A PRELIMINARY DESIGN OF THE MANUAL BREAST PUMP: AN ERGONOMICS APPROACH

NURUL SYAZRIN BINTI ROSLAN

BACHELOR OF ENGINEERING

UNIVERSITI MALAYSIA PAHANG

To

My parents and my family

Roslan b. Ramli

Che Zainun bt. Che Salleh

Mohd Idham Hafiz b. Roslan

Nur Illya Syazwani bt. Roslan

Mohd Farid Izzuddin b. Roslan

Izzah 'Atiqah bt. Roslan

for their tireless sacrifice, love and cheerful encouragement.

A PRELIMINARY DESIGN OF THE MANUAL BREAST PUMP: AN ERGONOMICS APPROACH

NURUL SYAZRIN BINTI ROSLAN

Report submitted in partial fulfilment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2009

UNIVERSITI MALAYSIA PAHANG

FACULTY OF MECHANICAL ENGINEERING

We certify that the project entitled preliminary design of the manual breast pump through an ergonomics approach is written by Nurul Syazrin binti Roslan. We have examined the final copy of this project and in our opinion; it is fully adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering. We herewith recommend that it be accepted in partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering.

Mr.Kumaran a/l Kadirgama ……

Examiner Signature

UNIVERSITI MALAYSIA PAHANG

FACULTY OF MECHANICAL ENGINEERING

We certify that the project entitled preliminary design of the manual breast pump through an ergonomics approach is written by Nurul Syazrin binti Roslan. We have examined the final copy of this project and in our opinion; it is fully adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering. We herewith recommend that it be accepted in partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering.

Mr.Muhamad bin Mat Noor ……

Examiner Signature

SUPERVISOR'S DECLARATION

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 Mechanical Engineering.

Signature:
Name of Supervisor: MDM. NURUL SHAHIDA BINTI MOHD SHALAHIM
Position: LECTURER
Date: 12 NOVEMBER 2009

STUDENT'S DECLARATION

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.

Signature
Name: NURUL SYAZRIN BINTI ROSLAN
ID Number: MA06047
Date: 12 NOVEMBER 2009

ACKNOWLEDGEMENTS

I am grateful and would like to express my sincere gratitude to my supervisor Madam Nurul Shahida binti Mohd Shalahim for her germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. She has always impressed me with her outstanding professional conduct and the time waste to guide me.

Very special thanks to my colleagues in Universiti Malaysia Pahang that always support me with the ideas and sometimes helping me with the problems that occurred during the project. I am also wants to thank Dr. Ahmad Syahrizan bin Sulaiman and Mr. Lee Giok Chui for their time and ideas.

I acknowledge my sincere indebtedness and gratitude to my parents Madam Che Zainun binti Che Salleh and Mr. Roslan bin Ramli for their love, dream and sacrifice throughout my life and also my siblings for their willingness to help me in this research.

And finally, I would like to thank to someone who doesn't want to be named but he knows who he is and so do I.

ABSTRACT

This study is to design the manual breast pump with an ergonomics approach. The problem statement of the study is to solve the musculoskeletal problems among mothers especially those who feed their babies using the manual breast pump. Meanwhile, the objectives for this study is to design a manual breast pump with an ergonomics approach using the Solidwork and to analyze the designed manual breast pump using the manual calculation. The methodology for this project used the survey instrument which is questionnaires and the software for the design stage. Result is the chapter where the analysis of the questionnaires that were distributed to the respondents. It is also included the analysis of the main part using the manual calculation. Lastly, it recovers the conclusion for the project. The study hopefully can help the future researcher in order to create and develop the new design for the manual breast pump.

ABSTRAK

Tujuan projek ini adalah untuk merekacipta *breast pump* manual dengan menggunakan kaedah ergonomik. Pernyataan masalah untuk projek ini adalah untuk menyelesaikan masalah otot atau *musculoskeletal disorders* terutamanya dikalangan ibu yang menggunakan *breast pump* manual untuk memberi susu kepada anak mereka. Selain itu, objektif utama projek ini adalah untuk merekacipta *breast pump* manual mengikut aspek ergonomik mengunakan Solidwork dan menganalisis menggunakan kira-kira manual. Kaedah untuk projek ini menggunakan peralatan untuk tinjauan iaitu soalan kaji selidik dan perisian untuk merekacipta. Hasil ialah bab di mana penganalisis soalan kaji selidik ditunjukkan setelah soalan kaji selidik diagihkan kepada ibu-ibu. Ia juga termasuk dengan kira-kira menggunakan rumus yang disediakan. Akhir sekali adalah kesimpulan untuk projek ini. Tesis ini diharap dapat membantu penyelidik lain di masa akan datang dalam merekacipta dan meningkatkan penggunaan *breast pump* manual.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

A	Contact surface area
F	Force that exerted to the hand
MSD	Musculoskeletal Disorders
P	Pressure

LIST OF FORMULAE

$P = FA$

CHAPTER 1

INTRODUCTION AND GENERAL INFORMATION

1.1 INTRODUCTION

Nowadays, most of the mothers have to breast feed their babies anytime, anywhere and whenever they go travel. In this important situation, they had to choose the most suitable breast pump in order to make sure they still can give the best and proper care to their children. Breast milk is ultimately the best source of nutrition for newborns. It is also prepares the best immune's system to protect against viruses and bacteria. But breast-feeding isn't always a smooth and easy process (Bregram T, Fride E. and Kirkam TC.,2005).

In order to choose the best breast pump, they have to consider several criteria such as in ergonomic ways, whether it is comfortable, easy to use, or the price. A breast pump is indispensable in several number of scenarios such as you want to continue breast-feeding but have to return to work, need to formula-feed your baby temporarily for medical reasons but want to resume breast-feeding when you get the permission from your doctor, or even the need to occasionally miss a feeding because you're traveling or be far away from your baby. A breast pump allows you to store milk in bottles or storage bags for later, then bottle-feed it to your baby or mix a little in cereal when he or she reaches the "solid" food stage. Mothers can refrigerate breast milk safely for five to seven days, or freeze it for up to a year ((Bregram T, Fride E. and Kirkam TC.,2005).

Most of the breast pumps were designed to satisfy the needed and the most important, the health of mothers. In order to avoid the musculoskeletal disorder problems (MSD), the project is created on designing the manual breast pump in

ergonomics way. The MSD problem is a condition where a part of musculoskeletal system is injured over time. The disorder occur when a body part is continually use to work hard, stretch farther, impact more directly or otherwise functions at a greater level then it is suppose to. The immediate impact may be minute, but when it occurs repeatedly the constant trauma cause damage. These conditions are often focused on a joint and affect the muscle and bone. However other areas can be strained and their response to that trauma may be an injury (Spence, 1990).

In this project, it is mainly focusing on breast pump that will be designed considering the ergonomics criteria. Several aspects are considered such as the safety, the comfort when use, the handling method, productivity or performance of the product (International Ergonomics Association, 2008).

1.2 PROJECT OBJECTIVES

There are several objectives that have to be achieved in this project:

(i) To design a manual breast pump with ergonomics approach using Solidworks™.
(ii) To analyze the designed manual breast pump using manual calculation.

1.3 PROJECT SCOPES

The developed manual breast pump is only on preliminary stage and only theoretical data will be considered in developing the product.

1.4 PROBLEM STATEMENTS

This project is to solve the musculoskeletal problems among mothers especially those who breast feed their babies using the manual breast pump. Currently, there are very few studies have been done for such a function. We are going to produce a manual breast pump that will adapt the ergonomics criteria. In order to achieve this main goal, we are going to tackle some of the problems associated with the musculoskeletal disorders.

1.5 THESIS ORGANIZATION

This thesis will be divided into five chapters. First chapter, which is introduction to the thesis, is a briefing about the project's idea and the information about the breast pump. It also included the major concern of the project that is ergonomics which will be applied in the design process of the breast pump. There will also include the problem statement, scopes of the project, and objectives included.

Second chapter is for the literature review. This chapter will discuss about the history of breast pump and some information about their application in mother's world. This chapter also includes the briefing and the main idea about the ergonomics before we applied it in the design chapter. The details information about the project is also stated.

The third chapter is methodology. This chapter is about the method used and the progress of the project. For the design process, there are several numbers of steps need to be completed before achieving the goals such as, the distribution of the questionnaire on breast pump to the user, doing the sketching of the design, and the analysis of the collected data. This project used Solidwork™ in the designing process which is for the sketching process. The sketching process included two different parts which first are based on the literature review and second are based on the data that collected from the analysis of the distributed questionnaires. After the final design is selected which are based on the data, the design then will be analyzed using the manual calculation. Only critical parts are analyzed in these processes which are the pump, the funnel, the valve cap and the tube.

Next chapter is chapter four which is for the data analysis and finding for questionnaire. The collected data will be analyzed and the results will be shown graphically or in tables. This will help readers to understand more about user's interest, opinions and recommendation regarding on the current breast pumps design. This information will be applied in the designing process which it can complete some of the part of the body such as hand, that should be considered in order to avoid the MSD. It

also gives some important knowledge about the common problems that users usually faced while using the current breast pump. This chapter also included the result from the survey, the drawing using Solidwork™, and the analysis using manual calculation.

The last chapter is for the conclusion. The problems and the recommendation are also stated in this chapter. It is important for the use of future study.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, it will discuss about the findings on several topic which is considers important to this research. The topic is divided into three subtopics which are breast pump, musculoskeletal disorders and ergonomics. The research then is summarized according to the definition, the history, the previous findings or information. The information and the review are taken from the journals, books, and information from the websites.

2.2 BREAST PUMP

This subchapter is about the study on the previous types of currently manual breast pump. What is meant by breast pump? Is it a tool which helps mothers to suck the milk from their breasts because of some problems using natural way? Or is it a tool that can help you to store the milk during the travelling? Breast pump is designed to apply vacuum to the nipple and areola to draw them into the tunnel of the breast shield also called funnel or flange in the same way that a baby draws the areola into his mouth. If the breast shield is an appropriate size, the angle at the entrance of the tunnel will apply gentle pressure at the same area on the areola where the baby's gums apply pressure to suckle and remove milk. Therefore, it is imperative that the nipple and areola move in and out of the shield freely, without touching the sides of the funnel. A breast pump does not work in isolation but it works in conjunction with the milk ejection reflex (E. Jones and Spencer, 2007). Expressing milk has different meanings for each mother. Some see it as a way to continue providing breastmilk in their absence, especially in families with a history of allergies. Some mothers prefer to express milk by hand because they obtain

as much milk in as quick a time as they do when using a pump. Other mothers view pumping as part of a reaction that is reinforced every 2 to 3 hours when they must use a pump in the absence of a baby at breast.

There are several manual breast pumps that exist rely on differing mechanisms to generate suction. Due to the research on several books, the types of the manual breast pumps are shown in the table 2.1 below.

Table 2.1 Types of Manual Breast Pump

TYPES	DESCRIPTION
1) Rubber bulb models (Fewtrell M et al., 2001)	• Squeezing and releasing a rubber bulb generates a vacuum. • Rubber bulb is attached directly to the collection container. • Some manufacturers separated the bulb from the collection container by modifying the angle at which it is attached so the pump or by adding a length of tubing – this modifications were thought to reduce the high potential for bacterial contamination of the bulb caused by the easy backflow of milk. • Vacuum control on these pumps is extremely difficult – increasing the nipple pain and damage. • Pressure – type bulb –vacuum control is left to chance. • Inexpensive, collect only about one half ounce of milk, must be emptied frequently. • Mothers complain of nipple pain during pumping and low milk yields.

Table 2.1 Continues

2) Cylinder – Pumps Models (Arnold LDW., 1999)	• The outer cylinder generates vacuum as it is pulled away from the body. • The inner cylinder with the flange is placed against the breast; a gasket at the other end helps form a seal with the edge of the outer cylinder.Gasket may need to be replaced occasionally if they dry out, or lose their ability to form a seal. • Can harbor bacteria and must be removed during cleaning, contrary to some user instructions. • When placing the gasket back on the cylinder, roll it back and forth over the cylinder to help restore the shape. • Some pumps come with extra gaskets. • Small plastic or silicone inserts can be placed in the inner opening to custom fit the pump to the breast. • Silicon liners; designed to collapse against the breast during the suction phase to provide external posture. • This type is lightweight, not too expensive, easily cleaned.
3) Squeeze – Handle Models (Grob – Wargo S et al, 1996)	• Typically used for occasional pumping and are a type that can be used when no electricity is available. • Easily cleaned but their operation may present difficulties for women with hand or arm problems, such as arthritis. • The hand and wrist can tire easily with repeated use.

In the nutshell, we can summarize that the manual breast pumps are easy to find and inexpensive. These pumps are typically used in the short–term or occasionally. Some of the benefits that listed down by Women's Health Care are they are typically silent and thus more discreet than an electric, which can be quite noisy at times. They also allow you to control the intensity of suction to mimic your baby's sucking more closely. In addition, they can suit one of ergonomics criteria which they are extremely lightweight and portable. They cost a fraction of what some more elaborate electric models do. But, if they are not designed according to suitable criteria or techniques,

they maybe give some disadvantages that will lead to diseases or MSD. The hand and wrist can tire easily with repeated use. Some problems that can occur from the repeated use are one of Musculoskeletal Disorders (MSD). In this project, the problems that mothers have to face during using the pumps should be considered for the comfort use. The parts maybe related to this project are the hand, the wrist and the arm. The MSD description and information will be explained more in the next subchapter.

2.3 MUSCULOSKLETAL DISORDERS

This second of subchapter explains about the study on the related Musculoskeletal Disorders (MSD) that occurs due to the repeated use. Through the research, there are several studies about the problems that occur during using the working tools as it is not in ergonomics way. The definition of the MSD according to Spence, S. (1990), an injury that affects the bones, muscles, or other related tissues of the body joints.

The MSD is divided into two categories which are:

(i) Conditions caused by trauma, such as a slip or fall resulting in, for example, a strained back, bruised leg, or sprained ankle;
(ii) Conditions due to exposure to a repeated, a chronic, type of physical activity, resulting in, for example, soreness from inflamed tendons or ligaments.

There are parts of body that will be considered and related to my project which are the hand, the wrist, the elbow and the backrest. The fingers of the hand are referred to by name that is starting with the thumb, then the index, middle, ring and little fingers. The ranges of movement at the complex joints in the fingers at the wrist vary greatly between individuals and generally reduce with age and onset of arthritic disease. Brumfield and Champoux (1984) found that daily activities such as eating, reading and making a telephone call can be accomplished with motions of the wrist between 5°

flexion and 35° extension, while for personal care activities such as washing, dressing and others, the range is 10° flexion to 15° extension.

There are some figures of the hand and wrist postures. Figure 2.1 shows a number of hand and wrist postures. The movement of flexion, extension and radial and ulnar deviation occur at the wrist joint complex that is at the radiocarpal joint and at the various articulations which are presents between the eight small bones of the wrist. Ulnar deviation is sometimes known as ‘adduction’ of the wrist and radial deviation as ‘abduction. This information is considered because of the hand will do the activities that lead to the extension of the joint and will cause to the MSD. Some of the information should be considered trough ergonomics terms in order to design the best manual breast pump especially the part that use the hand to control it.

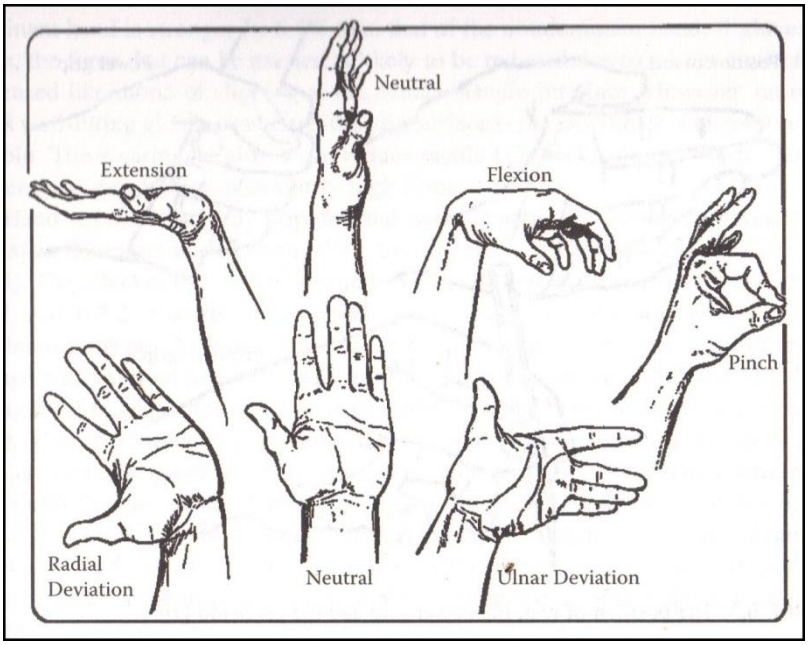


Figure 2.1 Hand and Wrist Postures (From Putz-Anderson, V. (1998). Cumulative Trauma Disordes.

In practice, however, the natural hand movements we use in everyday life often entail actions of pronation and supination in combination with movements occurring at the wrist. The findings recover that the same thing for overuse injuries to the hand, wrist and arm, which are endemic in people who do repetitive hand-intensive work on

industrial assembly lines. It has been known for over 5 years that people who work on industrial assembly parts are liable to suffer from these sorts of conditions.

Next part that related to this project is the position of arm. The position of the armrest is when the wrist in its neutral position, the long axis of a cylindrical handle that is held firmly in the hand makes an angle of 100 to 110° to axis of the different lengths (Pheasant, S. T., 1991). Through the research, the degree of bend should be provided for different tools. This cannot simply be decided by aligning the tools axis with the neutral wrist posture when the tool is held statically in the hand. The use of the tool may involve complex motions, and some tools are used for variety of tasks. A design compromise may be needed to achieve good usability and adequate speed of work at the same time as minimizing wrist deviation.

As a summary, there are numbers of techniques should be approached to ensure that the risks such as MSD can be avoided. Mothers usually use their effort and all forces at the hand in pressing or squeezing the pumps. So the hands maybe will feel tired and this will lead to the MSD. Due to the research on MSD, some of factors that lead to MSD should be avoided during the design process. Some of the factor that should be considered is the posture during the expressing activities whether the arm, hand or vertebra posture. In this project, the theoretical approach is ergonomics which can help in avoiding the MSD. The history and principles are discussed in the next chapter.

2.4 TECHNIQUE APPROACH

In this subchapter, the techniques approach is the ergonomics. It will discuss about the term, the criteria that should be applied in designing the tools, the principles and the example of previous findings on ergonomics.

2.4.1 Ergonomics

Ergonomics is the science of work of the people who do it and the ways it is done, of the tools and equipment they use, the places they work in, and the psychosocial

aspects of the working situation. It is also the scientific discipline concerned with designing according to human needs, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. The field is also called human engineering, and human factors (Stephen Pheasant and Christine M. Haslegrave, 2006).

2.4.2 History of Ergonomics

The word “ergonomics” is derived from Greek Word “ergon” that means work and “nomos” that means law. In the United State, term ergonomics is also known as “human factor”. A short and snappy definition of ergonomics would be that ergonomics aims to design appliance, technical system and task in a way that can improve human safety, health and comfort without sacrifice the performance and efficiency for that particular design (International Ergonomics Association, 2008).

In the work environment, the selection and creation of tools, machines, and work processes continued. Over centuries, the effectiveness of hammers, axes and plows improved. With the Industrial Revolution, machines such as the spinning jenny (a machine that produced yarn to make cloth) and rolling mills (a method of flattening iron ore into flat sheets) were developed to improve work processes. This is the same motivation behind much of ergonomics today. The association between occupations and musculoskeletal injuries was documented centuries ago. Wojciech Jastrzebowski created the word ergonomics in 1857 in a philosophical narrative, "based upon the truths drawn from the Science of Nature" (Jastrzebowski, 1857). In the early 1900's, the production of industry was still largely dependent on human power/motion and ergonomic concepts were developing to improve worker productivity. Scientific Management, a method that improved worker efficiency by improving the job process, became popular.

After World War II, the focus of concern expanded to include worker safety as well as productivity. Research began in a variety of areas such as muscle force required to perform manual tasks, compressive low back disk force when lifting, cardiovascular response when performing heavy labor, perceived maximum load that can be carried,

pushed or pulled. Areas of knowledge that involved human behavior and attributes for example, decision making process, organization design, human perception relative to design became known as cognitive ergonomics or human factors. Areas of knowledge that involved physical aspects of the workplace and human abilities such as force required to lift, vibration and reaches became known as industrial ergonomics or ergonomics (Sperling L., Dahlman S., 1993)

After certain years, modern ergonomics was introduced. Modern ergonomics differ from conventional ergonomics as modern ergonomics only contributed to design and evaluation of work system and product. For conventional ergonomics, engineer design a whole machine or product.

2.4.3 Principles of Ergonomics

Through the review, ergonomics have some criteria that should be considered in design and also to make sure the productive of the product to the consumers. This criteria or aspects are based on the principle of ergonomics that are listed down by International Ergonomics Association. First is safety, for example in designing the medicine bottles. The print on them could be larger so that a sick person who may have impaired vision can more easily see the dosages and labels. Ergonomics could design the print style, color and size for optimal viewing. Second is the comfort. An example for the comfort is in designing the alarm clock. Some displays are harshly bright, drawing one's eye to the light when surroundings are dark. Ergonomic principles could redesign this based on contrast principles.

Third is the ease of use which for example applied in street signs design. In a strange area, many times it is difficult to spot street signs. This could be addressed with the principles of visual detection in ergonomics. Fourth is the productivity or the performance. This criterion is applied in designing the HD TV. The sound on HD TV is much lower than regular TV. So when the switch on from HD to regular, the volume increases dramatically. Ergonomics recognizes that this difference in decibel level creates a difference in loudness and hurts human ears and this could be solved by evening out the decibel levels.

There are several studies on the principles and the previous findings of ergonomics about the hand tool design. The findings is summarize in the table 2.2.

Table 2.2 The Principles and The Previous Findings

Title of Journal/Book	Principles
1. Folk Norms and Biomechanics (Drills R. J, 1963).	Six basic requirements for properly designed hand held tools: • Should effectively perform the function for which it was intended; • Should be properly proportioned to the body dimensions of the operator; • Should be suitable adjusted to strength and work capacity of the operator; • Should not cause premature fatigue; • Must provide feedback such as surface texture, temperature, and force to the operator, and • Should be inexpensive and easy to maintain.
2. Industrial Ergonomics (Konz S. 1990).	Outline the following principles for the design and selection of hand tools: • Use special-purpose tools, • Design tools to be used by either hand, • Power with motors rather than with muscles, • Use a power grip for power and precision grip for precision, • Make the grip the proper thickness, shape and length, • Design the grip surface to be compressible, nonconductive, and smooth, • Consider the angles of the forearm, grip, and tool,.

Table 2.2 Continues

3. Designing workstation (Waldemar Kaewoski and Gavriel Salvendy, 1998).	• Height of the working surface should maintain a definite relationship with the operator elbow height, depending on the type of work • The maximum reach can be consider as the boundary on the work surface in front of an operator that he/she can reach without flexing his own/her torso • The minimum lateral clearance at waist level are determined by adding 5 cm on both side or 10 cm to hip breadth(standing position).
4. Ergonomics for beginner (Jan Dul and Bernard Weerdmeester, 2001)	• Activities where considerable force has to be exerted or where the work place has to be frequently changed should be carried out in standing position • Guideline for work carried in standing position ▪ Alternate standing with sitting and walking ▪ Work height depend on the task ▪ Height of the work table must be adjustable ▪ Avoid using platform Provide sufficient room for legs and feet.

As the conclusion, designers and engineers can apply the basic principles of ergonomics and safety to the design and selection of hand held tools to reduce injury incident rate. Administrative measures can minimize exposure to the repetitive tasks, thereby improving productivity and reducing the risk of injury. We also have to consider the satisfaction of the consumer as they will use our product and the effects are faced by them.

2.5 RESULTS

This subchapter discusses the design sketches based on the literature review. The design again will be sketches after receiving the data and analyzed using the

Microsoft Excel. The briefing for each figure will be included in the next table beside the figures.

2.5.1 Design

In this study, the data used is anthropometry data and it is defined as measurement of the dimensions of the body and other physical characteristics. Due to the limited source on Malaysian population, this study will used the anthropometry data of Thailand population as it is quite similar to Malaysian. The design will use the data as it will give the comfort ability to the user. The data helps the designer or engineer to design the things or gadget in order to fix and help in living the better life. The anthropometry data for Thailand population will be included in the appendix.

Figure 2.2, 2.3 and 2.4 are the examples of the current manual breast pump. This figure has several parts that should have on the breast pump which are the funnel, the valve cap, the tube, the pump and the bottle.

Figure 2.2 The Manual Breast Pump (www.drbrownsmanualbreastpump.com)

Figure 2.3 The Manual Breast Pump (www.fda.gov)

Figure 2.4 The Manual Breast Pump (http://www.babyworld.co.uk)

After considering these three current manual breast pumps, there are five crucial parts which are the funnel, the manual pump, the bottle, the valve and the valve cap. And thus, I came out with the preliminary design which is totally depending on the literature review which is shown in figure 2.5. Figure 2.5 is the figure of the first design that based on the literature review. The description for each part is in the table 2.3.

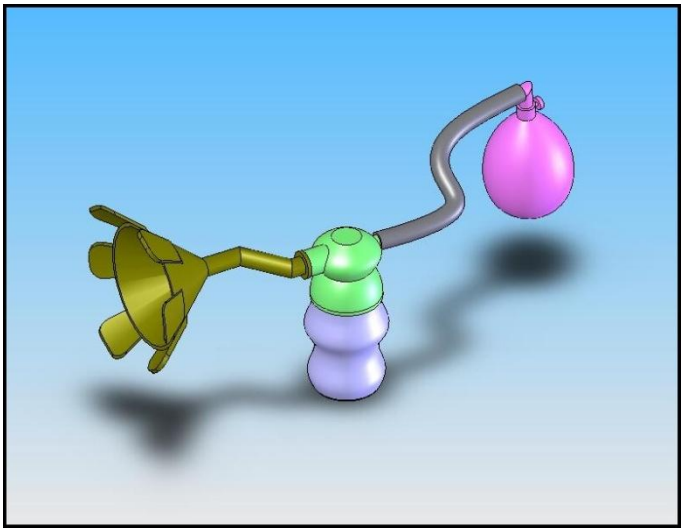


Figure 2.5 Manual Breast Pump Based on Literature Review

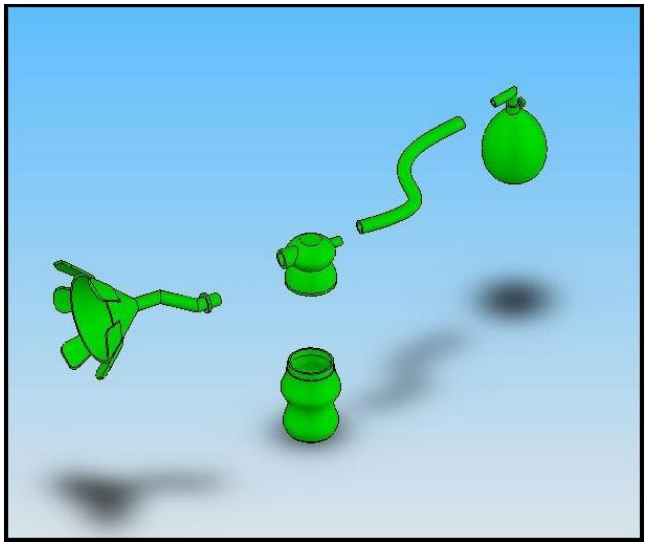


Figure 2.6 Manual Breast Pump Based on Literature Review (exploded view)

Table 2.3 Description for the Manual Breast Pump

Parts	Descriptions
 The Funnel	• The petals are created to place the silicon cushions. As you pump, the petals gently massaging your breast. The silicon cushions also will be placed inside the funnel where their functioning are to massage the area around your nipple (areola), stimulating your breast to express milk comfortably and painlessly. It imitates perfectly the way your baby breast feeds. • Additionally, the unique angled cup neck helps to prevent milk backflow and drips while pumping.
 The Bottle	• The design of shape is chose because it is easy to hold. The design also considers the "Power Grips", in which the fingers are used to clamp the objects. • The shape is to reduce the pressure point that can lead to uncomfortable feeling and can cause restrain in nerve function as well as blood flow.
 The Pump	• The pump is design because it is easy to grip and squeeze. The ability to exert a pressing will generally be greatest with a power or hook grip and least if the handle is small that only a pinch grip can be used. • According to anthropometry data for Thailand people, for female are: hand breadth: 7.77 mm hand length: 17.84 mm.

Table 2.3 Continues

 The Tube	• The tube is design according to the position of armrest. The position of armrest is when the wrist in its neutral position, the long axis of a cylindrical handle that is held firmly in the hand makes an angle of 100 to 110° to axis of the different lengths.

The design is based on the literature review and the criteria are considered such as the arm and the hand position. The design will be finalized after the collected data analyzed.

2.6 DESIGN SKETCHING METHOD

2.6.1 Solidwork

This software works faster through unmatched performance and ease-of-use, including familiar Windows® functions like drag-and-drop, point-and-click, and cut-and-paste. With SolidWorks™ software, design data is 100% editable, and relationships between parts, assemblies, and drawings always stay up-to-date (Solidwork Corporation, 2001)

The parts have to be assembled to view the actual shape or imagine the function. With the Solidwork™, the assembly work becomes easy. We can reference other parts directly and maintain relationship when creating new parts. Besides that, we can view assemblies in full motion with dynamic assembly motion and observe the interaction of moving components with dynamic collision detection and clearance.

2.7 DATA COLLECTION METHOD

The data should be collected for the purpose of analysis and helping in improvement of the breast pump. There are many types of collecting data such as

questionnaires, interview and observational surveys. Neuman (2000) identified three different types of surveys. The advantages and disadvantages are presented in table 2.4.

The following are the explanations of each of the survey methods summarized in Table 2.4.

Table 2.4 Survey Methods

Features	Questionnaire	Face to Face Interview	Telephone Interview
Administrative Issues			
Cost	Cheapest	Moderate	Expensive
Speed	Slowest	Fastest	Slow to Moderate
Length	Moderate	Short	Longest
Response Rate	Lowest	Moderate	Highest
Research Control			
Probes Possible	No	Yes	Yes
Specific Respondent	No	Yes	Yes
Question Sequence	No	Yes	Yes
Only One Respondent	No	Yes	Yes
Visual Observation	No	No	Yes
Success With Different Questions			
Visual Aids	Limited	None	Yes
Open-Ended Questions	Limited	Limited	Yes
Contingency Questions	Limited	Yes	Yes
Sensitive Questions	Limited	Limited	Yes
	Limited	Some	Some
Sources of Bias			
Social Desirability	No	Some	Worse
Interview Bias	No	Some	Worse
Respondents Reading Skills	Yes	No	No

2.7.1 Mail and Self-administered Questionnaires

In this type of survey, questionnaires are sent directly to respondents and it is by far and cheapest type of survey (Neuman, 2000). In this past, this type of survey was conducted primarily via the postal system, but with improvements in technology and the availability of email and the World Wide Web, questionnaires can now be administered electronically. This type of survey can therefore enable the targeting of very large

samples either locally or over much wider geographical areas. This type of survey also offers the greatest level of anonymity, as there is no direct contact with respondents. This lack of direct contact also has the added advantage of eliminating interviewer bias (Neuman, 2000).

This type of survey is still the most popular and convenient method for model testing and refinement. In this instance, this method was selected as it satisfied the criteria relating to the need to target a large, geographically dispersed sample, in a very limited period.

2.7.2 Telephone Interview

Telephones interviews are another popular type of survey and may be thought of as a compromise between mail surveys and face-to-face interviews and therefore combine many of the advantages of each type (Sekaran, 2000). First in the list of disadvantages is the fact that a high percentage of the population can be reached by telephone and this almost guarantees an intermediate response (Neuman, 2000). However, this also presents the possible disadvantage that it may not always be convenient for the target to respond to questions. Naturally, this type of survey tends to be more expensive than a mail survey. In addition, the interview periods must be short as it may not be convenient or cost effective to hold long interviews over the telephone.

2.7.3 Face-to-Face Interviews

This type of survey has the distinct advantage of providing the highest response rate compared to the other two types. In addition, this type of survey has all advantages of telephone interviews and with the added advantage of allowing for longer interview periods. This feature therefore provides the opportunity to ask all types of questions including very complex questions that could not otherwise be asked in a brief questionnaire. Further, the face-to-face interview is the only survey type that allows the interviewer to observe both the respondent in their element and their reactions to the question posed (Neuman, 2000). However, this type does have the disadvantage of having the highest cost, particularly with the large samples, in that interviews may need

to be conducted by a number of researchers who may require to be paid some form of allowances.

From the research, this project used the questionnaires method. Questionnaire design is one of most critical stages in the research process (Zikmund, 2000). Good questionnaire design should focus upon three areas that were summarized in the table 3.2 (Sekaran, 2000). The principles are included the wording of the questions, the principle of measurement and general appearance of the questionnaire summarized in Table 2.5.

Table 2.5 The Principles of The Questionnaire Method

AREAS	DESCRIPTIONS
1. The wording principles of the questions.	These principles relate to biases resulting from respondents' responses and the questionnaire itself. Consistent with these principles, the following factors were considered during the development of the questionnaire used in this study: • The questionnaire used simple language to approximate the understanding level of the respondents. • Closed questions with alternative answers were chosen as they help the respondents to make a quick answer. • The purpose of each question was scrutinized to minimize unnecessary questions. • The length of the questions was kept as shortly as possible. Ambiguous, double barreled, leading and loaded questions were also considered to minimize confusion and bias of responses.
2. The principle of measurement	These principles are concerned with reliability and validity of data to be analyzed. Considering that the development of the questionnaire was based on principles of suggested above, combined with the use multi item scales, the 22 questionnaire used in this study could increase reliability and validity of the collected data (Pedhazur and

Table 2.5 Continues

	Schmelkin, 1993)
3. General appearance of the questionnaire	An attractive and neat questionnaire with appropriate instruction, and a well arrayed set of questions and response alternatives will facilitate the respondents in understanding and answering the questions. However, the general appearance of the questionnaire is not an important aspect in this study, because the study employed structured interview for the data collection.

2.7.4 Analysis Method for Questionnaires

The analysis for the questionnaires will be completed using the Microsoft Excel. Microsoft Excel is a spreadsheet-application written and distributed by Microsoft for Microsoft Windows and Mac OS X. It features calculation, graphing tools, pivot tables and a macro programming language called VBA (Visual Basic for Applications). It has been the most widely used spreadsheet application available for these platforms since version 5 in 1993. The software is suitable used in analyzed the data for the questionnaires.

There are some benefits using the software which are it can keep record, the data can be displays using the graphs and to perform the calculations automatically.

2.8 SUMMARY

This chapter is the description of the literature review of the software and the concept that used during the project. It describes the research design and the data collection methods which is questionnaires and a brief description of alternatives methods and why they are not chosen.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter is about the methodology used in this project. The explanation of the justification of the questionnaires is included in this chapter. Besides that, the properties of material are also discussed as it is one of the important criterions in order to design any good.

3.2 FLOW CHART OF THE PROJECT

Figure 3.1 show the flow chart of the project. This flow chart is simplifying the methodology for the project. It is show the step takes to complete the project.

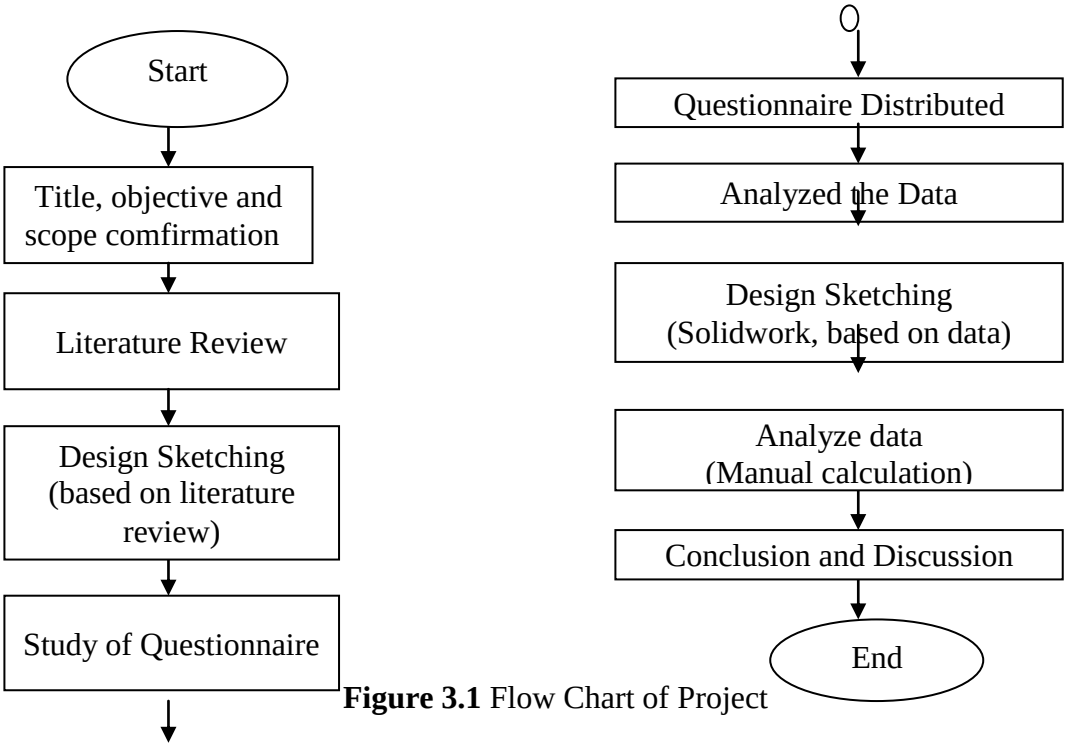


Figure 3.1 Flow Chart of Project

3.3 DESIGNING QUESTIONNAIRE

In order to get information from the respondents, the questionnaire is used. Questionnaire has been decided as a way for a survey based on several factors which are:

(i) Money constrain
(ii) Time constrain
(iii)Simplest ways to conduct survey but effective

3.3.1 Justification of Questionnaire

The questionnaires included multi items and variables. Section one contains 3 items of consumer's information, while section two contains of breastfeed details. Section three is the breast pump details consists of 9 items. Then, section four consists of 6 items is about the information about the body posture. This study focuses on three sections that are section B, C and D which will help to give the information for the improvement for the future design. The overall layout of interest in the questionnaire is shown in table 3.1.

Table 3.1 The Justification of Questionnaire according to the Section

Section	Variable	No. of Items
B	1. Objectives of breast pump 2. Famous type of breast pump. 3. Breastfeeding activities	6
C	1. Duration of breastfeeding activities. 2. Problems using breast pump. 3. The important criteria choose by consumers.	9

Table 3.1 Continues

D	1. Posture detail. 2. Factor of MSD	6
TOTAL		21

3.3.1.1 Section B

This section contains 6 questions. All questions in this section required the respondents to answer the question in the space provided. The three items are shown in table 3.2.

Table 3.2 Justification of Section B

Items	Justification
Duration for nursing	To know the time provided for breastfeed activities.
Plan to breastfeed	To know the time planning for mothers to breastfeed.
Status of breast pump	To know whether mothers using the pump or not.
Type of pump	To know the famous type of breast pump used.
Bra cup size	To know the common size for the breast shield.
Position used during breastfeed activities	To know the best position during breastfeed for example, sit, lay and stand.

3.3.1.2 Section C

This section included 9 questions related to the information for the design process. The justification of the section C is shown in table 3.3. This section included the information about breast pump and opinion for the future breast pump.

Table 3.3 Justification of Section C

Items	Justification
Pressing activities	To know how many pressing provided to fill the bottle.
Travelling information	To know whether mothers travel or not.
Status of breast pump	To know whether breast pump is needed or not during the travel.
Problems using the current breast pump	To know what type of problems are mothers facing while using the breast pump.
Pump information	To know whether the current pump is sufficient enough or not.
Breast pump information	To know the comfortable or comment using the current breast pump.
Problems	To know the common part of body that feels the pain.
Breast pump information	To know some opinions from mothers for the design process.
Ergonomics Criteria	To know which ergonomics criteria attract most.

3.3.1.3 Section D

This section consists of 6 questions with the aim of information about posture during breastfeed and holding the breast pump. This question required the respondents to circle their answers according to scale that shown in table. The justification is shown in table 3.4.

Table 3.4 Justification of Section D

Items	Justification
Problems of using breast pump	To know the posture during breastfeeding gives the respondents back pain(one of the musculoskeletal disorders)
Posture	To know the posture during the breastfeeding.

Table 3.4 Continues

Posture	To gather information whether if the posture is the factor that leads to MSD.
Force applied	To know whether the part easy to feel tired.
Arm position	To know the opinion from the respondents if the position is the best position during using the breast pump.

3.4 MATERIAL SELECTION

The material selection for the parts which are the bottle, the funnel, the tube and the manual pump is silicon rubber. The properties of the silicon rubber are suitable for the part. It has its own advantages. Properties that have made this family of rubbers important engineering materials include (Amirkhanian, S. and Franzese, W., 2001):

(i) Good thermal stability
(ii) Constancy of properties over a wide temperature range leading to large operating range (e.g. –100 to 250°C)
(iii) Ability to repel water and form water tight seals
(iv) Excellent resistance to oxygen, ozone and sunlight
(v) Flexibility
(vi) Good electrical insulation
(vii) Anti-adhesive properties
(viii) Low chemical reactivity
(ix) Low toxicity

But it also has its own disadvantages (Bahia, H. and Davies, R., 1995):

(i) Vulcanized rubbers display poor tensile properties
(ii) Some grades have poor hydrocarbon, oil and solvent resistance
(iii) High gas permeability (not always a problem)
(iv) Relatively high cost

The thermal stability of silicones stems from the thermal stability of Si-O and Si-CH_3 bonds which they thermally stable are. However, the partially ionic nature of these bonds (51%), means that they can be easily destroyed by concentrated acids and alkalis at ambient temperatures. In general these materials are flexible at low temperatures due to their low glass transition temperature (Tg). However, they also tend to stiffen up at higher temperatures. The first compositions to exhibit oil resistance were those that had nitrile groups (CN) substituting for some of the methyl groups. These were superseded by silicones containing fluorine, which display excellent resistance to oils, hydrocarbons and solvents (http://www.azom.com/,April 16th 2009).

At 25°C the permeability of silicone rubber is approximately 400 times that of butyl rubber. This allows this material to be used for gas permeable applications such as oxygen permeable membranes in medical applications. Silicones are excellent electrical insulators with grades available with volume resistivity as low as 0.004 ohm.cm. Their thermal stability means that properties such as volume resistivity, dielectric strength and power factor are not affected my changes in temperature. They also display arc and corona resistances surpassed only by mica.

The part called bottle's valve cap and the material selection for the part is polypropylene. Polypropylene is an economical material that offers a combination of outstanding physical, chemical, mechanical, thermal and electrical properties not found in any other thermoplastic. Compared to low or high density polyethylene, it has a lower impact strength, but superior working temperature and tensile strength.

Polypropylene possesses excellent resistance to organic solvents, degreasing agents and electrolytic attack. It has a lower impact strength, but it's working temperatures and tensile strength are superior to low or high density polyethylene. It is light in weight, resistant to staining, and has a low moisture absorption rate. This is a tough, heat-resistant, semi-rigid material, ideal for the transfer of hot liquids or gases. It is recommended for vacuum systems and where higher heats and pressures

are encountered. It has excellent resistance to acids and alkalis, but poor aromatic, aliphatic and chlorinated solvent resistance.

Some of its properties or features:

(i) Lightweight
(ii) High tensile strength
(iii) Impact resistant
(iv) High compressive strength
(v) Excellent dielectric properties
(vi) Resists most alkalis and acids
(vii) Low moisture absorption
(viii) Non-toxic
(ix) Non-staining
(x) Easily fabricated
(xi) High heat resistance

3.5 SUMMARY

This chapter is the description of the methodology that has been used in order to get the information from mothers about the current breast pump and the suggestion for the future design. This chapter also included the material selection for each part of the first stage design and the characteristic for the material.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter will discuss about the results or analysis from the questionnaires that has been distributed. The questionnaires were distributed to the twenty respondents. As informed, the results will be analyzed and shown using the Microsoft Excel™. After the analysis process, the design will be renewed or re-sketched again and the critical part will be analyzed using the Algor™.

4.2 QUESTIONNAIRE ANALYSIS

The questionnaire that already distributed to the respondents will be analyzed and the result is shown using the chart. The results will be used in improving the design in order to avoid MSD using the ergonomics approach.

4.2.1 Respondents' Age

First section of the question is about to know the general information about the respondents. The first question is about the age and the results show that 50% of respondents' age is in the range 31 – 35 years old. Other results, each 20% of the respondents' age is in the range 26 – 30 years old and 36 – 40 years old while 10% of the respondents' age is in the 20 – 25 years old. The range of the age for the mothers is around 31 – 39 years and the potential for them to have MSD is high as they are exposed to repetitive activities such as a long time period of gripping that will lead to MSD. Figure 4.1 shows the respondents' age.

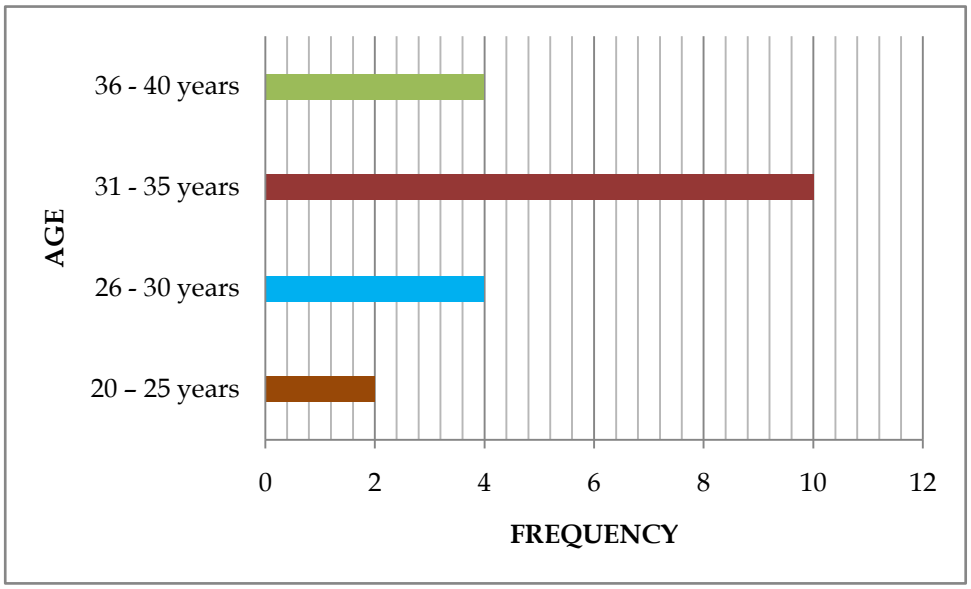


Figure 4.1 Chart of Respondents' Age

4.2.2 Respondents' Status of Work

Second question of section A is about the status of the respondents' work. The results show 75% of the respondents is a working mother while 25% of the respondents are not working. Most of the respondents are working. So, the breast pump should be described in a compatibility size as it will be easy for the mothers to bring it anywhere in order to make sure they give the best nutrition to their babies. Figure 4.2 shows the status of respondents' working.

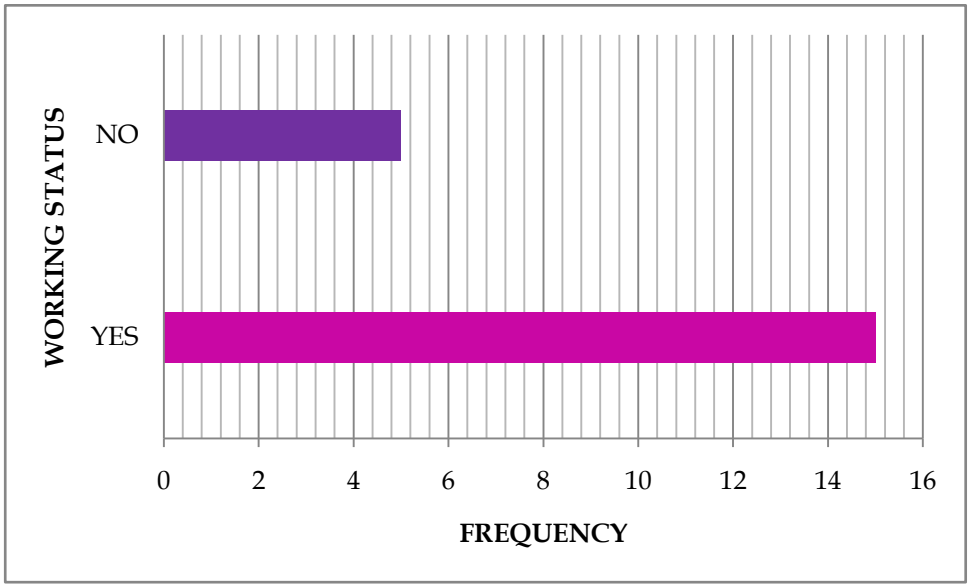


Figure 4.2 Bar Chart of Respondents' Status of Working

4.2.3 Duration for Nursing

This question is about to know the time provided for breastfeed activities. The results show that 30% of the respondents spent one to two hours and 30% of the respondents spent two to three hours for nursing activities. 25% of the respondents spent more than 4 hours while 15% of the respondents spent three to four hours. The chance for the mothers to expose to the MSD because of the repetitive activities is quite high (Spence, S. 1990). So, the ergonomic criteria should be considered as it will reduce the chance to get MSD. Figure 4.3 shows the distrbutions of anwers from the respondents by percentage.

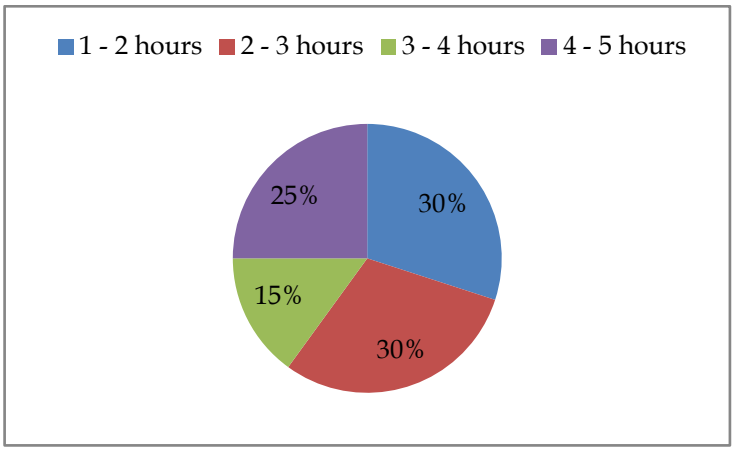


Figure 4.3 Nursing Hours

4.2.4 Plan to Breastfeed

This question needs the respondents to choose the period of time to breastfeed. The result shows 50% of the respondents plan to breastfeed for 1 ½ years to 2 years. 25% of the respondents choose to spend more than 2 years to breastfeed their babies. 10% of the respondents plan to breastfeed for 1 day to 1 year while 15% of the respondents plan to breastfeed for 1 year to 1 ½ years. Figure 4.4 shows the distrbutions of anwers from the respondents by percentage.

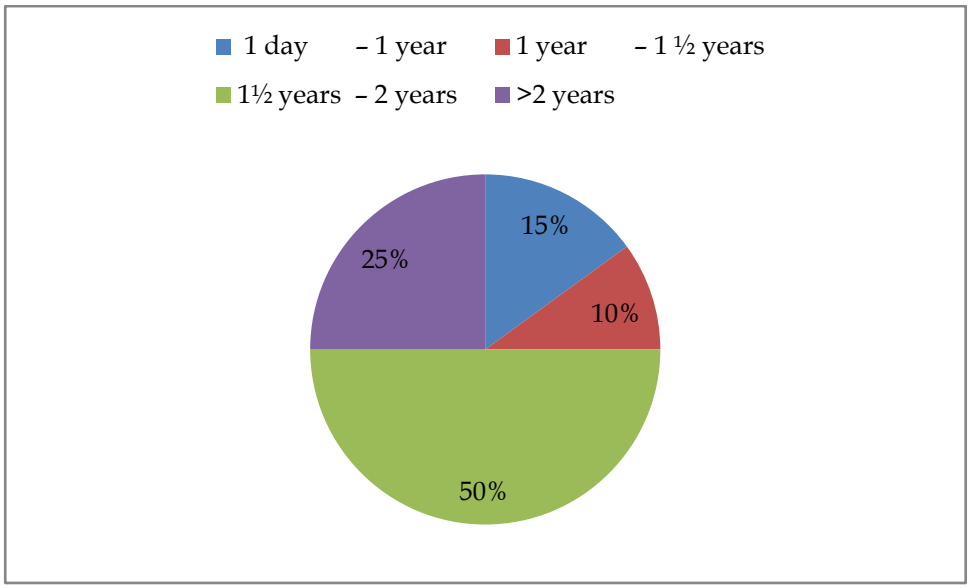


Figure 4.4 Plans to Breastfeed

4.2.5 Breast Pump's Status

This question asked the respondents either they are using the breast pump or not. 100% of the respondents do use the breast pump. Figure 4.5 shows the distrbutions of anwers from the respondents by percentage.

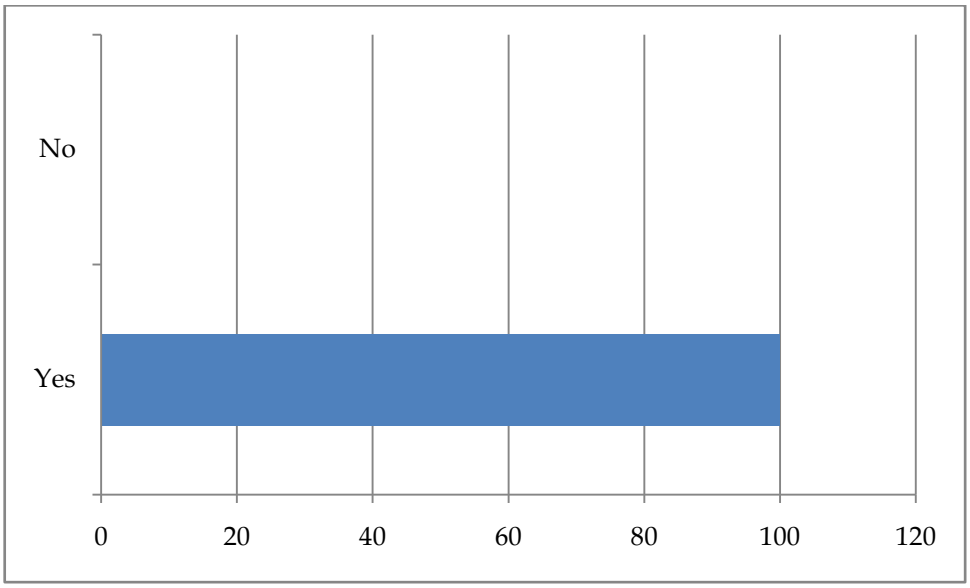


Figure 4.5 Utilization of the Breast Pump

4.2.6 Type of the Breast Pump

The results show that 90% of the respondents using the manual breast pump while 0% of the respondents using the electric breast pump. Mothers view pumping as part of a reaction that is reinforced every two to three hours when they must use a pump in the absence of a baby at breast. Figure 4.6 shows the distrbutions of anwers from the respondents by percentage.

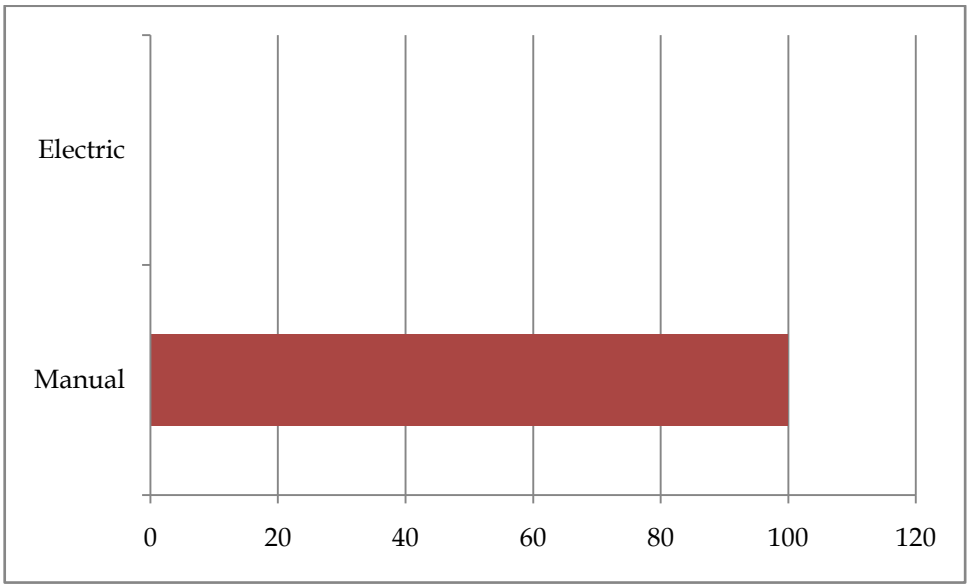


Figure 4.6 Type of the Breast Pump

4.2.7 Recently Bra Cup Size

The result shows that 60% of the respondents used the C size. The perimeter for normal C's size is 36 inches or 80 cm. 25% of the respondents used the B size, 10% of the respondents used the D size while 5% of the respondents used the A size. So, the size for the funnel of the breast pump should be designed in different size in order to make sure mothers will feel comfortable. It is also avoids mothers from being exposed to some problems such as cracked nipples and mastitis (E. Jones and S.A. Spencer, 2007). Figure 4.7 shows the distrbutions of anwers from the respondents by percentage.

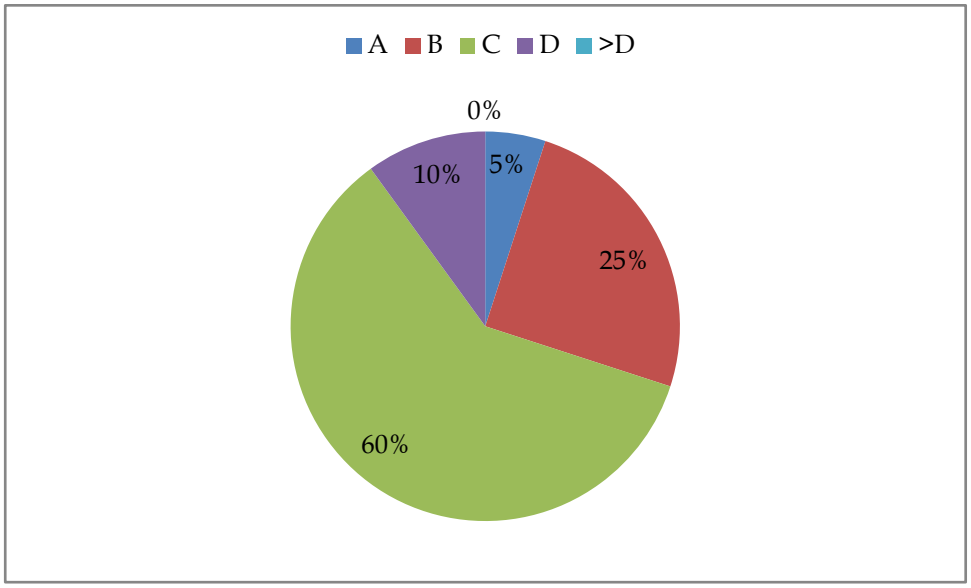


Figure 4.7 Bra Cup Size

4.2.8 Position While Breastfeeding

This question required the respondents to choose their comfortable position during the breastfeed activities. 85% of the respondents choose to sit during the breastfeed activities. The result shows that the breast pump should be designed to suit in sitting position. Meanwhile, 15% of the respondents choose to lay during the breastfeed activities and 0% of the respondents choose to stand during the breastfeed activities. This means that the best position during the breastfeed activities is sit. Height of the working surface should maintain a definite relationship with the operator elbow height, depending on the type of work (Waldemar Kaewoski and Gavriel Salvendy, 1998). Figure 4.8 shows the distrbutions of anwers from the respondents by percentage.

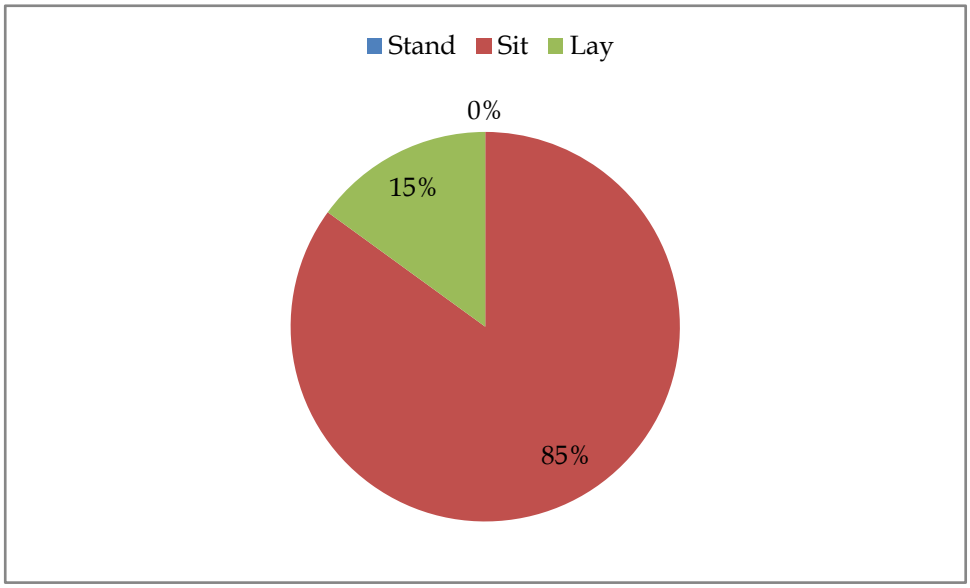


Figure 4.8 Best Position during Breastfeed Activities

4.2.9 Pressing Activities

From the question, the results show that 65% of the respondents need only 20 times pressing in order to fill the five ounce. Meanwhile, 20% of the respondents need 40 times pressing and 15% of the respondent need to press 3 times only in order to fill the bottle. The more mothers grip, the more chances for mothers to expose to the MSD as it is one of the cause. The findings recover that the same thing for overuse injuries to the hand, wrist and arm, which are endemic in people who do repetitive hand-intensive work on industrial assembly lines (Brumfield and Champoux, 1984). Figure 4.9 shows the distrbutions of anwers from the respondents by percentage.

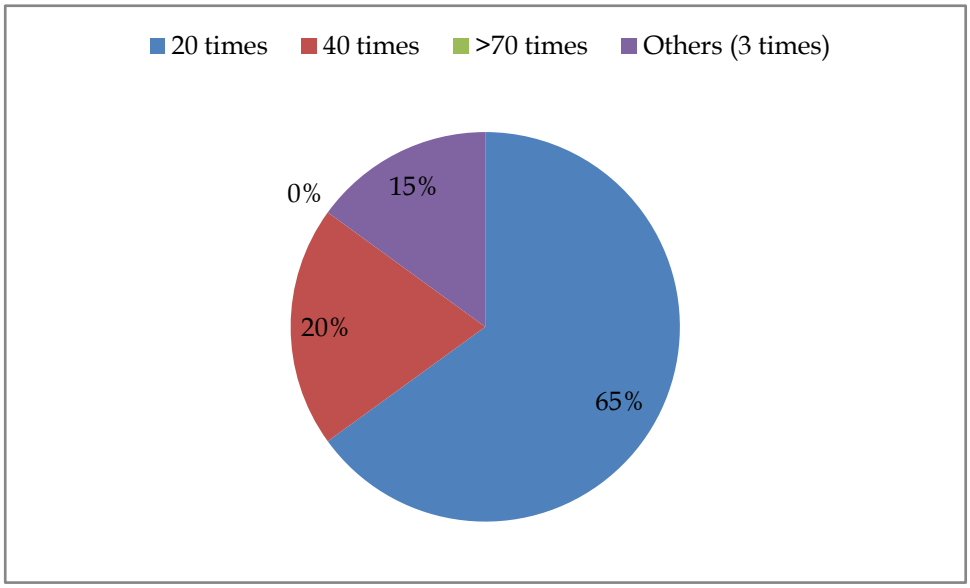


Figure 4.9 Pressing Activities

4.2.10 Travelling Information

60% of the respondents did travel while 40% did not. So, the design should suitable in order to give the comfortness to the mothers during the travelling. The size especially can help the mothers to use the breast pump anywhere at suitable place. So, designing the breast pump according to the ergonomics approach is important as it will help to give the comfort ability to the mothers. Figure 4.10 shows the distrbutions of anwers from the respondents by percentage.

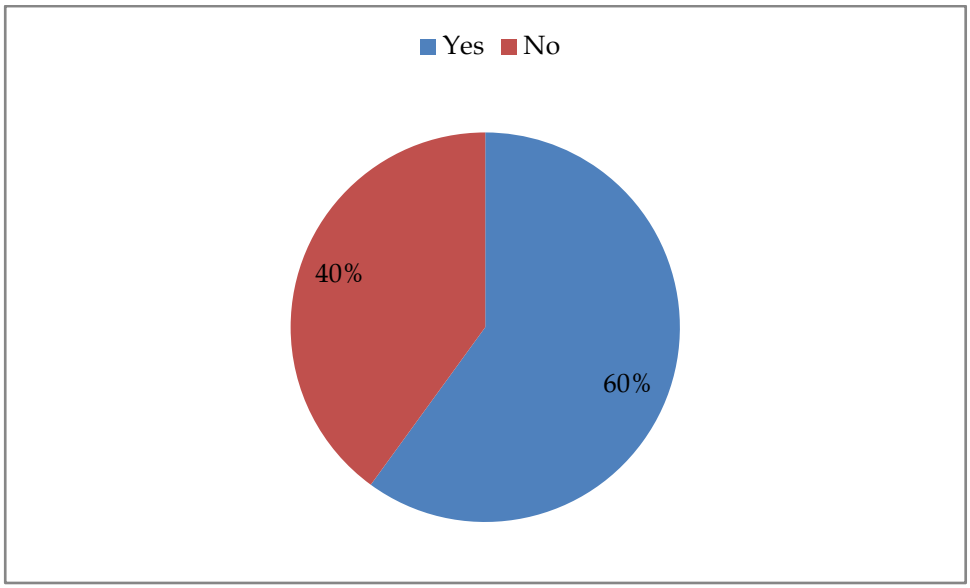


Figure 4.10 Travelling Information

4.2.11 Status of Breast pump During The Travelling

This question is about the status of the breast pump during the travelling which is related to one of the ergonomic's criteria, comfort ability. 80% of the respondents do bring the breast pump when travel and 20% of the respondents did not. This information can help in redesign the size of the breast pump whether it is easy to bring to anywhere or not. The pie chart below show the percentage of the results. Figure 4.11 shows the distrbutions of anwers from the respondents by percentage.

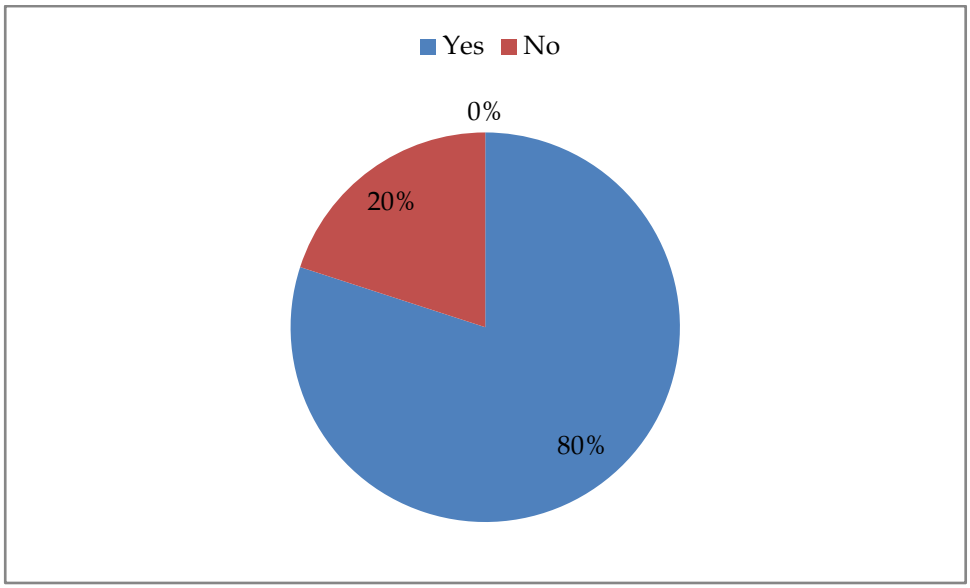


Figure 4.11 Status of the Breast Pump during Travelling

4.2.12 Problems using the Current Breast Pump

Sometimes, mothers will face problems using the breast pump. This question required the respondents to state what type of problems mothers are facing while using the breast pump. 50% of the respondents state that they having repeated engorgement which is one of the effects of the musculoskeletal disorders. 30% of the respondent state that they did not face any problems while using the breast pump and 20% of the respondents state they having sore and cracked nipples. This means that mothers have develop MSD and actually heading to a way of MSD to becoming more serious. Figure 4.12 shows the distrbutions of anwers from the respondents by percentage.

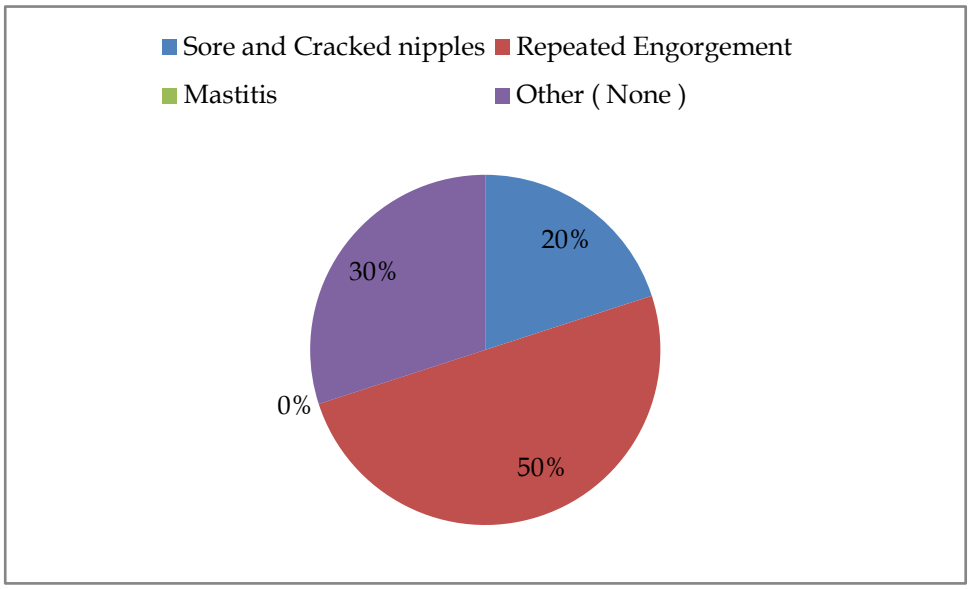


Figure 4.12 Problems using the Current Breast Pump

4.2.13 Breast Pump Information in Term of Comfort Ability

The results show that 45% of the respondents satisfy with the current breast pump while 55% of the respondents did not satisfy with their current breast pump. This happen due to the problems that they are facing while using the current breast pump. Although a lot of respondents are satisfied with their current breast pump, there are still plenty of room for improvement. This can improve the breast pump performance and the mothers as well. Figure 4.13 shows the distributions of answers in percentage.

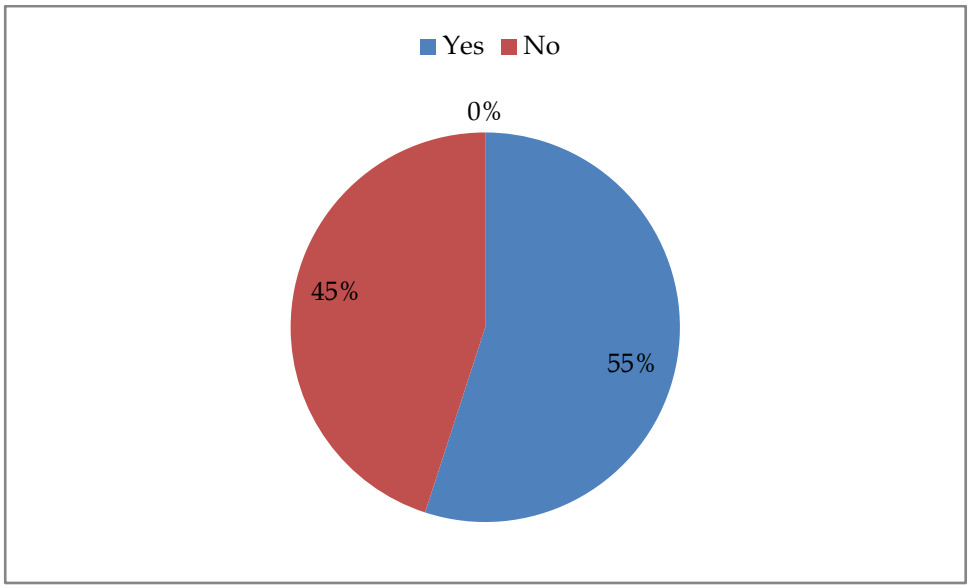


Figure 4.13 Breast Pump' Information in Term of Comfort Ability

4.2.14 Problems Information in Term of Body's Part

This question required respondents to state which are the body part that usually faced the problems while using the current breast pump. 50% of the respondents state that they are having problems at wrist while using the current breast pump. This can explain the 4th question in section B which they have the repeated engorgement. Meanwhile, 25% of the respondents state they have problems at palm, 20% of the respondents having the problems at their vain and 5% having the problems at their arm. Wrist is one of the body part that can expose to the repetitive engorgement that lead to MSD. Although it can be treated, but if it repeatedly occur at the same point and causing the amount of pain to be multiplying, then solutions must be find to reduce the pain. So with the ergonomics approach, it will help to reduce the MSD. Figure 4.14 shows the distrbutions of anwers from the respondents by percentage.

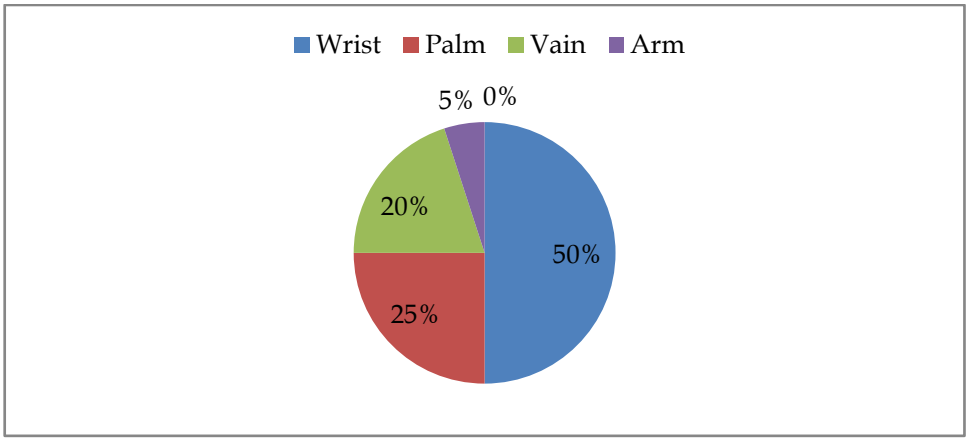


Figure 4.14 Problems Information in Term of Body's Part

4.2.15 Breast Pump in Term of Respondents' Suggestion

This question required the opinion from the respondents whether one of the ergonomics' criteria that are ease of use is appealing or not. 60% of the respondents agree that it is quite appealing while 40% of the respondents agree that it is very appealing. Tools that is easy to be handle will enhance the efficiency of a person. If it is hard to use, it will make the mothers stress that comes from the difficulty of using it and the breastfeed process will take more times. Besides that, it is one cause of MSD. Figure 4.15 shows the distrbutions of anwers from the respondents by percentage.

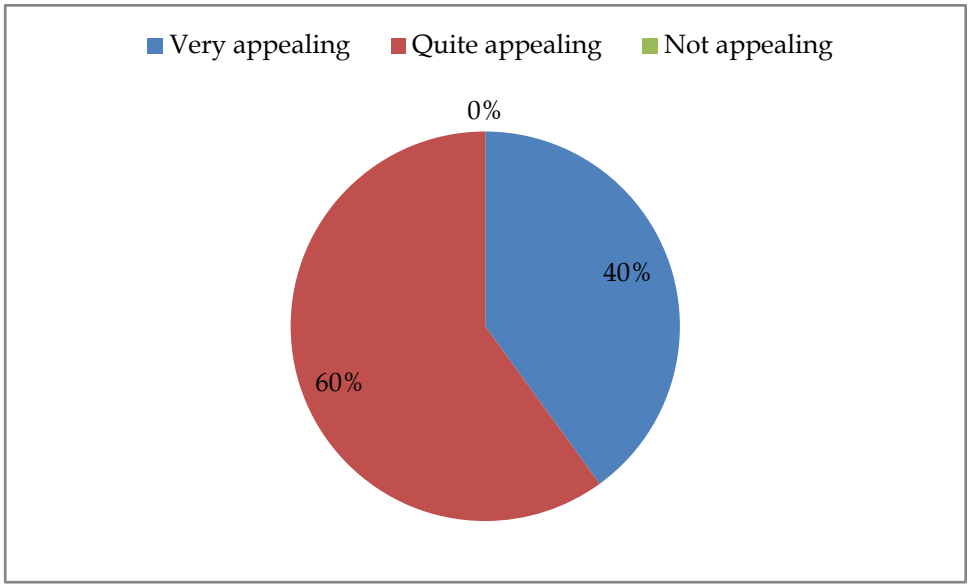


Figure 4.15 Suggestion of the Breast Pump

4.2.16 Ergonomics Criteria

From the results, 60% of the respondents choose the easy and simple use is the most important among the other criteria. As we know, 75% of the respondents are working mothers. So, they usually will bring along the breast pump in order to give enough milk to their children. 15% of the respondents choose the recommended as their most important criteria. They probably believe the promoter's opinion because they surely know the best about the product and as they want to give the best for their babies. 10% of the respondents choose the brand criteria while 10% of the respondents choose the price criteria as the most important. 5% of the respondents choose the times takes to fill the bottle as the most important criteria. This question also explains one the principle of the ergonomics, ease of use. The respondents also agree that if the breast pump is easy to use, they will not expose to stress condition and this will help to reduce times taken to fill the bottle. Fogure 4.16 shows the distrbutions of anwers from the respondents by percentage.

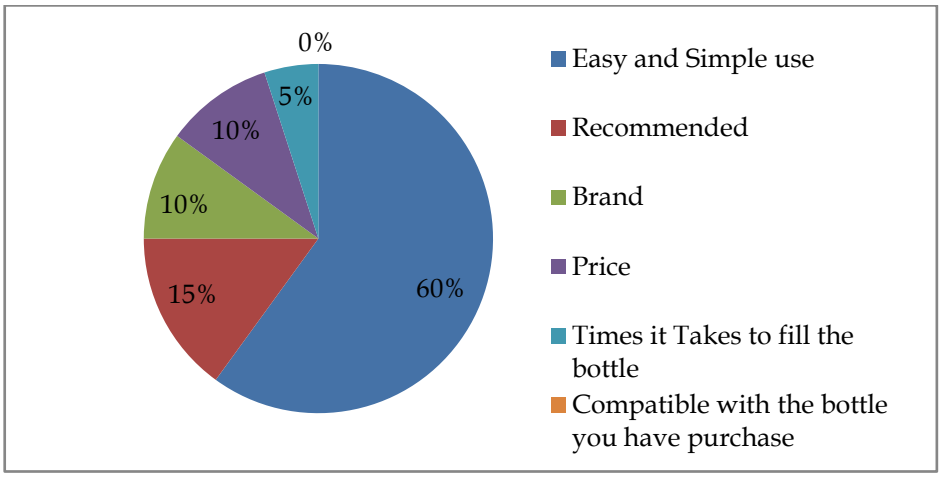


Figure 4.16 Opinion on Ergonomics Criteria

4.2.17 Problems of using Breast Pump in Term of Body Posture

This question required the respondents to state whether the current posture during the breastfeed gives them back pain which is one of the musculoskeletal disorders. 65% of respondents agree that the posture that they used gives them back pain. 20% of the respondents disagree because they use the sitting position during the breastfeed activities. This same goes with 5% of the respondents that strongly disagree with the posture they currently used during the breastfeed activities. In order to help to reduce the pain, the height of the funnel should be considered so that mothers will not expose to MSD. The length of the tube is also will be considered as the right position for the arm is in the 100 - 110° or when the wrist is in neutral position. Through the research, the degree of bend should be provided for different tools (Pheasant, S. T., 1991). Figure 4.17 shows the distrbutions of anwers from the respondents by percentage.

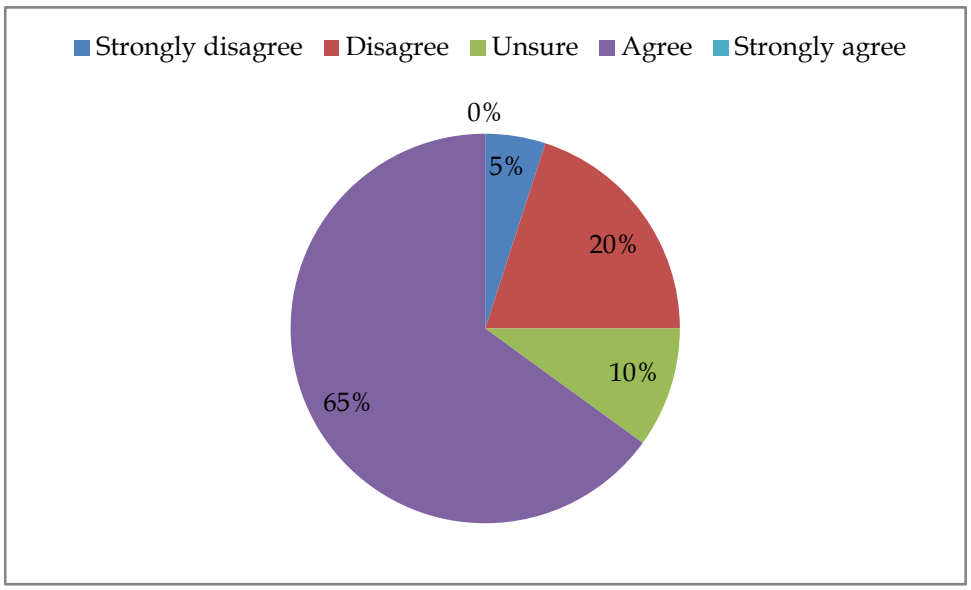


Figure 4.17 Problems of using Breast Pump in Term of Body Posture

4.2.18 Posture in Term of Position

75% of the respondents agree that they use the same position during the breastfeed activities. Most of them did not change their position until the breastfeed activities are over. 15% of the respondents are unsure whether they change their position or not. 10% of the respondents disagree that they are using the same position during the breastfeed activities. One of the categories of MSD are the conditions due to exposure to a repeated, a chronic, type of physical activity, resulting in, for example, soreness from inflamed tendons or ligaments (Spence, S., 1990). So, the design should be improved in order to reduce the MSD. Figure 4.18 shows the distrbutions of anwers from the respondents by percentage.

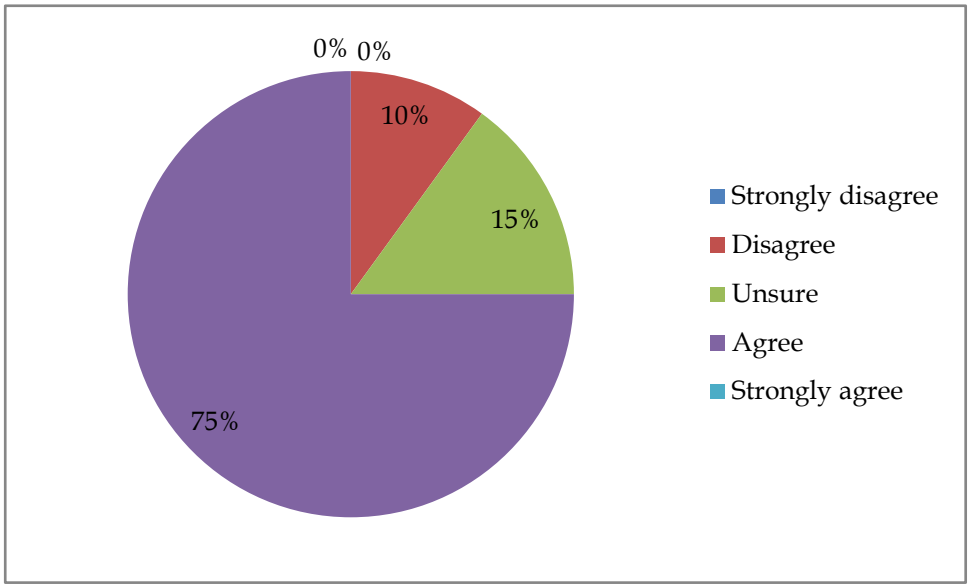


Figure 4.18 Postures in Term of Position

4.2.19 Best Suggestion Posture

This question is about the opinion of the respondents for the best posture during the breastfeed activities. 50% of the respondents agree that sitting is the best posture during the breastfeed activities. This same goes with the 10% of the respondents strongly agree that sit position is the best posture. 25% of the respondents are unsure whether the sit position is the best posture for breastfeed activities. Meanwhile, 15% of the respondents are disagreeing with the suggestion. Figure 4.19 shows the distrbutions of anwers from the respondents by percentage.

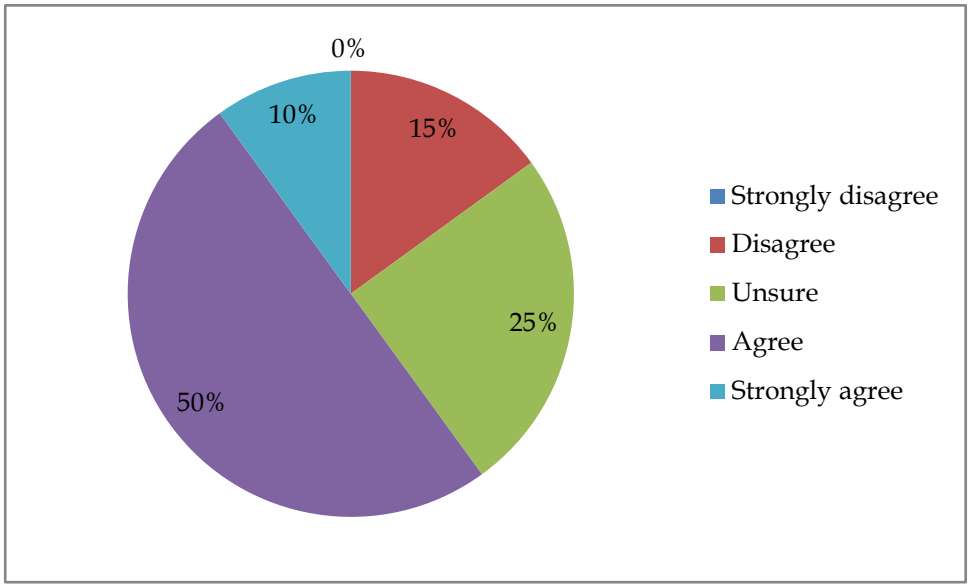


Figure 4.19 Best Suggestion Posture

4.2.20 Posture

From the results, 50% of the respondents agree that the body needs to bend during the breastfeeding and 10% of the respondents strongly agree with that statement. They probably want to reduce their back pain during the breastfeed activities. 15% of the respondents are unsure about the question. 20% of the respondents disagree with the statement and 5% of the respondents strongly disagree with the statement. Some of the breast pumps are in the suitable high that required mothers to sit in 90° position. Figure 4.20 shows the distrbutions of anwers from the respondents by percentage.

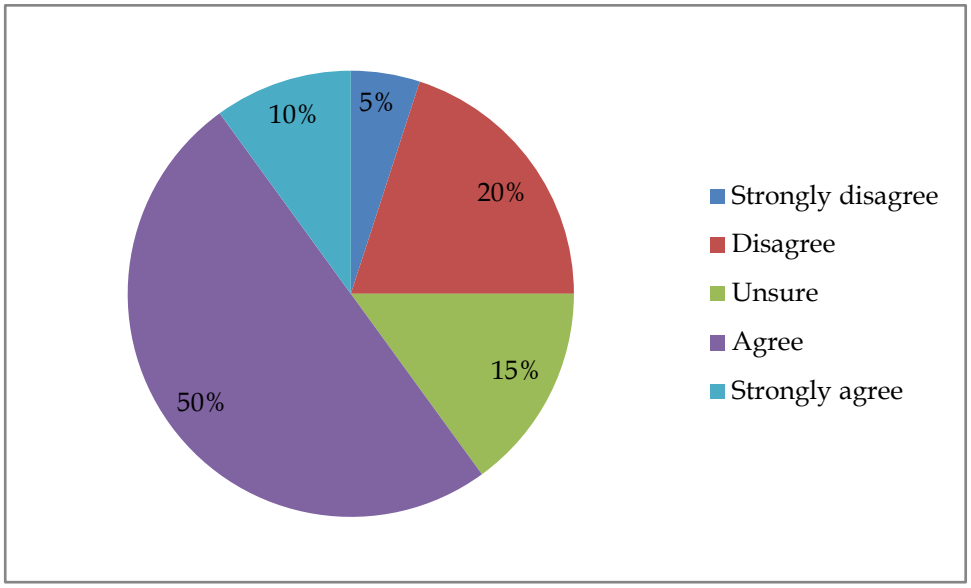


Figure 4.20 Posture

4.2.21 Force Applied to the Hand during the Breastfeed Activities

This question asked the respondents whether the hands are easily to feel tired during the breastfeed activities. 50% of the respondents agree that all the forces are being concentrated to the hand during the breastfeeding. Furthermore, 10% of the respondents strongly agree with the statement. 20% of the respondents are unsure while 20% of the respondents are disagreeing with the statement. From the statement, we can know the critical body part when using the breast pump is the hand. So, for the redesign process, we can consider the part where is the hand takes control and can avoided the repetitive activities in order to reduce MSD. When gripping, the hand is been subjected to a force to drive the tools. The part of the hand is repeatedly been subjected to the same force and at the same spot. This will cause fatigue and from time to time, the mothers will feel the pain from it (Helander, 2006). Figure 4.21 shows the distrbutions of anwers from the respondents by percentage.

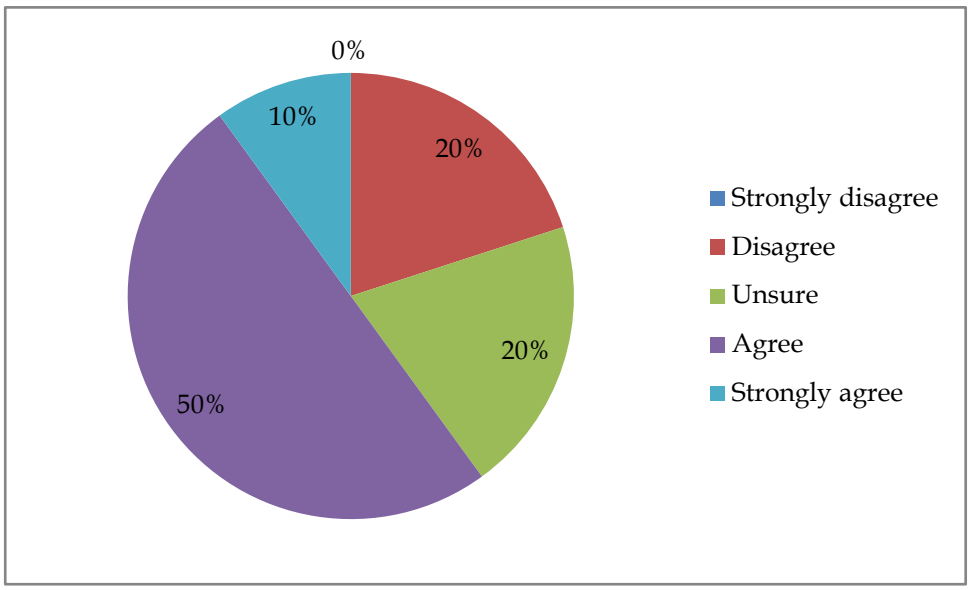


Figure 4.21 Force Applied to the Hand during the Breastfeed Activities

4.2.22 Arm Position

From the question, the result shows that 45% of the respondents agree that the best position of the arm is in the rest position which should be located between 100 - 110°. Moreover, 10% of the respondents are strongly agreed with the statement. 45% of them are unsure. The ranges of movement at the complex joints in the fingers at the wrist vary greatly between individuals and generally reduce with age and onset of arthritic disease. Brumfield and Champoux (1984) found that daily activities such as eating, reading and making a telephone call can be accomplished with motions of the wrist between 5° flexion and 35° extension, while for personal care activities such as washing, dressing and others, the range is 10° flexion to 15° extension. A design compromise may be needed to achieve good usability and adequate speed of work at the same time as minimizing wrist deviation in order to reduce the MSD. Figure 4.22 shows the distrbutions of anwers from the respondents by percentage.

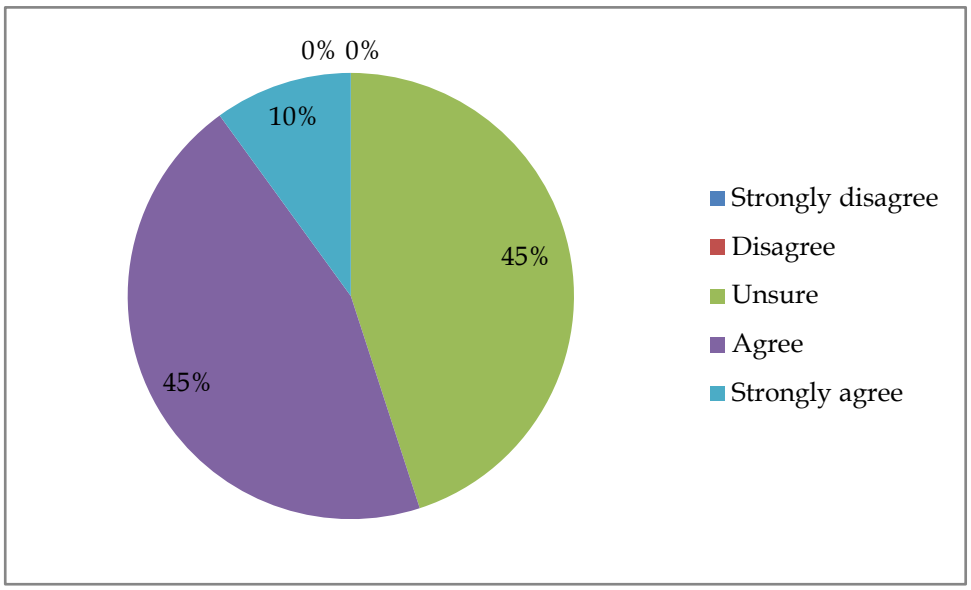


Figure 4.22 Arm Position

4.3 EXPECTED RESULTS AND DISCUSSIONS

This subchapter will discuss about the expected results. The design is designed according to the comparison between the current breast pump, literature review and the results from the questionnaire. The comparison between the current breast pump will be discussed in the next subchapter. The design then is modified according to the researches and suggestions from the respondents in order to improve the manual breast pump. The modified of the design then will be explained in the next subchapter according to its parts.

4.3.1 The Comparison of the current Breast Pump

The table shows the comparison of the three current model that has been used. From this comparison, the features of the manual breast pump are considered.

Table 4.1 Comparison between the Current Breast Pump

 Model A	 Model B	 Model C
The pump - Not in the best position for the waist to do the gripping and squeezing process. – Mothers reported that the pump creates noise and vibrations that are annoying to a user, may cause further discomfort, and prevent the user from using the breast pump discretely.	The pump The pressure pump is suitable because the pressures that lead to the hand are not too high but still the position will lead to MSD. – The size often requires the woman to extend her hand in an uncomfortable manner. After repeated cycles of pumping, such designs can result in prolonged discomfort and lingering pain in the user's hand. The design should consider the average size of the female or mothers' hands	The pump - Not in the best position for the waist to do the gripping and squeezing process. – Mothers reported that the pump creates noise and vibrations that are annoying to a user, may cause further discomfort, and prevent the user from using the breast pump discretely.

Table 4.1 Continues

	in order to give the comfort ability.	
The funnel – The angle used can avoid the milk to flow back to the funnel. – Mothers reported that they having cracked nipples and pain on breast during breastfeed process due to the size of funnel or cup.	The funnel – The angle has the same function with the first model. – The surface of the funnel is not sufficient enough in order to give the comfort ability to mothers.	The funnel – The angle used does not avoid the milk to flow back to the breast. – The size of the funnel gives the comfort and the size is in the average breast size for Asians' female (C cup size).
The bottle – The shape is in the correct shape for the baby to hold.	The bottle – The shape is not ergonomic.	The bottle – The shape is in the ergonomic shape as it easy for the baby to hold it.

4.3.2 The Mechanical Drawing of each part

This subchapter is about the mechanical drawings for each part. The description of each part also will be explained briefly. The explanation is included in the Table 4.2.

Table 4.2 Description of The manual Breast Pump

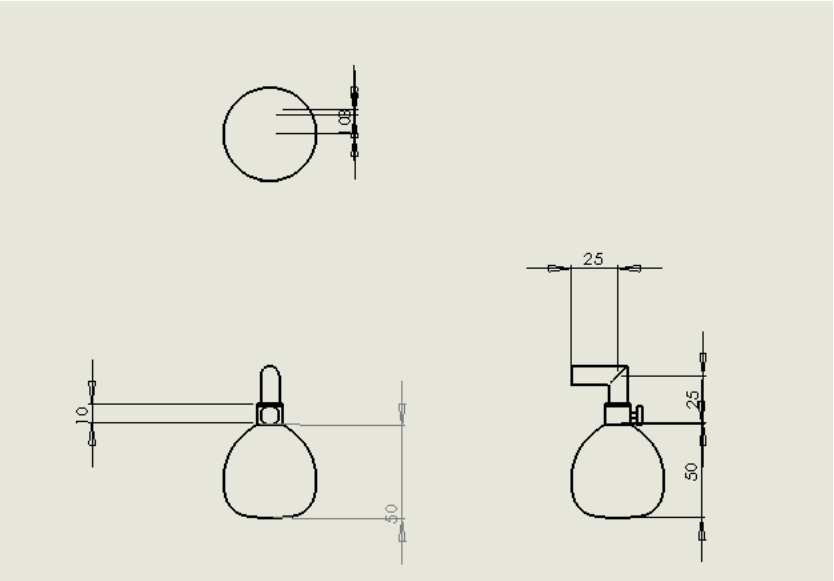
PART	DESCRIPTION
1) The Pressure Valve and The Tube	 **Figure 4.23** The Pressure Valve

Table 4.2 Continues

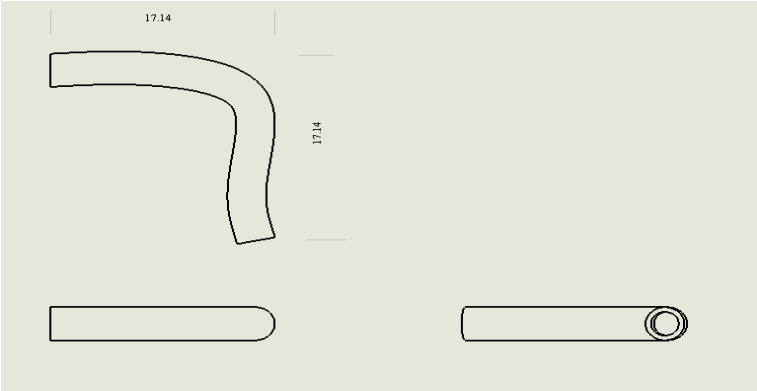
	 **Figure 4.24** The Tube Due to the questionnaires, 50% of the respondents state that they are having problems at wrist while using the current breast pump. The tube – modified due to the position of the arm rest. According to the questionnaire, 45% of the respondents agree that the best position of the arm is in the rest position which should be located between 100 - 110°. Moreover, 10% of the respondents are strongly agreed with the statement (Pheasant, S. T., 1991). The pressure valve or the pump – modified as it can give the comfort ability to the users. *'Corlett, E. N. and Clark, T. S. (1995). The Ergonomics of Workspaces and Machines: A Design Manual, 2nd ed. London: Taylor & Francis.'* *'Pheasant, S. T. (1991). Ergonomics, Work and Health. London: Macmillan.'*

Table 4.2 Continues

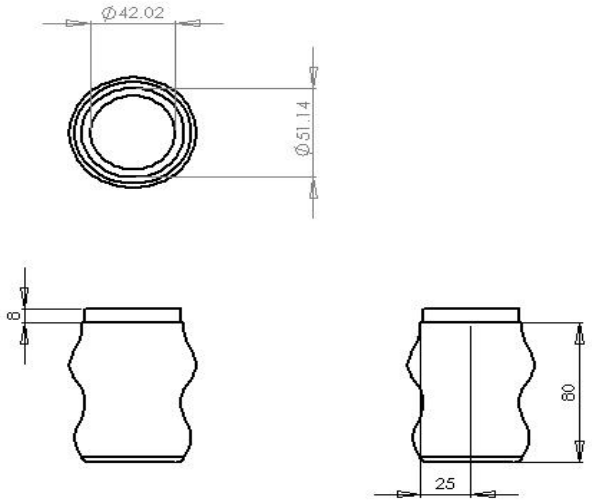
2) The Bottle	 **Figure 4.25** The Bottle The design of the shape is chose because it is easy to hold. The design also considers the "Power Grips", in which the fingers are used to clamp the objects. The shape is to reduce the pressure point that can lead to uncomfortable feeling and can cause restrain in nerve function as well as blood flow (Konz S. 1990). *Waldemar Karwowski and Gavriel Salvendy (1998), "Design and selection guide for hand held tools" Topic, Ergonomics in Manufacturing.'*

Table 4.2 Continues

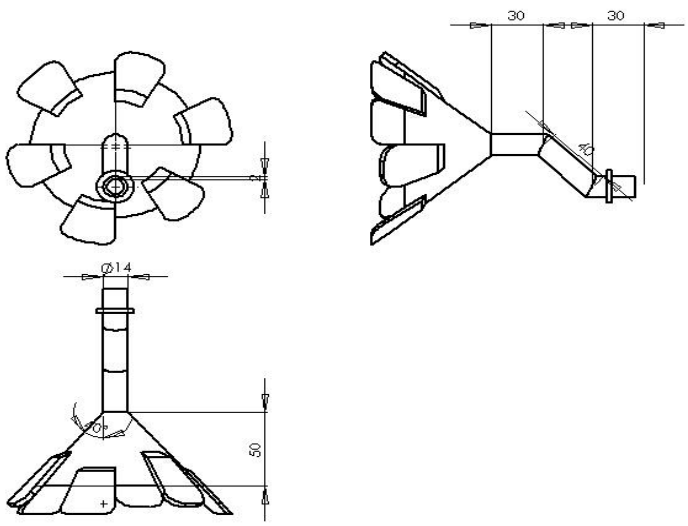
3) The Funnel	 **Figure 4.26** The Funnel The funnel has soft silicone cushion. The silicone cushion has six petal massagers. As you pump the petals gently massaging the area around your nipple (areola), stimulating your breast to express milk comfortably and painlessly. It imitates perfectly the way your baby breast feeds. The funnel size is according to the respondents from questionnaire. 60% of the respondents used the C size. So, the standard size for the cup C is in the range of 16 – 18 cm. *'Guyton, AC (1977), Basic Human Physiology: Normal Function and Mechanisms of Disease, 2nd ed., W. B. Saunders Co. Philadelphia.'*

Figure 4.27 shows the assembly for the manual breast pump. The assembly part included the valve cap, the pump, the tube and the bottle.

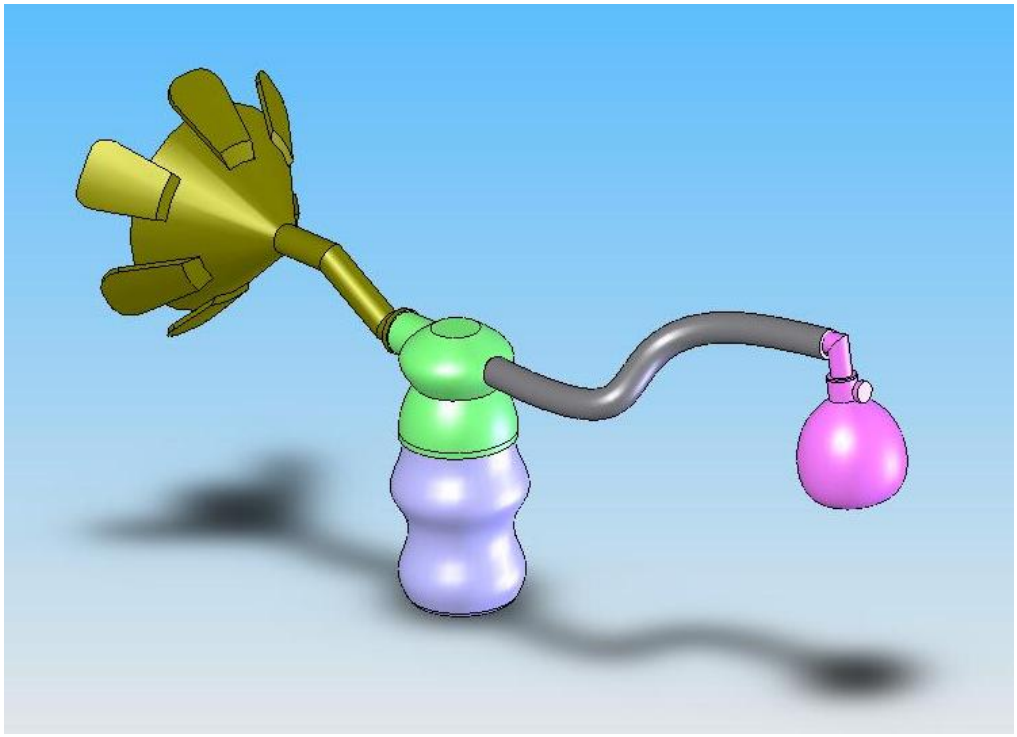


Figure 4.27 The Assembly Breast Pump

4.4 MANUAL CALCULATION FOR THE MAIN PART

The subchapter will show the manual calculation for the main part of the design. The subchapter will show the equation that has been used in calculated the best main part.

50% of the respondents said that they are having repeated engorgement when using the current breast pump. So, the pressure pump or valve is chose as the main part because the hand plays the big role in handling the pump. Moreover, 50% of the respondents state that they are having problems at wrist while using the current breast pump means that they are actually having the MSD.

In order to design the most suitable pressure valve, we have to do some research on the standard size of the breadth and the length of Asians female's hand. Malaysia does not provide the complete anthropometry data, so, the design will use the data for the Thailand population as Thailand is quite similar to Malaysian' population.

4.4.1 CALCULATION FOR THE PRESSURE PUMP

The formula used is

P = F/A ---------- (1)

Where,

P = pressure exerted to the hand

F = Ergonomic Force according to literature review (21 N)

A = ¾ area of the hand. *

* According to Franson and Wrinkle, (1991) in Ergonomics guidelines and problem solving, the cross-section area of the hand that exposed to the tools is only ¾ which is included the palm and the finger surface. The palm will help to hold and to push the tool while the fingers will help to give the force in order to make the tools function.

To calculate the area of the hand that exposed to the pump;

Breadth of the hand = 7.77 cm

Length of the hand (maximum length) = 16.61 cm

So, the area calculated is;

Area = ¾ (7.77 x 16.61)

= ¾ (129.0597)

= 96.7948 cm ---------- (2)

From the area, we can calculate the pressure that exerted to the hand.

Insert the value (2) in the formula (1).

As we know, the value of the force is 21 N.

P = 21/96.7948

= 0.2170 Pa

So, in order to reduce and to prevent the MSD, the pressure exerted cannot be over the 0.2170 Pa.

The area for the pump will include the width and the length. The length for the pump is when the pump is divided into two. The figure 4.28 and figure 4.29 show how the length and the width are considered. Figure 4.28 is the original shape for the manual pump. figure 4.29 is the shape of the manual pump after it is divided into two. The length and the width then measured.

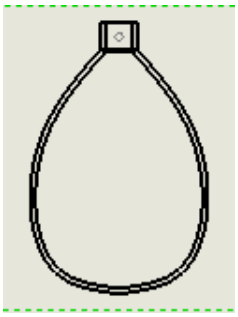


Figure 4.28 The Manual Pump

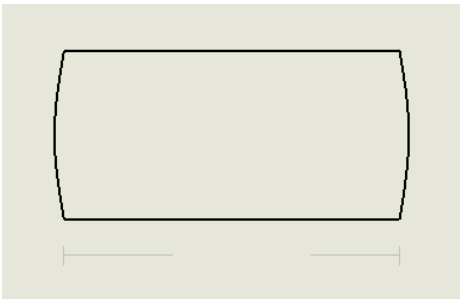


Figure 4.29 The Manual Pump After It Is Dividing

4.4.1.1 CALCULATION FOR DESIGN

This section is for the calculation process. The main part of the manual breast pump which is the pump is analyzed. The area for each measurement is calculated and the best pump is choose after the calculation.

1)

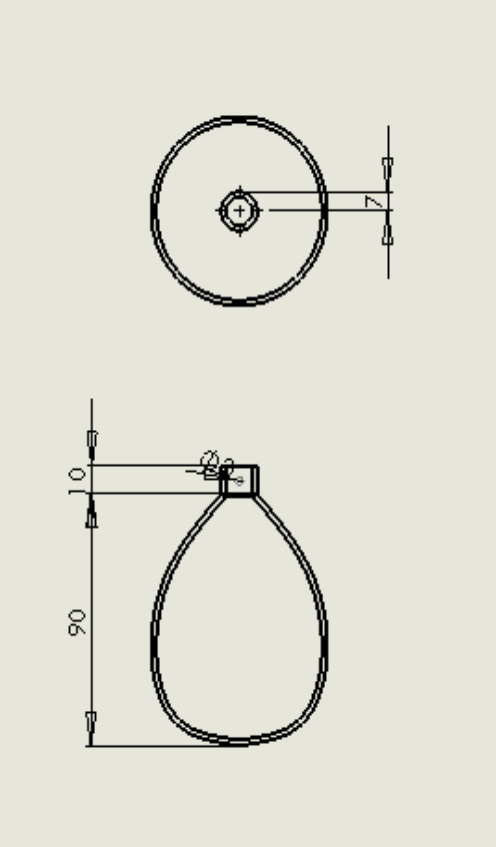


Figure 4.10 The Manual Pump with width 9 cm and length 10 cm

Width = 9 cm
Length = 10 cm
Area = 9 x 10
= 90 cm
So,
P = F/A
P = 21/90
= 0.2333 Pa
The value of the pressure for the design is over the value for the limit pressure that is 0.2170 Pa. Hence, the design is not ergonomics and not suitable to use in order to prevent the MSD.

2)

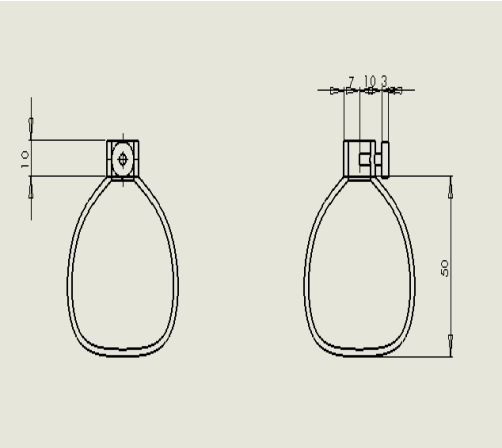


Figure 4.11 The Manual Pump with width 5 cm and length 16 cm

The width = 5 cm

The length = 16 cm

Area = (5 x 16)

= 80 cm

So,

P = F/A

P = 21/80

= 0.2625 Pa

The value of the pressure for the design is over the value for the limit pressure that is 0.2170 Pa. Hence, the design is not ergonomics and not suitable to use in order to prevent the MSD.

3)

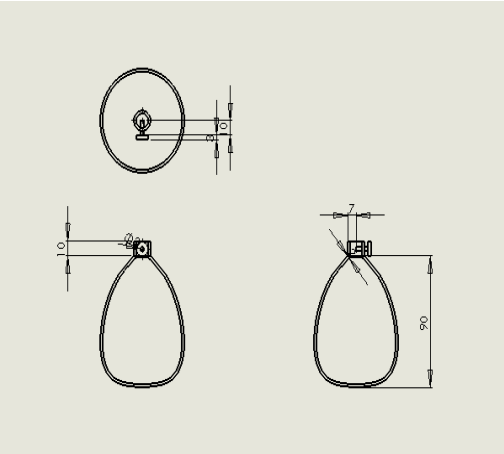


Figure 4.12 The Manual Pump with width 9 cm and length 16 cm

The width = 9 cm

The length = 16 cm

Area = (9 x 16)

= 144 cm

So,

P = F/A

P = 21/144

= 0.1458 Pa

The value of the pressure for the design is not over the value for the limit pressure that is 0.2170 Pa. Hence, the design is ergonomics and suitable to use in order to prevent the MSD.

So, in order to prevent the MSD the manual pump with the width is 5 cm and the length is 16 cm is chosen. The pressure calculated using the pump is not over the limit of the required pump. The stress while using the uncomfortable pump can be avoided by using this pump.

4.5 SUMMARY

The design is finally selected and the main part is calculated. The chapter also shows the mechanical drawings which is important in the design process in order to give the information to the community.

CHAPTER 5

CONCLUSION

5.1 INTRODUCTION

This chapter is the conclusion of the research on the findings and the results based on the literature review and the information from the questionnaire. The objective of the research will also be evaluate in this chapter. The recommendations in improving the research for the future will also be disscussed.

5.2 OBJECTIVES ACHIEVED

The first objective of the study which is to design a manual breast pump with ergonomics approach using Solidworks™. This objective has been achieved since the preliminary design has been skecthed and redesign into several designs before the final design has been chose based on the ergonomics criteria.

The second objective is to analyze the main part using the manual calculation. This is to know how much pressure that is exerted to the hand of the user. The main part of the design is the pump which is controlled by the hand of the users. Trough the calculation, we can choose the suitable size for the pump in order to give the comfort ability to mothers in handling the pump. Several size are used according to the size of the female's hand and the suitable sizes is chose after the calculated pressure is not exceed the pressure that supposed to be exert to the female's hand while working or using the tools.

5.3 CONTRIBUTION OF THE STUDY

One of the contributions of the study is the approach of ergonomics in order to avoid and to reduce the MSD among mothers. The analysis of the questionnaire in chapter four clearly shows that mothers actually are having the MSD while using the current breast pump. The design of the project would not cause the MSD to the mothers as considers the ergonomics criteria.

Second is the usage of the questionnaire. The instrument is contributes to the idea and the information from the mothers that is the users of the manual breast pump as it is important in designing and the sketching the manual breast pump that satisfies the mothers needs.

Next is the usage of the software. The software had help much during the research. The Solidwork™ had helped in sketching the design and can be modified anytime. With the Solidwork™, the assembly work becomes easy and we can reference other parts directly and maintain relationship when creating new parts. The design can be viewed in actual shape or can imagine the function. The software helps in smooth the study.

This kind of research should be continued in order to satisfy human needs as the technology is always changing. Besides that, it can help in improving the safety of life and help human to live the life comfortably.

5.4 RECOMMENDATIONS

In order to improve more the product, the ergonomics software can be suggested in order to simulate the design.

Then, in order to make it as a foundation, the fabrication process should be applied to validate it through the ergonomic aspects. This can help in prove the design is ergonomics and safe to use for the users. The objective is to test the product and make sure it is in ergonomic way. Besides that, validation is the process of checking if the

product satisfies the ergonomics criterion. It is also a part of quality management system that confirms the needs of an external customer or user of a product.

5.5 CONCLUSION

This study has achieved the objectives in designing the manual breast pump through the ergonomic approach. The design can help in reduce and control the MSD among the mothers. The data gathered from 20 respondents that using th manual breast pump is accurate as they are actual the user.

Human beings are varied and deserve individual solutions to their problems. One of the solutions is the ergonomics principle that can give the comfortably to the user. As human beings are changing, the design should be improved in order to satisfy the needs and help human to live a better life.

REFERENCES

This thesis is prepared based on the following references.

Arnold LDW. (1999) *Recommendation for collection, storage and handling of a mother's milk for her own infant is the hospital setting*. Denver, CO; Human Milk Banking Association of North America.Book: *Breastfeeding and Human Lactation* by *Jan Riordan*

Amirkhanian, S. and Franzese, W., *Establishment of an Asphalt Rubber Technology Service (ARTS). Beneficial Use of Recycled Materials in Transportation Applications,* Arlington VA, November 13-15, 2001.

Bahia, H. and Davies, R., *Factors Controlling the Effect of Crumb Rubber on Critical Properties of Asphalt*
Binders. Association of Asphalt Paving Technologists, Vol. 64, 1995.

Bowen Jones A. Thompson C, Drewett RF. (1982), *Milk flow and sucking rates during breast-feeding.* Journal: *Currents in human milk banking.*

Brumfield, R. H. and Champoux, J. A. (1984). *A Biomechanical study of normal functional wrist motion. Clinical Orhtopaedics.*

Corlet, E. N. and Clark, T. S. (1995). *The Ergonomics of Workspaces and Machines: A Design Manual,* 2nd edition. Guildford, United Kingdom.

Drills R. J (1963), "*Folk Norms and Biomechanics*", Human Factors. California.

E. Jones and S.A. Spencer (2007), *Optimizing the provision of human milk for preterm infants, Arch.* Dis. Child. Fetal Neonatal Ed. 92 .

Elazar J Pedhazur, Liora Pedhazur Schmelkin, (1993), *Measurement, Design, and*

Analysis : An Integrated Approach. Journal: *American educational research journal.New York.*

Fewtrell M. and J Ham Lacr (2001) *Randomized study comparing the efficacy of novel manual breast pump with mini-electric breast pump in mothers term infants.*

Fride E, Bregman T, Kirkham TC. (April 2005). Topic "*Endocannabinoids and food intake:newborn suckling and appetite regulation in adulthood"*, Experimental Biology and Medicine.

Grob – Wargo S et al. (1996) "*The utility of bilateral breast pumping styles for mothers of premature infants",* Pediatrics.

Guyton, AC (1977), Basic Human Physiology: *Normal Function and Mechanisms of Disease*, 2nd ed., W. B. Saunders Co. Philadelphia.

INTERNATIONAL ERGONOMICS ASSOCIATION http://www.iea.cc/ April 16th 2009

Jan Dul and Bernard Weerdmeester,(2001) "*Ergonomics for beginner: Basic Posture*" Florida.

Jaruwan Klamklay, Angoon Sungkhapong. Nantakrit Yodpijit and Patrick E. Patterson, ,2007.*Anthropometry of the Southern Thai Population, International Journal Of Industrial Ergonomics* 38 (2008) p. 111-118.

Johnson CA. (1988) "*As evaluation of breast pump currently available on the American market.*" Book : *Feeding and Nutrition in the preterm infant.*

Jose Neuman De Souza, Raouf Boutaba, (2000), *Managing Qos in Multimedia Networks and Services* : Ieee/Ifip Tc6-Wg6.4 & Wgh.6 Third International Conference on Management of Multimedia Networks and Services.

Konz, S, (1990) , "*Work Design: Industrial Ergonomics*" 3rd edition Scottsdale, Az Publishing Horizons Inc. Los Angeles.

Material Guide for Rubber http://www.azom.com/, April 16th 2008

Pheasant, S. T. (1991). *Ergonomics, Work and Health*. London: Macmillan.

Putz-Anderson, V. (1988). *Cumulative trauma disorders, London*, Taylor&Francis.

Sekaran, U. (1992). *Research Methods for Business: a skills building approach* (2nd Edition). New York: John Wiley & Sons.

Sekaran, U. (2000). *Research Methods for Business* (3rd Edition). New York: Hermitage Publishing Services.

Spence, S. (1990). "*Pshychopathology amongst acute and chronic patients with Occupationally related upper limb pain versus accident injuries of the upper limbs"*. Australian Psychologist.

Sperling L., Dahlman, S., Wikstrom, L., Kilbom, A. and Kadefors, R. (1993). "*Applied Ergonomics"*. United State of America.

Stephen Pheasant and Christine M. Haslegrave, Third Edition, 2006 publisher, "*Anthropometry, Ergonomics And The Design of Work"*, CRC Press, Taylor & Francis Group. Florida.

Thompson, A. R., Plewes, L. W., and Shaw, E. G. (1951). *Peritendinitis and simple tenosynovitis: a clinical study of 544 cases in industry*. Britsh journal of industrial Medicine.

Waldemar Kaewowski and Gavriel Salvendy,(1998) "*Ergonomics in Manufacturing: Designing workstation".* Florida.

Wilde et al., C.J. Wilde, A. Prentice and M. Peaker (1995), *Breast-feeding: matching supply with demand in human lactation*, Proc. Nutr. Soc. 54 (1995).

William G. Zikmund, Michael D'Amico, (June 2000), *Marketing With Infotrac* (7th edition) Chicago.

http://www.womenshealthcaretopics.com/breast_pump.htm, April 20th 2009.

APPENDIX

QUESTIONNAIRES

SOALAN KAJI SELIDIK

DESCRIPTIVE DATA FOR EACH SECTION

ANTHROPOMETRY DATA

Engineering of Mechanical
Universiti Malaysia Pahang
Lebuhraya Tun Razak, 26300 Gambang,
Kuantan, Pahang Darul Makmur

SURVEY QUESTIONNAIRES

Research on ergonomics design and the uses of the manual breast pump.

This questionnaire seeks some information about the information, the perception and the opinion about the ergonomics design on manual breast pump. Your answers will be kept anonymous, so please be candid in your response. Your input is very important to our research. All the responses will be maintained in strictest confidence. Your kindness is much appreciated.

A. CORRESPONDENT DETAILS

In this part we want to know general information about you. Please fill in the space provided.

Age : ☐ 20-25 ☐ 26-30 ☐ 31-35 ☐ 36-40

Working : ☐ Yes ☐ No

B. BREASTFEED DETAILS

This part will provide us about your breastfeed activities. Please answer the questions in the space given.

1. How many nursing in 24 hours?

☐ 1-2 hours
☐ 2-3 hours
☐ 3-4 hours
☐ ➢ 4 hours

2. How long do you plan to breastfeed?

☐ 1 day – 1 year
☐ 1 year – 1 ½ years
☐ 1 ½ years – 2 years
☐ ➢ 2 years

3. Do you use any breast pump?

☐ Yes (If yes,please proceed to the next question)
☐ No (If yes, you can stop here. Thank you)

4. What was your bra cup size prior to your most recent pregnancy?

☐ A ☐ B
☐ C ☐ D
☐ More than D

5. What position do you use while using the breast pump?

☐ Stand ☐ Sit ☐ Lay

C. BREAST PUMP DETAILS

This part will be provided us about your information about your breast pump and your opinion of future breast pump. Please kindly answer the question in the space given.

1. How many times do you press or pump your breast to fill the bottle?

☐ 20 times
☐ 40 times
☐ ➢ 70 times
☐ Others (State) : _____

2. Do you always travelling?

☐ Yes
☐ No

3. Do you use breast pump during the travels?

☐ Yes
☐ No

4. What are the problems that you faced while using the recent breast pump?

☐ Mother has sore and cracked nipples
☐ Mother reports repeated engorgement
☐ Mother has mastitis (inflammatory disease of the breast or mammary gland)

Others:

_____

_____

5. Do you comfortable with the currently breast pump that you use?

☐ Yes
☐ No

6. Can you specify which part of your body feels the pain?

- [ ] Wrist
- [ ] Palm
- [ ] Arm
- [ ] Vain

7. A breast pump that is really easy to use is

- [ ] Very appealing
- [ ] Quite appealing
- [ ] Not appealing

8. While choosing a breast pump, what was/is important criteria for you? Please rank top from 1 to 6 being most important which 1 is the most important and 6 is less important.

- [ ] Brand
- [ ] Price
- [ ] Easy and simple use
- [ ] Times it takes to takes to fill the bottle
- [ ] Recommended
- [ ] Compatible with the bottle you have purchase?

D. BODY POSTURE DETAILS

In this section, we want to know the posture and your position while breastfeeding your baby. Please circle your answer according to the scale below.

1	2	3	4	5
Strongly disagree	Disagree	Unsure	Agree	Strongly agree

1. Your position during the breastfeed gives you back pain. 1 2 3 4 5
2. Your position is same during the breastfeeding 1 2 3 4 5
   process.
3. Sitting is the best position during the breastfeeding process. 1 2 3 4 5
4. The body needs to be bend during the breastfeeding process. 1 2 3 4 5
5. All the force are being concentrated to the hand during the breastfeeding process. 1 2 3 4 5
6. The arm should be located between 100 - 110° or in other words, arm is in rest position. 1 2 3 4 5

We sincerely appreciate your time and cooperation. Please check to make sure that you have not skipped any questions. Thanks you.

Engineering of Mechanical
University Malaysia Pahang
Lebuhraya Tun Razak, 26300 Gambang,
Kuantan, Pahang Darul Makmur

SOALAN KAJI SELIDIK

Kaji selidik tentang penggunaan manual 'breast pump' dan mengaplikasi cirri-ciri ergonomic dalam proses rekaciptanya.

Soalan kaji selidik ini mengandungi 4 bahangian yang perlu dijawab oleh pengguna. Jawapan ini hanya akan digunakan atas tujuan penyelidikan sahaja. Semua jawapan dan maklumat akan dirahsiakan.
Terima kasih.

A. MAKLUMAT PENGGUNA

Bahagian ini bertujuan untuk memberitahu pihak kami mengenai sedikit maklumat tentang diri anda (pengguna). Isikan jawapan anda di tempat yang disediakan.

Umur: ☐ 20-25 ☐ 26-30 ☐ 31-35 ☐ 36 - 40

Bekerja: ☐ Ya ☐ Tidak

B. MAKLUMAT PENYUSUAN

Dalam bahagian ini anda dikehendaki menjawab soalan berkaitan dengan aktiviti penyusuan. Isikan jawapan anda di tempat yang disediakan.

1. Adakah anda menyusukan anak anda?

☐ Ya
☐ Tidak

2. Berapa jam anda peruntukkan bagi aktiviti penyusuan dalam masa 24 jam?

☐ 1-2 jam
☐ 2-3 jam
☐ 3-4 jam

3. Berapa lama anda merancang untuk menyusukan anak anda? Sehinggan anak anda berumur:

☐ 1 hari – 1 tahun
☐ 1 tahun – 1 ½ tahun
☐ 1 ½ tahun – 2 tahun
☐ Lebih dari 2 tahun

4. Apakah jenis pam yang anda gunakan?

☐ Manual (Jika ya,sambung ke soalan seterusnya)
☐ Elektrik (jika ya,anda boleh berhenti di sini. Terima kasih)

5. Apakah saiz bra/coli anda gunakan terutamanya selepas kali terakhir anda mengandung?

☐ A ☐ B
☐ C ☐ D
☐ Lebih dari D

C. MAKLUMAT ‘BREAST PUMP’

Bahagian ini berkaitan dengan maklumat pam yang anda gunakan dan tentang pandangan anda untuk rekacipta pada masa hadapan. Sila isikan jawapan anda pada tempat kosong yang disediakan.

1. Berapa kali anda mengepam buah dada anda untuk memenuhkan satu botol?

☐ 20 Kali ☐ >70 Kali
☐ 40 Kali ☐ Lain- lain(Nyatakan)

2. Adakah anda selalu mengembara atau berada di luar rumah?

☐ Ya
☐ Tidak

3. Adakah anda menggunakan ‘breast pump’ ketika mengembara?

☐ Ya
☐ Tidak

4. Apakah masalah yang anda hadapi ketika menggunakan pam yang sedia ada?

☐ Ibu mempunyai alahan dan rekahan pada puting.
☐ Ibu mengalami lenguh yang berulang pada mana-mana bahagian badan.
☐ Ibu mengalami jangkitan pada buah dada yang disebabkan oleh proses penyusuan.
☐ Lain-lain(nyatakan):

_____

_____

5. Adakah anda selesa dengan ‘breast pump’ anda sekarang?

☐ Ya
☐ Tidak

6. Nyatakan bahagian tubuh yang berasa sakit ketika aktiviti penyusuan dijalankan.

☐ Pergelangan tangan
☐ Tapak tangan
☐ Lengan
☐ Tulang belakang

7. ‘Breast pump’ yang sangat mudah digunakan adalah

☐ Sangat diperlukan
☐ Agak diperlukan
☐ Tidak diperlukan

8. Semasa memilih ‘breast pump’, apakah ciri-ciri yang penting anda ambil kira? Sila kategorikan berdasarkan tahap 1 hingga 6 mengikut keutamaan. Dari 1 yang paling penting sehingga 6 paling kurang penting.

☐	Jenama
☐	Harga
☐	Senang dan mudah digunakan
☐	Masa yang digunakan untuk memenuhkan satu botol. (4 ounce)
☐	Disyorkan
☐	Sesuai dengan botol yang dibeli.

D. MAKLUMAT POSISI BADAN

Dalam bahagian ini, kami ingin mengetahui kedudukan anda ketika proses penyusuan. Sila bulatkan jawapan anda berdasarkan skala yang disediakan di dalam jadual di bawah.

1	2	3	4	5
Sangat tidak setuju	Tidak setuju	Tidak pasti	Setuju	Sangat setuju

1. Kedudukan anda ketika proses penyusuan menyebabkan anda mengalami kesakitan tulang belakang. 1 2 3 4 5

2. Kedudukan adalah sama sepanjang proses penyusuan. 1 2 3 4 5

3. Kedudukan yang paling sesuai ialah duduk. 1 2 3 4 5

4. Posisi badan perlu dibongkokkan sedikit ketika proses penyusuan. 1 2 3 4 5

5. Semua tenaga ditumpukan pada tangan ketika proses penyusuan. 1 2 3 4 5

6. Kedudukan tangan perlu diletakkan pada kedudukan antara 100°-110°atau dalam keadaan rehat. 1 2 3 4 5

Kami amat menghargai kerjasama yang diberikan dan masa yang anda luangkan. Sila pastikan anda menjawab semua soalan. Terima kasih.

DESCRIPTIVE OF THE RESPONDENT FOR EACH SECTION

SECTION A

Demographic	Category	Frequency	Percentage (%)
Age	20 – 25	2	10
	26 – 30	4	20
	31 – 35	10	50
	36 – 40	4	20
Working	Yes	15	75
	No	5	25

SECTION B

Demographic	Category	Frequency	Percentage (%)
Duration for Nursing	1 – 2 hours	6	30
	2 – 3 hours	6	30
	3 – 4 hours	3	15
	> 4 hours	5	25
Plan to breastfeed	1 day – 1 year	3	15
	1 year – 1 ½ years	2	10
	1 ½ years – 2years	10	50
	> 2 years	5	25
Breast Pump status	Yes	20	100
	No	0	0
Type of Breast Pump	Manual	20	100
	Electric	0	0
Recently Bra Size	A	1	5
	B	5	25
	C	12	60
	D	2	10

	>D	0	0
Position during Breastfeed	Stand Sit Lay	0 17 3	0 85 15

SECTION C

Demographic	Category	Frequency	Percentage (%)
Pressing Activities	20 times 40 times ➢ 70 times Others (3)	13 4 0 3	65 20 0 15
Travelling Information	Yes No	12 8	60 40
Problems during using current Breast Pump	Sore and Cracked Nipples Repeated Engorgement Mastitis Other (None)	4 10 0 6	20 50 0 30
Breast Pump Information in term Comfort Ability	Yes No	9 11	45 55
Demographic	Category	Frequency	Percentage (%)
Problems Information in term of Body's Part	Wrist Palm Arm Vain	10 5 1 4	50 25 5 20
Breast Pump in term of Respondent' Suggestion	Very Appealing Quite Appealing	8 12	40 60

	Not Appealing	0	0
Ergonomic Criteria	Brand Price Easy and Simple to use Times to take to fill the bottle Recommended Compatible with the bottle you've purchase	2 2 12 1 0	10 10 60 5 15 0

SECTION D

Number of Question	Strongly Disagree		Disagree		Unsure		Agree		Strongly Agree	
	N	%	N	%	N	%	N	%	N	%
1	1	5	5	25	2	10	13	65	0	0
2	0	0	2	10	3	15	15	75	0	0
3	0	0	3	15	5	25	10	50	2	10
4	1	5	4	20	3	15	10	50	2	10
5	0	0	4	20	4	20	10	50	2	10
6	0	0	0	0	9	45	9	45	2	10

	Dimension[a]	Mean	S.D.	1st percentile	5th percentile	50th percentile	95th percentile	99th percentile
1	Weight (kg)	49.90	7.59	38.00	40.95	48.07	64.22	72.11
2	Stature	157.94	5.32	146.36	149.44	157.98	167.18	169.48
3	Eye height	146.29	5.15	135.73	137.41	146.03	155.09	158.57
4	Shoulder height	129.71	4.94	119.91	122.73	129.43	139.19	142.30
5	Elbow height	99.02	6.15	90.63	92.25	98.65	105.19	117.82
6	Hip height	78.36	4.08	69.76	72.62	77.90	85.67	87.27
7	Knuckle height	68.26	3.03	61.99	63.55	68.40	73.00	74.20
8	Fingertip height	59.08	2.89	51.97	54.56	59.22	63.11	65.38
9	Sitting height	83.70	5.00	77.22	79.39	84.00	88.43	91.01
10	Sitting eye height	72.97	2.93	66.12	68.76	73.27	76.75	80.55
11	Sitting shoulder height	56.50	4.35	47.13	52.33	56.25	61.24	66.83
12	Sitting elbow height	23.12	2.06	18.96	20.02	23.07	26.04	27.21
13	Thigh thickness	12.01	1.03	10.27	10.62	11.87	13.84	14.90
14	Buttock–knee length	54.54	2.51	49.87	50.96	54.30	59.38	60.37
15	Buttock–popliteal length	46.43	2.22	42.73	43.39	46.12	50.69	52.07
16	Knee height	48.13	2.16	43.96	44.70	47.77	51.77	53.74
17	Popliteal height	40.17	1.41	36.66	38.13	40.08	42.90	43.24
18	Shoulder breadth (bideltoid)	38.75	1.96	35.24	35.83	38.57	41.88	44.67
19	Shoulder breadth (biacromial)	35.19	1.59	31.76	32.60	35.22	37.74	38.64
20	Hip breadth	36.15	2.18	32.36	33.18	35.65	39.91	41.15
21	Chest (bust) depth	19.95	1.67	17.52	17.83	19.70	23.35	24.22
22	Abdominal depth	18.45	1.70	15.23	16.20	18.30	21.76	23.34
23	Shoulder–elbow length	33.36	1.64	30.03	30.80	33.17	36.24	37.12
24	Elbow–fingertip length	42.57	3.52	38.93	39.36	41.92	45.77	47.31
25	Upper limb length	69.71	3.18	63.26	64.72	69.30	75.24	76.35
26	Shoulder–grip length	59.56	2.78	53.83	55.53	59.53	64.54	66.57
27	Head length	17.97	0.64	16.57	16.96	17.93	18.97	19.20
28	Head breadth	14.95	0.58	13.70	14.00	14.95	15.87	16.20
29	Hand length	16.61	0.73	15.20	15.46	16.57	17.84	18.10
30	Hand breadth	7.26	0.34	6.50	6.57	7.30	7.77	7.87
31	Foot length	22.68	0.94	20.50	21.05	22.78	24.00	24.57
32	Foot breadth	8.63	0.47	7.46	7.93	8.63	9.47	9.63
33	Span	157.41	6.86	143.96	146.97	155.60	169.46	172.50
34	Elbow span	81.17	3.35	74.97	76.02	80.55	87.31	88.24
35	Vertical grip reach (standing)	187.12	9.56	170.96	176.16	187.53	201.47	208.29
36	Vertical grip reach (sitting)	114.81	10.86	101.75	106.76	113.38	122.63	153.57
37	Forward grip reach	68.45	3.28	62.91	63.60	67.77	74.13	78.37

Anthropometry data of the female southern Thai population, aged 18–40 years (*n*= 100)