D. and Chua, C.K, 1995)

The solid or surface model to be built is next converted into a format dubbed the "STL" (Stereo-Lithography) file format which originates from 3D software system. The

STL file format approximates the surfaces of the model by polygons. Highly curved surfaces must employ many polygons, which mean that STL files for curved parts can be very large. However, there are some rapid prototyping systems which also accept IGES (Initial Graphics Exchange Specifications) data (Jacobs, P.F, 1992). A computer program analyzes a STL file that defines the model to be fabricated and "slices" the model into cross sections. The cross sections are systematically recreated through the solidification of either liquids or powders and then combined to form a 3D model. Another possibility is that the cross sections are already thin, solid laminations and these thin laminations are glued together with adhesives to form a 3D model. Other similar methods may also be employed to build the model.

Fundamentally, the development of RP can be seen in four primary areas. The Rapid Prototyping Wheel in Figure 2.6 depicts these four key aspects of Rapid Prototyping. They are: Input, Method, Material and Applications (Jacobs, P.F, 1992).

2.6 SUMMARY ON THE RELATED PROJECT

The design and develop a new multipurpose soap dispenser prototype will adopt a project that has been done by the other researcher which are the 'Optimization of a Tissue Dispenser'. This project consists of a complete product development process. This includes a market analysis, concept generation and evaluation, detail design, prototype building and testing. The different phases have been done in series of activity that follow each other in a natural way. The first step was to gather information through analysis of dispenser and benchmarking of its main competitors. The next step was to develop new cutting mechanisms. The following phase was to develop, build and test the chosen concept. The final stage was the evaluation of the result and to conclude the project. These methods have been used to organize and execute the project from initial research to the final concept.

Figure 2.7: Optimized Tissue Dispenser product

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter is discussed the ideas about the method how to implement this research. In this study, there are a few process stages will be conducted in this methodology process. The process started from collecting data by survey activities (questionnaire), apply a few tools of idea generation then proceed to the design process and will end up with a prototype product.

Figure 3.1 shows overall overview of the methodology that has been conduct in this research.

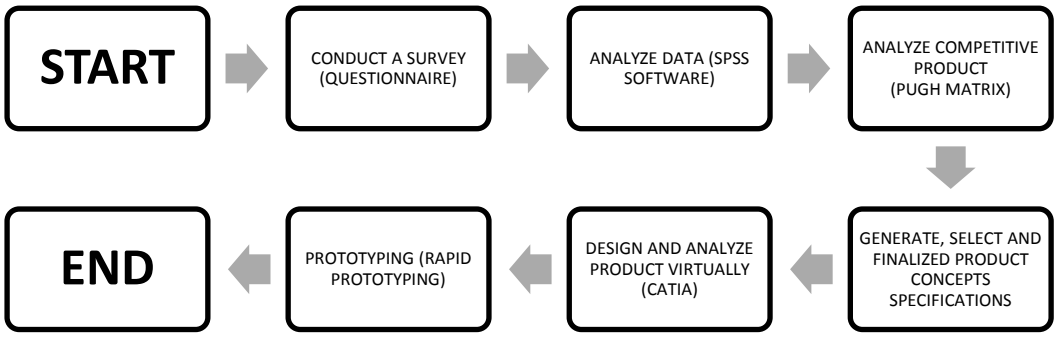

Figure 3.1: Overview of research methodology

3.2 IDENTIFY CUSTOMER NEED AND REQUIREMENTS

To define the customer need and expectations, a survey has been conducted. A survey is a systematic method of collecting data from a customer to determine their interest and need. The purpose of a survey is to collect information usually through the use of a structured and standardized questionnaire. The first task in conducting a survey is to define the objective of the study. The aim of the study is to develop and design a new multi-purpose soap dispenser which is related to the current customer demand and requirement.

There are several methods for obtaining survey research such as face to face interviews, focus groups interviews, telephone interviews, observations or questionnaires. The method that will be use for this study is questionnaires method. Questionnaires are an evaluation method that very familiar to most researchers. It consist of a set of questions or item that are designed for a selected group of people such as lecturers, administrators, parents, students or others. The step to develop a questionnaire is shown in Figure 3.2.

The first step to develop a questionnaire is to decide the kinds of information that need to know from the respondent in order to meet the survey's objectives. It should be clear from the research objectives and put the required information in the questionnaire. The information required for this project generally is about Soap Dispenser specifications such as design, shape, functionality purpose and the product strength.

The target of the respondent must be defined to determine which area or population of the data to be collected. In product development research, there must be a scope whether it should cover only existing user of the generic product type or whether to also include non-users. The research of Multi-Purpose Soap Dispenser will cover on the potential soap dispenser user area such as hospital, office, university and home.

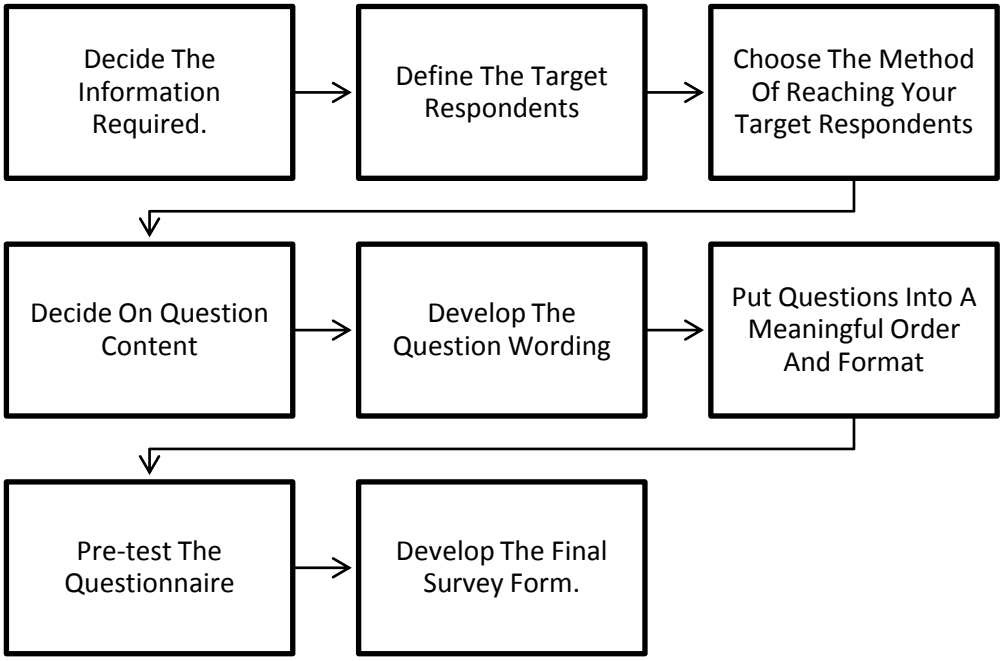

Figure 3.2: Questionnaire development process (Sudan, S, 1983)

There are several methods on how to approach target respondent. The questionnaire will be distributed at several areas which are office, hospital, and university and neighbor area. The most appropriate location to distribute a questionnaire is a place where members of the population frequent and is comfortable for them to participate in answering the questionnaire. A clearly explain about the purpose and benefits of survey will be explain first before giving a questionnaire.

In writing a questionnaire, the first step that needs to be considered is to determine if there is an existing questionnaire that can be used to collect the information needed for the research purpose. The question content for the Multi-Purpose Soap Dispenser will be developed based on several features which are the design, shape, purpose, functionality and add-on features. It is important to remember that the quality and usefulness of the information collected will depend on how the questions are worded.

A survey questions can be categorized into three forms which are close-ended, open-ended and open response (option questions). Closed and open-response questions provide an easy method to the respondent to indicating their answer. It will prompt the

respondent so that the respondent has to rely less on memory in answering the question. A survey questions can be divided into two types which is structured and unstructured. The study will use structured types questions to conduct this survey which is consist of Dichotomous, Level of Measurement and Filter Questions.

The questions will be design as easy to answer and not in any way threatening to the respondents. Some threatening question might cause the respondent to feel hesitate to answering the questionnaire while it should encourage the respondent to continue answering. The questions also will be design in some kind of psychological flow order. The particular questions that have same aspect will be grouped together. The length or number of questions also need to be considered during designing a questionnaire because if it too long the respondents might lose interest and answering in rush through. A complete questionnaire will be administered to a small group to get feedback then final survey form will be developing.

3.3 ANALYZE THE SURVEY DATA USING SPSS SOFTWARE

The information and data from the questionnaire activities will be gathering and analyze by using SPSS software which is stand for Statistical Package for the Social Sciences (SPSS). This software functions for managing, analyzing and presenting data to the graphical and syntactical interfaces. This software also use for managing data, conducting statistical analyze, creating table and charts.

3.4 ANALYZE COMPETITIVE PRODUCT USING PUGH MATRIX METHOD

Pugh matrix is a tool to facilitate the concept evaluation and selection process. The Pugh method is useful as an initial method in the early stages of design. In this method, a decision matrix is constructed as shown in Table 3.1.

Each of the specifications of a products A is compared with other product B and product C and the result is recorded in the decision matrix as (+) if more favorable and

(-) if less favorable. The decisions on whether product A, B or C is the best is based on the analysis of the results of comparison which is the total number of (+) and (-).

Table 3.1: Example of Pugh Matrix table for products comparison

SPECIFICATIONS		DATUM	Product A	Product B	Product C
Price					
Material Strength					
Design					
Weight					
Ease of Use					
Ease of Manufacture					
Portability					
Customer Need					
TOTAL	+				
	-				
SUM					
Ranking					

3.5 GENERATE, SELECT AND FINALIZED PRODUCT CONCEPT SPECIFICATIONS

All the information and data about a multipurpose soap dispenser will be gather in the constructed table. The next stage of the methodology is to select the best concept to integrate with a new multipurpose soap dispenser. The purpose of concepts specifications selections is to narrow the number of concept quickly and to improve the concepts. For these stages, the Pugh Method will be use again to analyze and select the best concept and compatible for a new multipurpose soap dispenser.

Table 3.2: Example of Pugh Matrix table for concept selection

Selection Criteria	Concept			
	Datum	**Concept A**	**Concept B**	**Concept C**
Ease of Assembly				
Capacity of Liquid Soap				
Capacity of Tissue Dispenser				
Capacity of Mini Dustbin				
Ease of Manufacture				
Portability				
Assembly mechanism				
Weight				
Design Shape				
TOTAL	+			
	-			
SUM				
Ranking				

3.6 DESIGN AND ANALYZE PRODUCT VIRTUALLY (CATIA)

Once the concepts of the new multipurpose soap dispenser have been finalized, the study will proceed to the next stages which are virtual designing process by using 3D software. CATIA is mechanical design software. It is a feature-based, parametric solid modeling design tool that takes advantages of the easy to learn windows graphical user interface. CATIA also has a features that can be use to make an analysis on the product designed. The features are called Finite Element Analysis (FEA). Once the design and analysis done, product file will be saved as the STL file format that can be exported to Rapid Prototyping Machine (RP) for prototyping process.

3.7 PROTOTYPING PROCESS (RAPID PROTOTYPING)

The next stages of multipurpose soap dispenser development are prototyping process by using Rapid Prototyping Machine (RP). Rapid Prototyping (RP) is an additive process used for building physical models, prototypes, tooling components and finished production parts from 3D computer-aided design (CAD) data. Product file that already saved in STL file format will be imported to the Rapid Prototyping machine then the parameter for the process will be setup. It will take several hours for prototyping process completely done. The prototyped product next will be douse in ultrasonic liquid for product refinement purpose.

Figure 3.3: Rapid Prototyping machine (FORTUS)

Figure 3.4: Ultrasonic Cleaner machine

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter will discuss about the results and discussion of the project. It consists of the result of the questionnaire survey, analysis of competitive product, product concept selection, analysis of the product design and prototyping process.

4.2 QUESTIONNAIRE RESULTS AND ANALYSIS

4.2.1 Background

In December 2011, the survey has been conducted in several places in Kuantan, Pahang. A questionnaire is distributed amongst the people based on their job fields. The target of the respondents is Education, Engineering, Medical and Government employees. This questionnaire was designed to survey the level of customer satisfaction about current soap dispenser product at the market and to determine the customer need and expectations in order to develop a new product.

4.2.2 Scope of Questionnaire

Completed responses to the survey were conducted from 40 respondents which are 10 respondents for each job fields. The employees that responded included lecturer, engineer, nurse, medical assistants, government officer, technician and many of them

from respondents targeted. In the Figure 4.1 we have detailed the data of the respondents about soap dispenser in different fields and backgrounds. To analyzing the expectations for a new multipurpose soap dispenser so the data has been sorting based on respondent's job fields and their age. The data in figure 4.1 shows that most of respondent's age range is about 30 to 40 years old.

In the education sector, the number of respondents is balance between range 21 to 30 years old and 31 to 40 years old which is 12.5%. In the engineering sector, the data shows that respondent's in range 21 to 30 years old is 10% and 31 to 40 years old is 15%. In the medical sector, the number of respondents for a range 21 to 30 years old is 5%, 31 to 40 years old is 15% and 41 to 50 years old is 5%. For the last sector which is government sector, the data shows that the number of respondents for a range 21 to 30 years old is 2.5%, 31 to 40% is 12.5% and 41 to 50 is 10%.

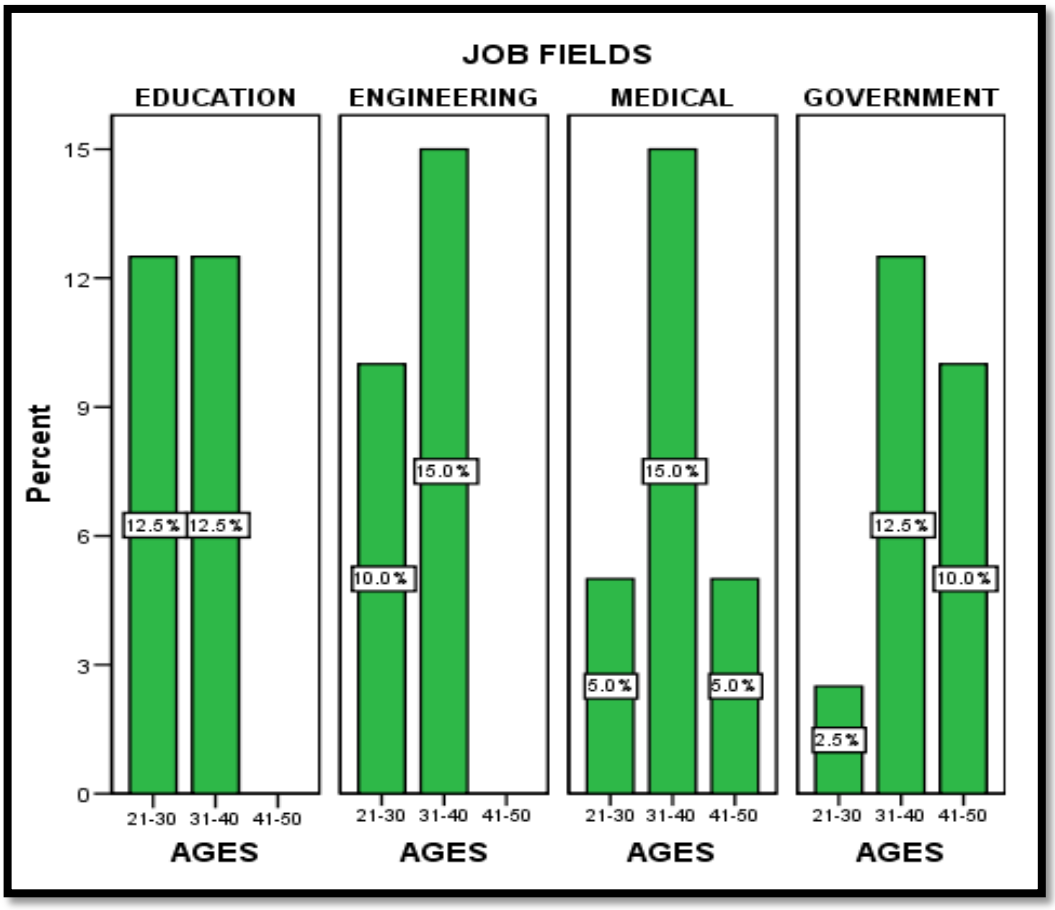

Figure 4.1: Distribution job fields across the specified age

4.2.3 Question: Do you have Soap Dispenser?

In the Figure 4.2, we found that most of the respondents do not have their own soap dispenser. Out of 40 respondents, there are only 14 of them having their own soap dispenser and the rest 26 respondents do not have. The most respondents that have a soap dispenser is from the government, medical and engineering fields while the most respondents that do not have a soap dispenser is respondents from the education fields.

Figure 4.2: Do you have Soap Dispenser?

4.2.4 Question: Where do you always found soap dispenser?

The most places that the respondents found a soap dispenser is at the office and the restaurants. Out of 40 respondents, there are 13 respondents found soap dispenser at the offices and restaurants and the rest found at the school and their home. In Figure 4.2, the results shown that 26 respondents do not have their own soap dispenser, therefore, the results in Figure 4.3 is almost same which are 26 respondents found the soap dispenser outside their home. We can conclude that they always use a soap dispenser at the public places instead at their home. Therefore the future design must meet the outside environmental specifications.

Figure 4.3: Where do you always found soap dispenser?

4.2.5 Question: When do you always use soap dispenser?

In the figure 4.4, we found that the respondents always use a soap dispenser while washing their hand. We can conclude that the most places which is soap dispenser being use to wash the hand are at the restaurant. Therefore, the data shown in figure 4.3 which are the most place respondents always found a soap dispenser is valid. The results in figure 4.4 shows that out of 40 respondents, there are 20 respondents use soap dispenser during washing a hand, 13 respondents use soap dispenser after use a toilet and 7 respondents use soap dispenser during take a bath. Therefore, the new multipurpose soap dispenser must be design based on hand washing activity considerations.

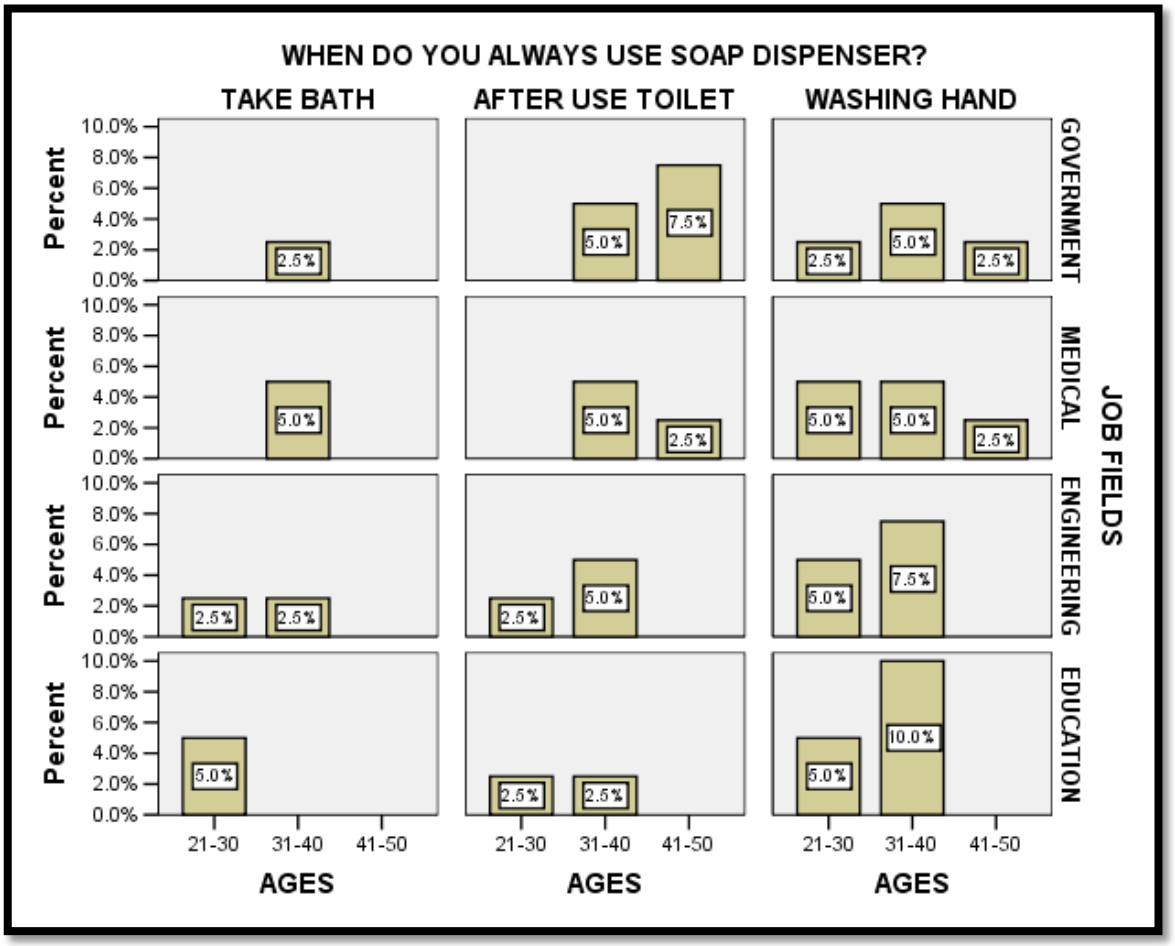

Figure 4.4: When do you always use soap dispenser?

4.2.6 Question: How often do you use soap dispenser daily?

The figures showed the results of soap dispenser usage in daily activity. It shown that, out of 40 respondents there are 18 respondents (45%) frequently use soap dispenser daily. 7.5% of them are from government sector, 15% of them are from medical sector, 12.5% of them are from engineering sector and 10% of them are from education sector. From the figure data, we can conclude that the higher frequently usage is from medical sector which are 15% because of soap dispenser is the important things for health manner that use in hospital. Therefore, another consideration that we need to highlight is the design must meet the hospital usage requirement.

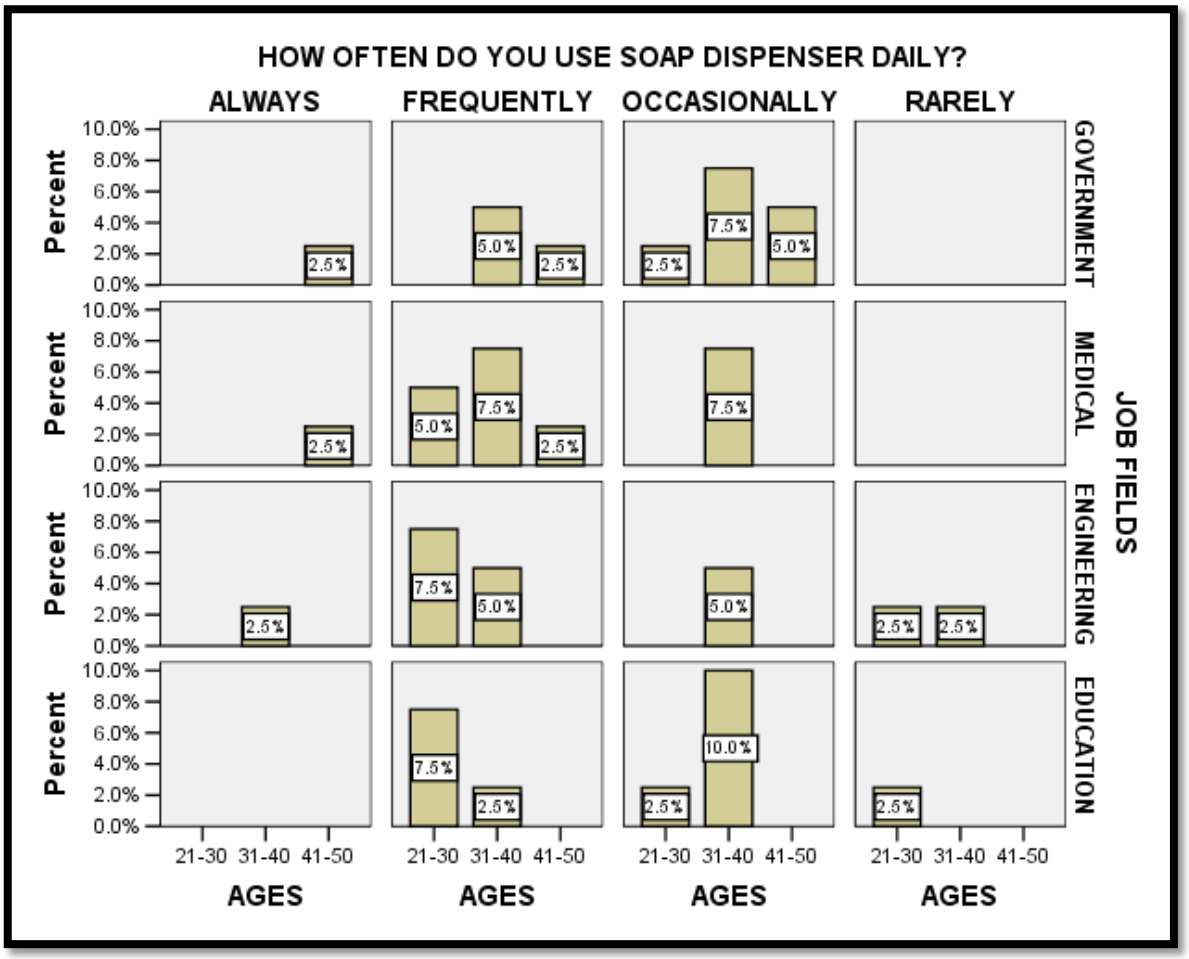

Figure 4.5: How often do you use soap dispenser daily?

4.2.7 Question: How would you describe about the current soap dispenser at the market? (Scale of satisfaction)

In the figure above showed the level of respondent's satisfaction on the current soap dispenser at the market. As we can see, most of respondents rate and describe the soap dispenser specifications at the market as level 2. We can conclude that the level of customer's satisfactions is below than normal rating. Therefore, the current soap dispenser must be redevelop and redesign to meet the customer satisfaction. The specification that highlighted by respondents can be detail in next questionnaire results data.

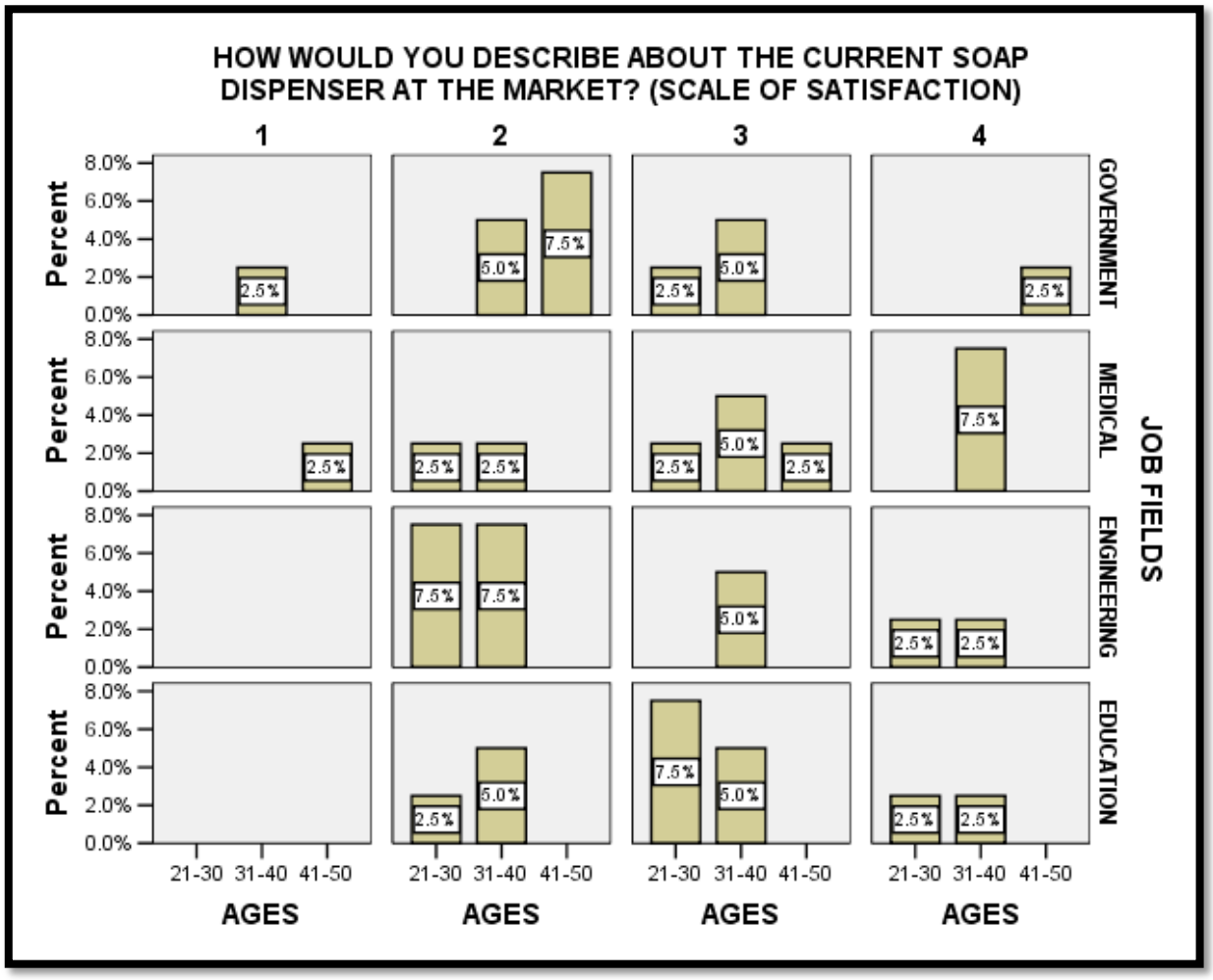

Figure 4.6: How would you describe about the current soap dispenser at the market?

4.2.8 Question: What is the most recommended add-on for the new multipurpose soap dispenser?

The figures had shown the results of the most recommended add-on for the new multipurpose soap dispenser. The data determine the additional functions that being integrated with new multipurpose soap dispenser. We can see that the most recommended is a Tissue Dispenser. The second is Mini Dustbin and the rest is Box Compartment and Ashtray. Since the objective of the project is to develop at least two new functions, therefore two highest recommendations add-on is chosen to integrate with a new multipurpose soap dispenser. There are Tissue Dispenser and Mini Dustbin.

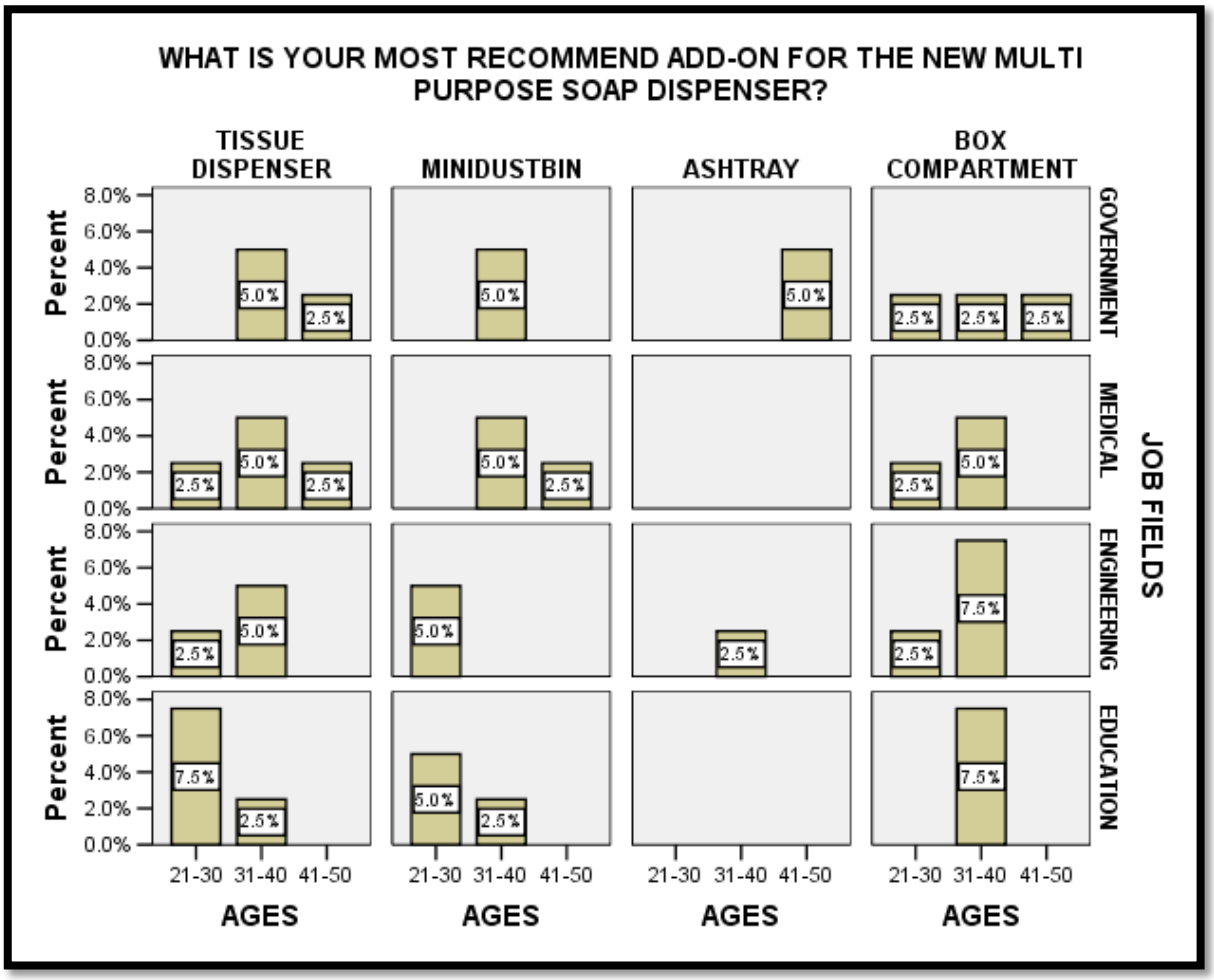

Figure 4.7: Most recommended add-on for the new multipurpose soap dispenser?

4.2.9 Respondents requirements rate based on specifications of the product.

Table 4.1 showed tabulated respondent requirement data based on product specifications. The specification data is about the size of the product, design of the product, shape of the product, weight of the product, functionality, colour of the product and the material use for the product. First of all, let's look at the rate on the shape of the product.

Most of the respondent chooses the neutral rate for the shape of the product. This is because of the size of the product at the market now is almost same. There has a common range of the size for the soap dispenser. Therefore, in order to design a new multipurpose soap dispenser, the size of the product must be considered to fulfil the range of the current product size.

The next specifications are the design of the product. From the Table 4.1, it shown that the respondents almost satisfied with the current the design because of the rating on neutral level is higher. But we must considered on the second higher, which is the design for a new multipurpose soap dispenser is important for certain customer. Therefore, the design for new multipurpose soap dispenser must be analyzed properly to meet the current trend and in the same time the cost is lower. The shape of the product also must be considered. It is important for the marketing planning to ensure the product is attractive and can be sell as well as recent product.

Product weight is the important specifications that must be considered. Most of the respondent rate the weight is neutral, which is important but not compulsory. Therefore, a new multipurpose soap dispenser must have a normal weight same as the current product although there has a new additional function that attached to the product.

Table 4.1: Product specifications requirements

		Job Fields				Total
		Education	**Engineering**	**Medical**	**Government**	
Size Of The Product	Not Important	1	3	1		5
	Neutral	5	4	7	7	**23**
	Important	4	3	2	3	12
Design Of The Product	Not Important		1	2	2	5
	Neutral	6	5	5	3	**19**
	Important	4	4	3	5	16
Shape Of The Product	Not Important		5	1	2	8
	Neutral	4	4	5	7	**20**
	Important	6	1	4	1	12
Weight Of The Product	Not Important	1	3	6	3	13
	Neutral	9	5	2	5	**21**
	Important		2	2	2	6
Functionality	Not Important	1				1
	Neutral	3	4	2	4	13
	Important	6	6	8	6	**26**
Colour Of The Product	**Not Important**	6	7	7	10	**30**
	Neutral	3	3	3		9
	Important	1				1
Material Of The Product	Not Important	3	2	3	3	11
	Neutral	7	4	5	5	**21**
	Important		4	2	2	8

Besides that the function of the product is important and compulsory based on respondent's rate. To ensure the product can be function as well as it supposed to be, a several research and testing will be conducted to the product. Thus, after the product is produced, the probability of the product to fail is almost zero.

The last specification that must be considered is the colour of the product and the material used. Nowadays at the market, there has a lot of product with a variety

colour. The colour of the product is the additional point for the marketing to ensure the product is attractive and can be sell at higher level. But, based on the survey, the respondents rate it as not so important. Thus, the colour is not a critical point to be considered.

The material of the product also needs to be considering as it will determine the strength and durability of the product. As the objective of the project is to produce a multipurpose soap dispenser prototype, therefore the material use is limited based on the Rapid Prototyping specifications.

Table 4.2: Summary of product specifications requirements scale

PRODUCT SPECIFICATIONS	SCALE
Size Of The Product	Neutral
Design Of The Product	Neutral
Shape Of The Product	Neutral
Weight Of The Product	Neutral
Functionality	Important
Colour Of The Product	Not Important
Material Of The Product	Neutral

4.3 ANALYSIS OF COMPETITIVE PRODUCTS

The overall objective of the analysis of competitive by using Pugh matrix method is to analyze and choose the best soap dispenser from the market that can meet the customer requirement based on the survey conducted. The data from the survey is the guidelines to fulfil the Pugh matrix method concepts.

From the Table 4.3, three different products has been analyze based on 8 criteria to choose the best soap dispenser for this project. The criteria chosen is the price, material strength, design, weight, ease of use, ease of manufacture, portability and meet

current costumer need. Those criteria are the compulsory and must be considered in order to produce a good multipurpose soap dispenser prototype product.

Table 4.3: Pugh Matrix method for product selection

SPECIFICATIONS		**DATUM**	 **Product A**	 **Product B**	 **Product C**
Price		0	-	+	-
Material Strength		0	+	-	-
Design		0	-	-	+
Weight		0	-	+	+
Ease of Use		0	+	+	+
Ease of Manufacture		0	-	+	+
Portability		0	-	-	+
Customer Need		0	-	+	+
TOTAL	**+**		**2**	**5**	**6**
	-		**6**	**3**	**2**
SUM			**-4**	**2**	**4**
Ranking			**3**	**2**	**1**

Notes:

+ = Better than

- = Worse than

0 = Same as

According to the Table 4.3, the Pugh matrix for product selection show that product C has the highest positive score which mean the best among 2 other product. Although there has a negative sign on the price and material strength specifications, but

there other criteria is strong enough to prove that product C is the best selection and can be used for this project to achieve the objective.

The product C is automatic dispensers which are using a sensor and a pump to dispense a liquid soap. The material use for this product is polypropylene (PP) where it is the widest use for the plastic parts. The design of product is simple and the capability to manufacture this product is high. This product is light and can portable.

4.4 GENERATE AND SELECT PRODUCT CONCEPTS

After the soap dispenser product has been selected, the next step is to decide the product multipurpose concepts. There are several concepts that may be used for this project. The purpose of the product concept generation was to develop a number of concepts that could meet the requirements. The concept generation was the initial part of the concept development where all the ideas were gathered. A wide variety of ideas was desirable to raise the chances for good innovations.

4.4.1 Concept A

Figure 4.8 shows the first concept of multipurpose soap dispenser. This concept consists of a rectangle shape for each part which is soap dispenser, mini dustbin and tissue dispenser. Each part attached each other by using a sliding concept where the tissue dispenser will assemble to the soap dispenser first before attached with mini dustbin.

4.4.2 Concept B

Figure 4.9 shows the second concept for multipurpose soap dispenser. This concept consists of a simple rectangle shape for each part also, but the assembly mechanism is different. The mechanism for this concept is known as ‘doghouse’ because they are consisting of the housing and the hook at the assembly contact area.

4.4.3 Concept C

Figure 4.10 shows the last concept for multipurpose soap dispenser. This concept consists of a rectangle shape and trapezium shape. It is different from other concepts in terms of size, capacity and the mechanism concept. This concept of using a clip mechanism that requires it be installed simultaneously.

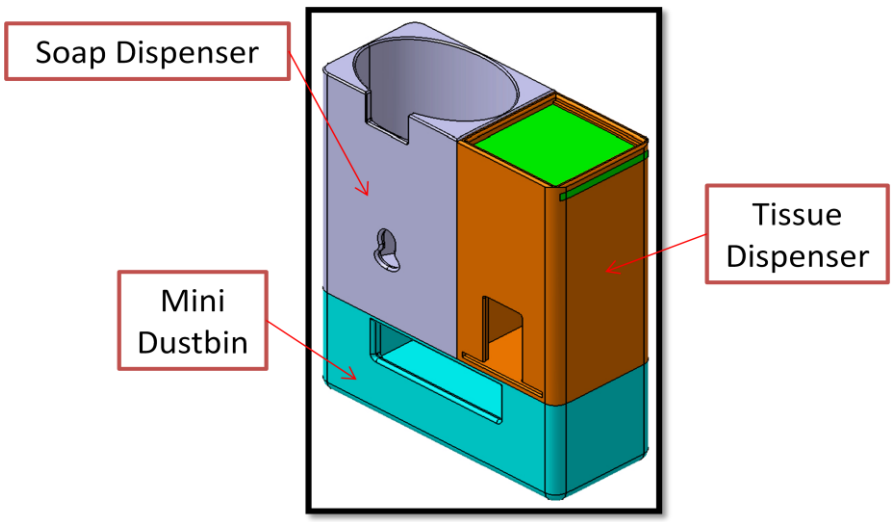

Figure 4.8: Multipurpose Soap Dispenser concept A

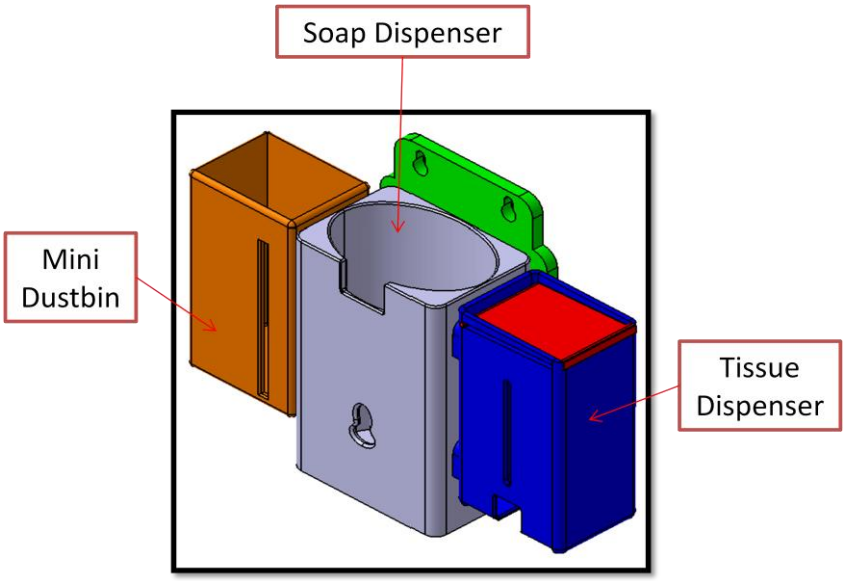

Figure 4.9: Multipurpose Soap Dispenser concept B

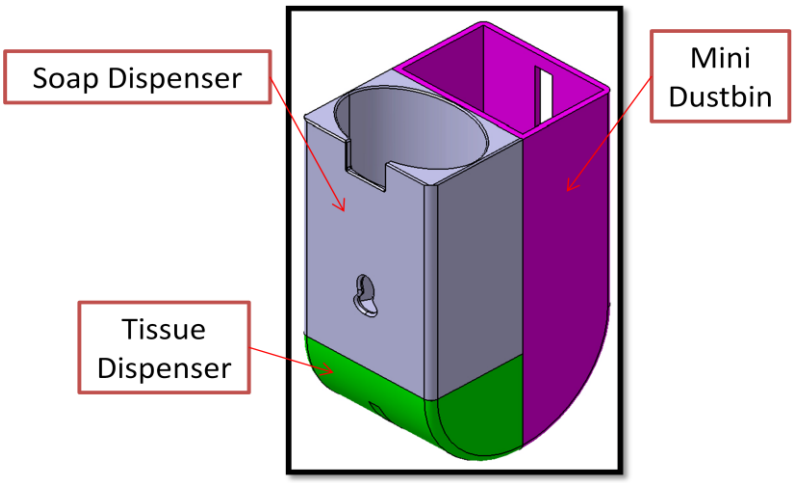

Figure 4.10: Multipurpose Soap Dispenser concept C

4.4.4 Approximate concepts specifications

The table 4.4 above shows the approximate specifications concept generated by CATIA software. It is compared in terms of the volume, area and mass of the parts. The total weight for the concept B is the 0.541kg and more light rather than other two concepts which are 0.727kg and 0.68kg.

Table 4.4: Approximate specification for the concepts

Specifications		**Concept A**	**Concept B**	**Concept C**
Soap Dispenser	Volume	0.0003343 m3	0.0003343 m3	0.0003343 m3
	Area	0.1 m2	0.103 m2	0.1 m2
	Mass	0.334 kg	0.336 kg	0.336 kg
Mini Dustbin	Volume	0.0002263m3	0.0001052 m3	0.0002757 m3
	Area	0.097 m2	0.072 m2	0.142 m2
	Mass	0.226 kg	0.105 kg	0.276 kg
Tissue Dispenser	Volume	0.0001674m3	0.00009959 m3	0.00006758 m3
	Area	0.087 m2	0.069 m2	0.047 m2
	Mass	0.167 kg	0.1 kg	0.068 kg
Total Weight		**0.727 kg**	**0.541 kg**	**0.68 kg**

4.4.5 Pugh Matrix concept selection

Table 4.5 shows the Pugh Matrix method for the concept selections. The criterion that has taken into accounts is based on Design for Manufacturing (DFM) considerations which are design for ease fabrications and others related guidelines. The results of the selection shows that the concepts B have the highest score (sum) rather than other concepts. Therefore, the concepts B are chosen as the finalized concept for a new multipurpose soap dispenser product.

Table 4.5: Pugh Matrix method for concept selection

Selection Criteria	Concept			
	Datum	**Concept A**	**Concept B**	**Concept C**
Ease of Assembly	0	+	+	+
Capacity of Liquid Soap	0	0	0	0
Capacity of Tissue Dispenser	0	-	+	-
Capacity of Mini Dustbin	0	+	-	+
Ease of Manufacture	0	+	+	-
Portability	0	-	+	-
Assembly mechanism	0	+	+	+
Weight	0	-	+	-
Design Shape	0	+	+	+
TOTAL	+	5	7	4
	-	3	1	4
SUM		2	6	0
Ranking		**2**	**1**	**3**

Notes:

+ = Better than,

- = Worse than,

0 = Same as

4.5 DETAIL PRODUCT DESIGN AND FINITE ELEMENT ANALYSIS

This section described about the detail product design and the Finite Element Analysis (FEA) for each parts. Basically, this Finite Element Analysis (FEA) aims to ensure the designed product is strong and capable enough to sustain any possible load occur.

4.5.1 Detail product design

The selected product concept was briefly described in terms of product dimension. The product has been design according to the actual chosen product size. Figures 4.11 show the approximate dimension of the product.

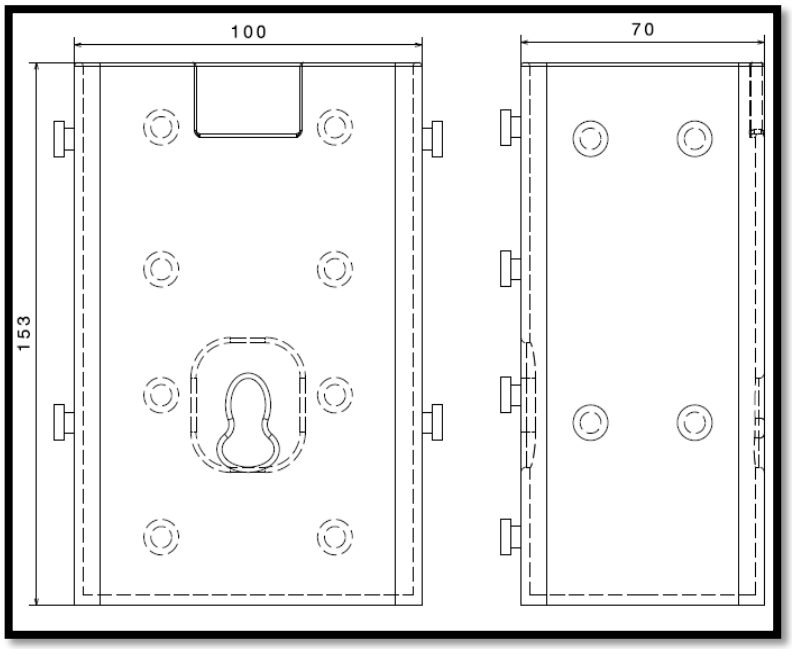

Figure 4.11: The approximate dimension for Dispenser compartment

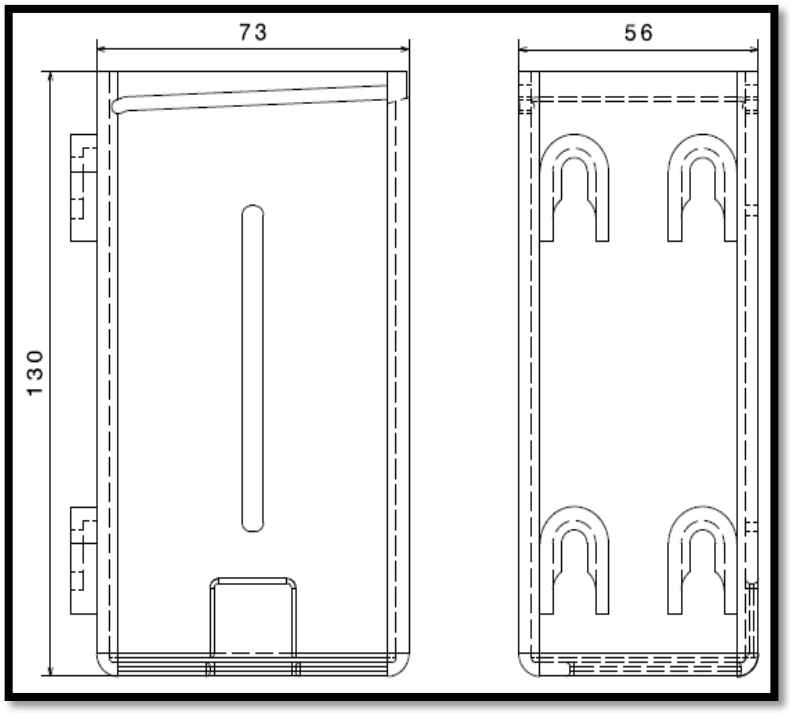

Figure 4.12: The approximate dimension for Tissue compartment

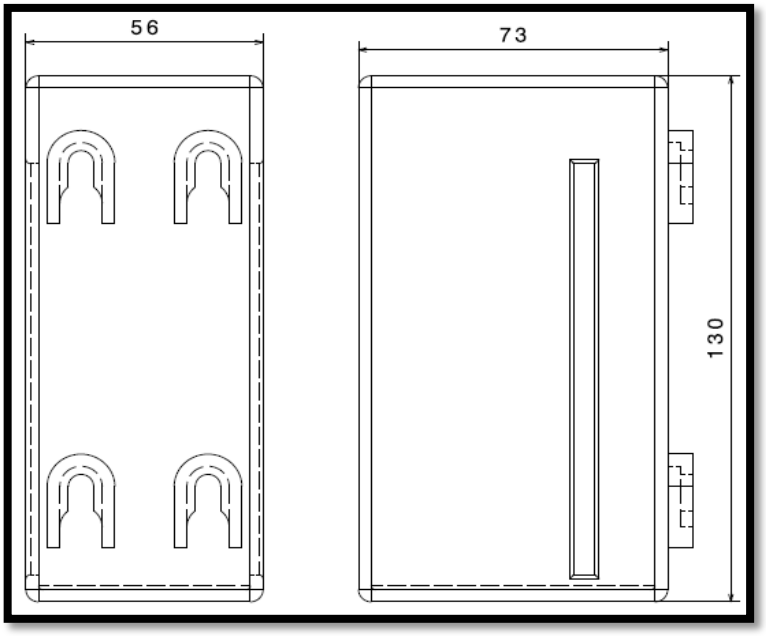

Figure 4.13: The approximate dimension for Dustbin compartment

4.5.2 Finite Element Analysis (FEA)

After the detail product design has been developed, and then the finite element analysis (FEA) for each part was analyzed. Figure 4.14 shows the analysis of load stress act on dispenser compartment, where the soap dispenser is located. A load given is 10N (Newton). The most critical point is at the red area, which is at the hook area. A result shows that the body compartment can sustain the load with a minimal stress area. The highest stress act on the body compartment is $2.35x10^4$ N/m^2 and the lowest stress is $2.35x10^3$ N/m^2.

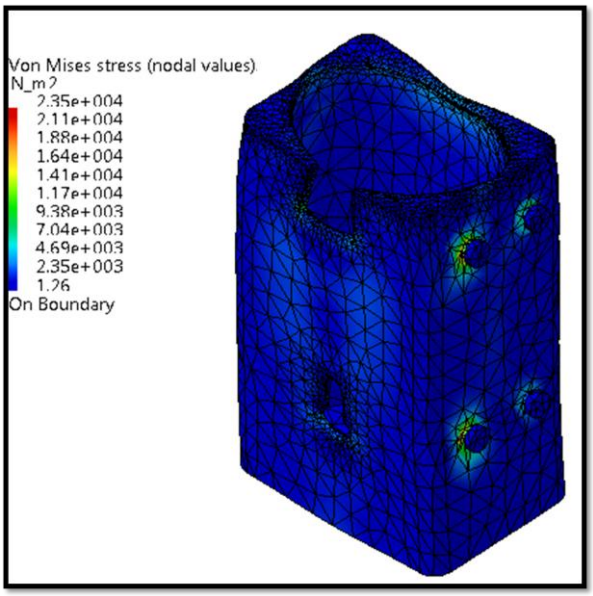

Figure 4.14: Finite Element Analysis for dispenser compartment

Figure 4.15 shows the analysis of load stress act on the tissue compartment, where the box to supply the tissue is. A load given on parts is 10N (Newton). The most critical point is at the green area, which is at the slot pocket and filleted corner radius area inside the parts. Results show that this part can sustain the load with the minimal stress area. The highest stress act on the tissue compartment is $2.83x10^5$ N/m^2 and the lowest stress is $2.84x10^4$ N/m^2.

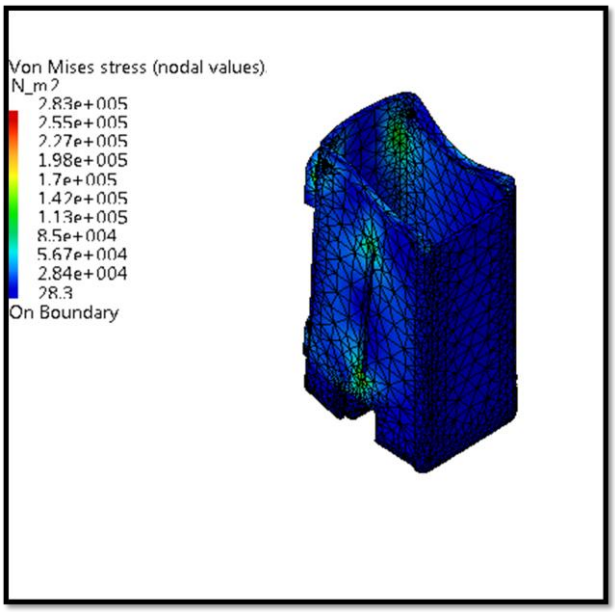

Figure 4.15: Finite Element Analysis for tissue compartment

Figure 4.16 shows the analysis of load stress act on the dustbin compartment, where the box to put the used tissue. A load given on parts is 10N (Newton). The most critical point is at the green area, which is at the slot pocket and filleted corner radius area inside the parts. Results show that this part can sustain the load with the minimal stress area. The highest stress act on the dustbin compartment is 3.57×10^5 N/m^2 and the lowest stress is 3.59×10^4 N/m^2.

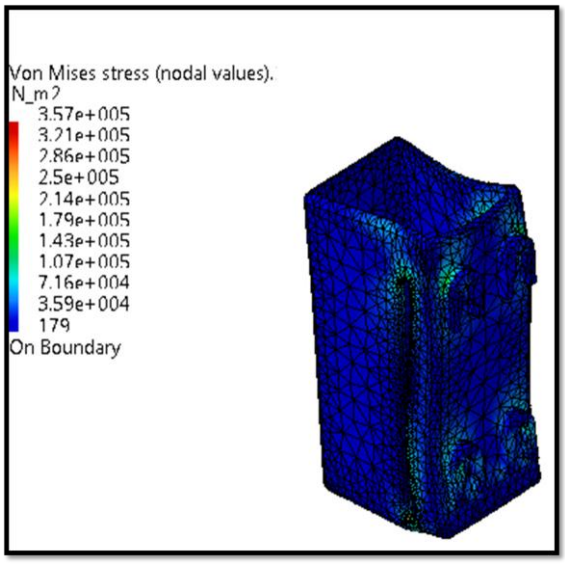

Figure 4.16: Finite Element Analysis for dustbin compartment

4.6 RAPID PROTOYPING

After the virtual design has been drawn by using 3D software which is CATIA, the project will continue with the prototyping process. This process will produce a real part from a virtual design drawing. The prototype machine called FORTUS 360mc. This machine is using INSIGHT software to run the prototyping process. Figure 4.17 show the diagram of multipurpose soap dispenser design. The 3D drawing from CATIA file must be saving as in STL file format to ensure that the INSIGHT software can read the file.

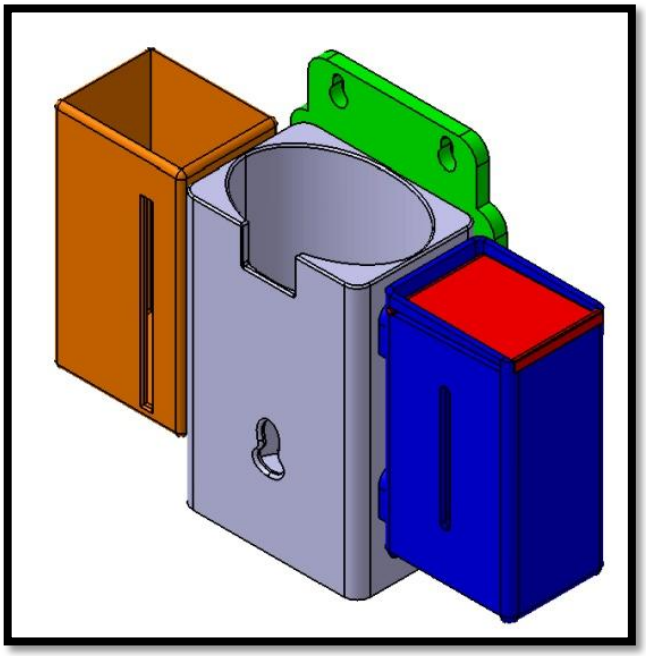

Figure 4.17: Multipurpose Soap Dispenser Drawing

4.6.1 Prototyping process

The process of prototyping begins after the 3D design is finalized. From the CATIA, the 3D product was saved in STL file then transfer to the FORTUS 360mc for the next step. The prototype process consists of two types of material which are ABS material (as the product) and SR-30 Soluble material (as the support). Therefore, the

material in the machine must be checked first to ensure the volume is full enough to meet the product volume needed. Figure 4.18 shows the solid prototyped product.

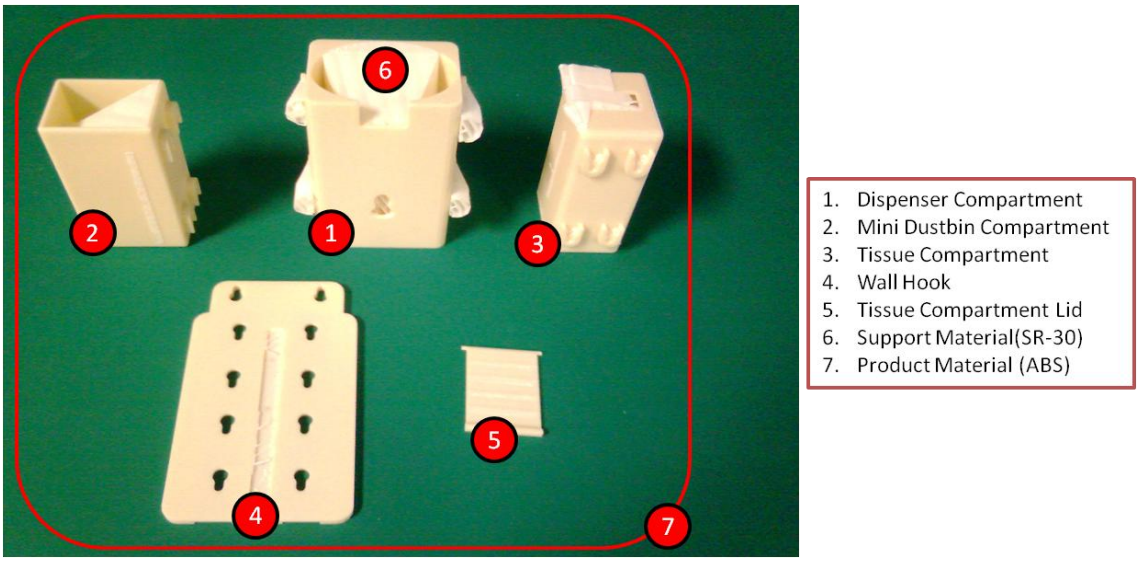

Figure 4.18: Prototyped product

4.6.2 Ultrasonic process

Since the prototyped product is build together with the support material (SR-30), therefore the prototyped product will be immersed in an ultrasonic solution for a few hours until the support material dissolved in the solution. The product will be placed in a special tray before being immersed in ultrasonic machines. The position of the product is as shown in figure 4.19. The product should be arranged as fit as possible with the tray bin to ensure the cleaning process is working well. Figure 4.20 shows the Ultrasonic cleaning machine. The temperature of the machine must not exceed than 90 degree Celsius to avoid the damage on the product based on product properties of materials. The maximum timing that can be set to machine is 30 minutes for each process. Therefore, the process should be repeated until the supports material is removed from the product. Figure 4.21 shows the finished multipurpose soap dispenser product.

Figure 4.19: Product before being immerse

Figure 4.20: Ultrasonic cleaner machine

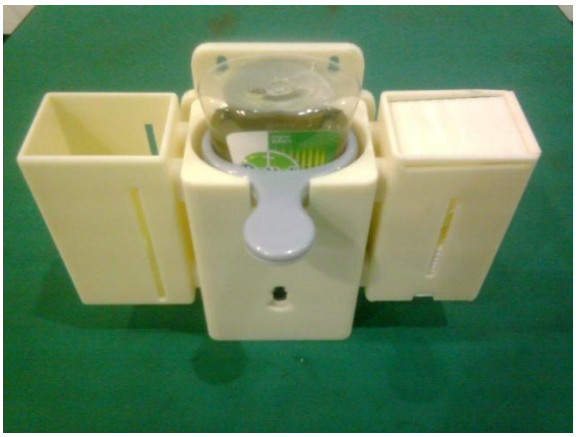

Figure 4.21: Product after being immersed in ultrasonic cleaner and assembled

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter reviews the overall conclusions which are made based on the results and analysis shown in the previous chapter. In the section 5.2 discusses on the conclusions of the study and section 5.3 discusses about the recommendations for future works.

5.2 CONCLUSIONS

The first chapter of this thesis provides a general background to the problem and defined the specific problem and the theoretical framework for the study. The specific problem is the current soap dispenser functions and design more focuses on to serve the liquid soap only rather than provide other functions to the user. The objectives of this project are to design and develop a new multipurpose soap dispenser that can meet current customer and market requirements. The next objective is to research the tools of idea and concept generation on developing a new multipurpose soap dispenser. The last objective is to enhance the ability and effectiveness of multipurpose soap dispenser that can suit to the usage environment.

Chapter 2 provides a review of literature related to the study which is New Product Development (NPD), product design process, factors impacting product design and Rapid Prototyping (RP) process. The major section concerning on the product

development process, discusses the process that involves in the idea generation and commercializing new products. The product development is the process of inventing new product to be sold and used by the customer. There are 5 processes in order to design a new product which is idea generation, product screening, preliminary design and testing the final design. The factors that impacting the product design consist of Design for Manufacturing (DFM), product life cycle, Concurrent Engineering (CE) and remanufacturing process. In order to produce a real part from the 3D drawing, therefore the rapid prototyping process has been selected for development process.

Chapter 3 describes the approach that used to develop the multipurpose soap dispenser. It describes the method on how to collect the data by survey activities, apply a few tools of idea generation then proceed to the design process and end up with a prototype product. The development of the product was starting by collecting the data about the current soap dispenser at the market and the satisfaction of the customer to the product. After the data gathered, then proceed to the idea generation and selection process by using Pugh Matrix concept. The finalized design and concept selected will be design and analyze virtually using CATIA 3D software. After the design is validated, then the rapid prototyping process can be executed to produce the multipurpose soap dispenser prototype.

Chapter 4 presents the conclusions to the development and validation of the multipurpose soap dispenser. First, section 4.2 details the results of the survey questionnaire including the expectations product requirements by the customers. Second, section 4.3 describes the analysis of competitive product at the market for the soap dispenser selections. The analysis is using Pugh Matrix selection concept. Third, section 4.4 present about the product concept generation and selection. Several concept of the product has been generated then select the best concept by using Pugh Matrix approach. Finally, the refined product concept and design is presented in section 4.5 and section 4.6. the refinement involved the generate detail product design analysis and rapid prototyping process to produce a real multipurpose soap dispenser prototypes.

5.3 LIMITATIONS AND RECOMMENDATIONS

The limitation of this project is the time and material sources constraints in carry out the research. Therefore, the survey results are achieved based on the limited sample size, covering only several places in Kuantan area. There are still many place located all over Kuantan that have a higher possibility of soap dispenser user. The material for Rapid Prototyping (RP) also is limited due to the canister cost price. Besides that, the availability of material for this prototyping process which is ABS and SR-30 (support material) is hard to find. Thus the design for a new multipurpose soap dispenser must consider for the material sources and use as low as possible volume of material or changes the material type and product design. Therefore, the future research should consider the time constraint and material use as well as to achieve high generalizability and validity.

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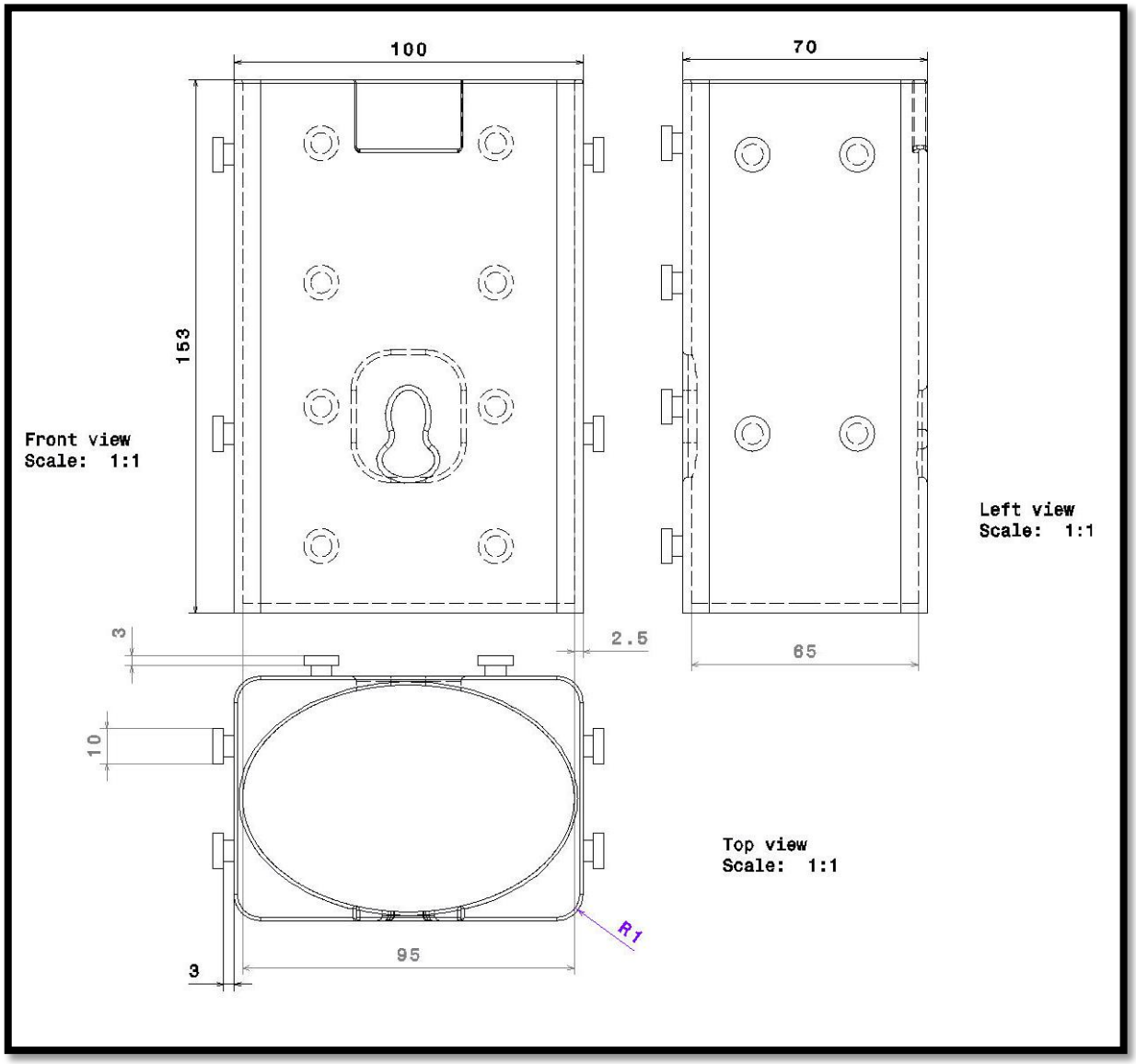
APPENDICES

APPENDIX A: GANTT CHART OF THE PROJECT

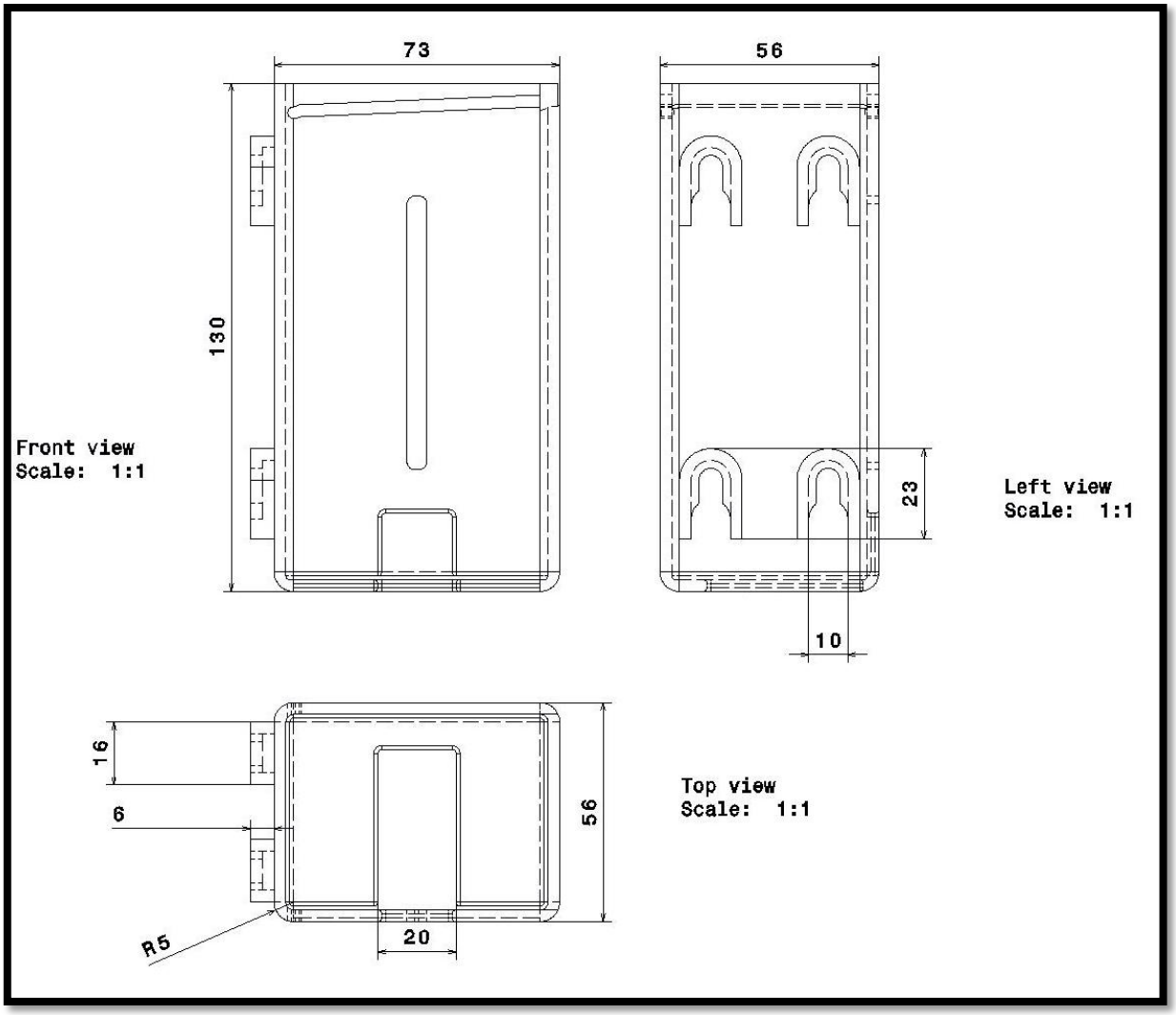
SEMESTER 1		**WEEK**													
TASK		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Briefing About Final Year Project	Plan														
	Actual														
Releasing Of Final Year Project Title	Plan														
	Actual														
Receiving Title Of The Project & Discussion	Plan														
	Actual														
Planning And Manage Gantt Chart	Plan														
	Actual														
Make An Analysis On Project Title (Literature Review)	Plan														
	Actual														
Development Of Project Methodology	Plan														
	Actual														
Present And Submit The Progress Of Report (Proposal)	Plan														
	Actual														

SEMESTER 2		**WEEK**													
TASK		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Develop and finalized a questionnaire	Plan														
	Actual														
Distribute Questionnaire to respondents and make an analysis using SPSS software	Plan														
	Actual														
Analysis on design selection process using 'Pugh Matrix' concept	Plan														
	Actual														
Design a 3D product using CATIA software	Plan														
	Actual														
Make an analysis on designed product	Plan														
	Actual														
Finish Up The Final Report And Project	Plan														
	Actual														
Preparing Final Slide Presentation	Plan														
	Actual														
Presentation of Final year Project	Plan														
	Actual														
Submit Final Year Report to Supervisor	Plan														
	Actual														

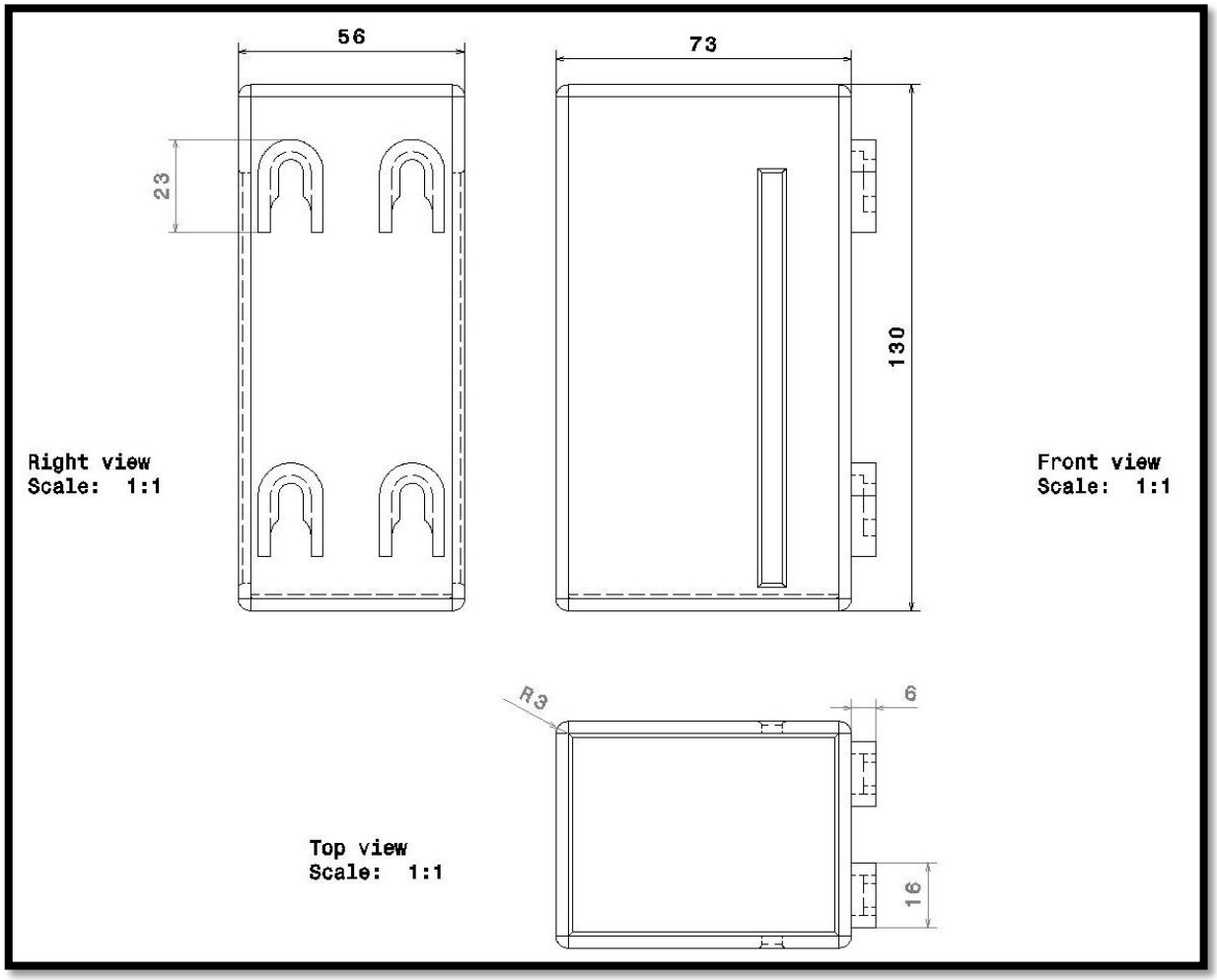
APPENDIX B: DETAIL DRAWING OF SOAP DISPENSER COMPARTMENT



APPENDIX C: DETAIL DRAWING OF TISSUE COMPARTMENT



APPENDIX D: DETAIL DRAWING OF MINI DUSTBIN COMPARTMENT



APPENDIX E: NEW MULTI-PURPOSE SOAP DISPENSER PROTOTYPE SURVEY

The purpose of this questionnaire is to help us gain an understanding of the people who will use Multi-Purpose Soap Dispenser, and to get any additional feedback about New Multi-Purpose Soap Dispenser.
We will use this information to try to ensure that New Multi-Purpose Soap Dispenser meets the needs of the people who will be using it.
All the information you provide is confidential. Your name is not stored with this questionnaire, and the information you provide will not be used for any other purpose.

1. AGES

☐ Under 20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 50 and Above

2. JOB FIELD

☐ Education ☐ Engineering ☐ Medical ☐ Government ☐ Others

3. DO YOU HAVE SOAP DISPENSER?

☐ Yes ☐ No

4. WHERE DO YOU ALWAYS FOUND SOAP DISPENSER?

☐ Home ☐ Office ☐ School ☐ Restaurant ☐ Others

5. WHEN DO YOU ALWAYS USE SOAP DISPENSER?

☐ During take a Bath ☐ After use a Toilet ☐ Washing a Hand ☐ Others

6. HOW OFTEN DO YOU USE SOAP DISPENSER DAILY?

☐ Always ☐ Frequently ☐ Occasionally ☐ Rarely ☐ Never

7. ON A SCALE OF 1 TO 5 BEING THE MOST SATISFACTION, HOW WOULD YOU DESCRIBE ABOUT THE CURRENT SOAP DISPENSER AT THE MARKET?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

8. FROM THE LIST OF FUNCTIONS BELOW, WHAT IS YOUR MOST RECOMMEND ADD-ON FOR THE NEW MULTI-PURPOSE SOAP DISPENSER?

☐ Tissue Dispenser ☐ Mini Dustbin ☐ Ashtray ☐ Box Compartment

9. PLEASE TICK HOW IMPORTANT THE FOLLOWING ITEMS ARE TO YOU IN YOUR DECISION FOR A NEW SOAP DISPENSER

CRITERIA	**NOT IMPORTANT**	**NEUTRAL**	**VERY IMPORTANT**
1.Size of the product	☐	☐	☐
2.Design of the product	☐	☐	☐
3.Shape of the product	☐	☐	☐
4.Weight of the product	☐	☐	☐
5. Functionality of the product	☐	☐	☐
6.Colour of the product	☐	☐	☐
7.Material of the product	☐	☐	☐

10. HOW OFTEN DO YOU THINK YOU WOULD USE THE PRODUCT AFTER IMPROVEMENT ON THE FUNCTIONS AND DESIGNS?

☐ Always ☐ Frequently ☐ Occasionally ☐ Rarely ☐ Never