UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF LOW-COST PORTABLE MICROSCOPE (LCPM)

VIISVAN A/L MANIKAM

BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (BMMV) WITH HONOURS

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VIISVAN A/L MANIKAM

Bachelor of Mechanical Engineering Technology (BMMV) with Honours

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VIISVAN A/L MANIKAM

A thesis submitted in fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (BMMV) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this Choose an item. entitled "Development of Portable Microscope" is the result of my research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature : viisvan

Name : VIISVAN A/L MANIKAM

Date : 06/06/2022

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Mechanical Engineering Technology (BMMV) with Honours.

Signature : Ts. KHAIRUL AMRI BIN TOFROWAIH
Pensyarah
Jabatan Teknologi Kejuruteraan Mekanikal
Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan
Universiti Teknikal Malaysia Melaka

Supervisor Name : KHAIRUL AMRI BIN TOFROWAIH

Date : 11 JAN 2023

DEDICATION

This thesis is dedicated to:

My dearest family, My parents, My supervisor, My lecturers, and all my friends. Thanks for the encouragement and support.

ABSTRACT

Microscopes are one of the most important devices in so many fields. A microscope is usually used for magnifying an object or small living things. It is also important to an entomologist. To help species identification as soon as possible to prevent the mosquitoes from dead for remote fieldwork. A microscope that can bring along with the fellow entomologist to help their species identify the mosquitoes on the exact spot they've obtained them. A portable microscope with some additional features and advantages is the purpose of this study. There are some problems faced by them with the usage of a normal microscope. This project aims to design and fabricate a Low-Cost Portable Microscope (LCPM) develop because it creates a device that can be used by entomologists to overcome problems, they faced by using a normal microscope. By conducting a group survey, analyzing the requirements, and identifying the appropriate design concept using Conceptual Design, the House of Quality (HoQ), and Pugh Method. Furthermore, Solidworks software is used to simulate the Portable Microscope model because it allows for a better understanding of the capabilities of each material. We will be able to reduce costs and create Low-Cost Portable Microscope (LCPM) by selecting the best and durable materials.

ABSTRAK

Mikroskop adalah salah satu alat terpenting dalam banyak bidang. Mikroskop biasanya digunakan untuk membesarkan objek atau benda hidup kecil. Ia juga penting kepada ahli entomologi. Untuk membantu pengecaman spesies secepat mungkin untuk mengelakkan nyamuk mati untuk kerja lapangan jauh. Mikroskop yang boleh membawa bersama rakan ahli entomologi untuk membantu spesies mereka mengenal pasti nyamuk di tempat tepat yang mereka perolehi. Mikroskop mudah alih dengan beberapa ciri dan kelebihan tambahan adalah tujuan kajian ini. Terdapat beberapa masalah yang dihadapi oleh mereka dengan penggunaan mikroskop biasa. Projek ini bertujuan untuk mereka bentuk dan mereka bentuk Mikroskop Mudah Alih Kos Rendah (LCPM) dibangunkan kerana ia mencipta peranti yang boleh digunakan oleh ahli entomologi untuk mengatasi masalah, mereka hadapi dengan menggunakan mikroskop biasa. Dengan menjalankan tinjauan kumpulan, menganalisis keperluan, dan mengenal pasti konsep reka bentuk yang sesuai menggunakan Reka Bentuk Konsep, Rumah Kualiti (HoQ), dan Kaedah Pugh. Tambahan pula, perisian Solidworks digunakan untuk mensimulasikan model Mikroskop Mudah Alih kerana ia membolehkan pemahaman yang lebih baik tentang keupayaan setiap bahan. Kami akan dapat mengurangkan kos dan mencipta Mikroskop Mudah Alih Kos Rendah (LCPM) dengan memilih bahan yang terbaik dan tahan lama.

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To achieve the objective of my project, I have done a lot of research by using the Internet, reading last year's thesis, research papers, books, and journals. With the encouragement that I had and the support given to me, I would like to give credit to those who helped me complete my final year project thesis.

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LIST OF SYMBOLS AND ABBREVIATIONS

- LED - Light emitting diode
- BLC - Bare leg catch
- DNA - Deoxyribonucleic acid
- °C - Degree celcius
- PBS - Phosphate Buffered Saline
- UV - Ultraviolet radiation
- TEM - Transmission electron microscope
- SEM - Scanning electron microscope
- USB - Universal serial bus
- RM - Ringgit Malaysia
- 3D - Three dimensional
- HOQ - House of quality
- FDM - Fused deposition modeling
- USAF - United states air force
- FOA - Fiber optic array
- OPM - Oblique plane microscope
- AFM - Atomic force microscope
- AC - Alternating current
- DC - Direct current
- CMOS - Complementary metal oxide semiconductor
- 3T3 - Mouse embryonic fireblast
- nm - Nano meter
- PDMS - Polydimethlysiloxane
- DIH - Digital inline holography
- FOV - Field of view
- MED - Mediterranean
- MEAM - Middle east Asia minor
- PCR - Polymerase chain reaction
- QFD -Quality function deployment
- ITN - Insecticide Treated Net
- RAM - Random access memory
- AMD - Advanced micro device
- SSD - Solid state drive
- kg - kilogram
- LCPM - Low-Cost Portable Microscope

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CHAPTER 1

INTRODUCTION

1.1 Background

The portable microscope is a unique design that is compact and portable. Some are pocketsized, while others are a little bigger. Their size prevents them from holding a mirror and repositioning the picture. They do, however, have a little stage where an object may be shown.

Figure 1.1: Portable microscope (microbite, n.d.)

Portable and pen-sized microscopes with magnifications ranging from 25x to 1000x also utilize batteries and contain an LED light. While some of these microscopes have a focus that can be adjusted. Many tiny microscopes may be used anywhere, including the classroom, and some come with rubberized eyepieces for comfort and safety, particularly when used by young children. Most of these microscopes have no moving parts and are ideal for introducing youngsters to the hidden world around them. (Microbe Notes , n.d.)

Portable microscopes are extremely useful in the manufacturing industry for detecting flaws in electrical components, metals, optics, glassware, and structural problems in equipment.

Pocket microscopes may be modest in size, but their imaging capacity is not. Some of these portable microscopes weigh only a few ounces and have focus powers comparable to, and in some cases exceed standard microscopes. Natural light and button or normal batteries are used to power pen-sized microscopes. High focal tiny optics used in manufacturing are the size of a standard eyepiece lens and may be driven by electricity. Some smaller hand-held microscopes with computer software allow pictures to be delivered immediately to a printer or computer for processing, or to a laboratory or classroom through electronic transmission from a remote location.

The majority of pocket microscopes feature an eyepiece on one end and a light on the other, as well as a tiny stage where an item may be put for inspection. Some do not have a stage thus the microscope is held at the proper viewing angle above the object. When the design of the microscope includes a mirror and lenses to magnify the image, some pocket microscopes see pictures in reverse. Some pocket microscopes, however, are too tiny to carry a mirror that can orient the picture correctly. (Microscope Master, n.d.)

Pocket microscopes were created so that you could see an object up close no matter where you were. Portable microscopes, as opposed to regular microscopes, may be held in the hand, moved over a big object, and carried in a pocket. Portable and pensized microscopes with magnifications ranging from 25x to 100x also utilize batteries and contain an LED light. While some of these microscopes have a focus that can be adjusted. Many include computer capabilities, allowing them to observe sections of bigger objects that are too large to fit on a microscope slide by transferring pictures to a computer.

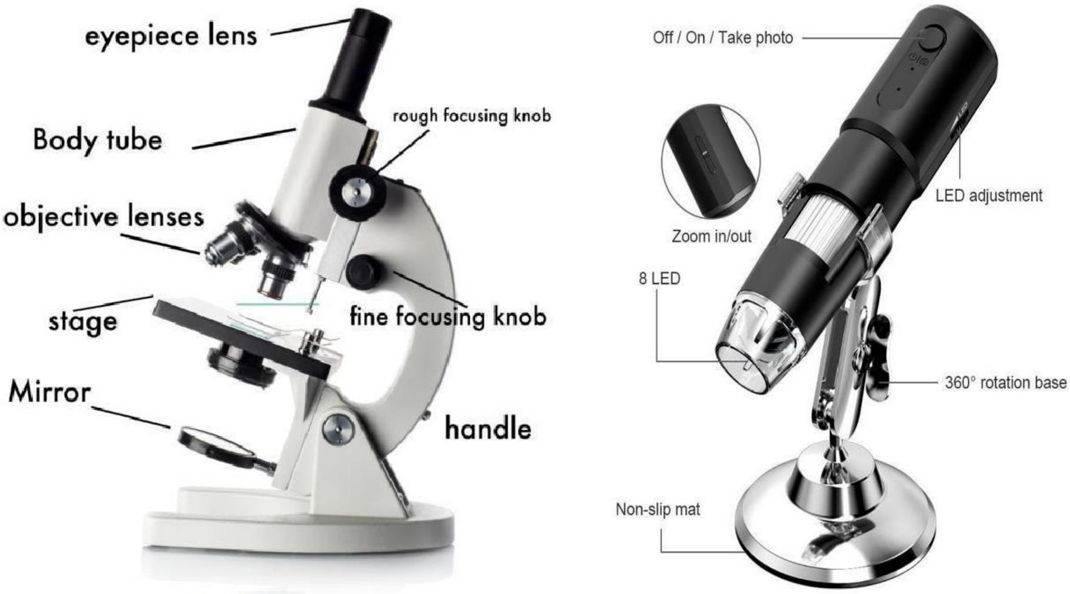


Figure 1.2: Components in Normal Microscope and Portable Microscope (RS Science , n.d.)

1.2 Causes and Effects

Portable microscopes were created so that you could see an object up close no matter where you were. Compare to the normal microscope, a portable microscope is light weighted and able to bring wherever we go. With a portable microscope, we were able to use a microscope on the spot without taking back the sample to the normal microscope that is usually located in the laboratory. Portable microscopes, as opposed to regular microscopes, may be held in the hand, moved over a big object, and carried in a pocket. Portable microscopes provide us with crisp pictures of subjects as tiny as 1 m across a broad field of view with minimum aberrations These tools are fundamental to contemporary microbiology and a variety of other sciences. Microscopists pioneered the use of polarised light illumination, phase contrast, darkfield imaging, and cameras.

1.3 Method

In this research the species used for this project is mosquitoes. The mosquito, the name originates from Spanish for "little fly," is a kind of insect of the Culicidae family. There are many mosquito species, but one distinctive feature is that the female has a tube-like mouthpart called a proboscis that pierces the skin of the host to suck blood. Female mosquitoes need the resources (mostly vitamins) in blood to lay eggs.

Mosquitoes generally prey on vertebrates such as humans and other mammals, as well as birds, reptiles, and other animals. The majority of species choose people or certain animals as the source of their blood diet. Body scents, carbon dioxide, and heat generated by humans or animals attract them. Most mosquitos prefer to bite at specific times of day, such as dusk or morning.

Different species have different preferences for feeding or resting locations; some prefer natural vegetative habitats, while others prefer urban surroundings, notably rubbish or receptacles in yards. Although the itching can be excruciating, the much more significant concern posed by mosquitos is their capacity to act as vectors, or carriers, for a variety of illnesses such as Zika virus, dengue, West Nile, yellow fever, and malaria, among many others. Certain mosquito species transmit disease-causing viruses and parasites. Three mosquito genera transmit the most prevalent mosquitoborne illnesses: Anopheles, Aedes, and Culex. (Rent To Kill, n.d.)

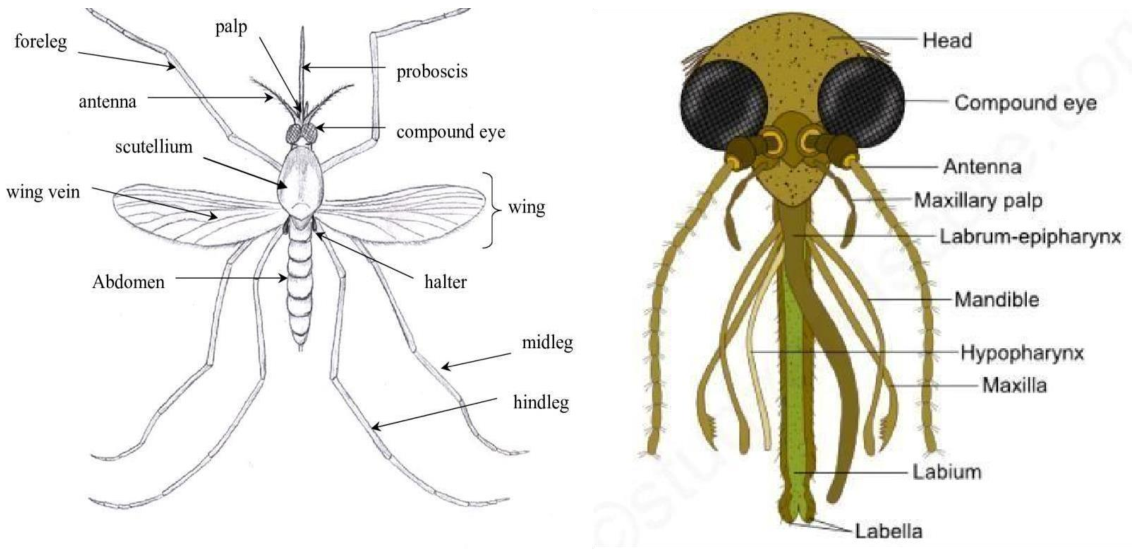


Figure 1.3: body and head parts of a mosquito (ocean county mosquito comission , n.d.)

1.3.1 Bare Leg Catch (BLC)

The bare leg catch (BLC) has long been the gold standard method for monitoring vector populations, including people, they sit with their bottom legs exposed, catching mosquitos that come to feed on them throughout the night. Before sitting Malaria Prophylaxis vaccine is injected from preventing dieses from the mosquito bites.The BLC is a simple, attractive, and efficient instrument. It offers information on the moment of biting and is the most direct measure of mosquito bites. It may be used indoors or outdoors. Data on mosquito bites' time and geographical distribution is critical in many regions where mosquitos attack outside or in the early evening, and it may be even more important in areas where malaria vectors that traditionally feed indoors late at night may be shifting their behaviors in the face of intense pressure from vector control interventions. Moreover, mosquitos are frequently kept alive until handling. This attribute allows a few lab systems that are hard to perform on examples that have been killed or have mid-regions loaded with blood or eggs.

These mosquitos dissected to determine parity as a measure of mosquito age 4-5 or oocyst counts as an indicator of mosquito infection rates. Insecticide resistance tests, which are the direct indicator of the viability of insect poisons utilized for vector control, may also be performed on live mosquitos. Cow bait trap and Ovitrap are among other methods to capture the mosquitoes still BLC is chosen because it's gave fast results and high number of samples within a short period of time.

Figure 1.3.1: Bare leg catch activity at Taman Melaka Baru (pembantu kesihatan awam , n.d.)

1.3.2 Species Identification

The identification of species is critical for ecological monitoring. Species perceptions are utilized to illuminate and assess preservation endeavors such as population trend monitoring, population management plan execution and evaluation, ecosystem health assessments, and extinction analyses.

While specialists identify species in these circumstances regularly, there is also a long record of members of the public submitting identification data to scientific study.

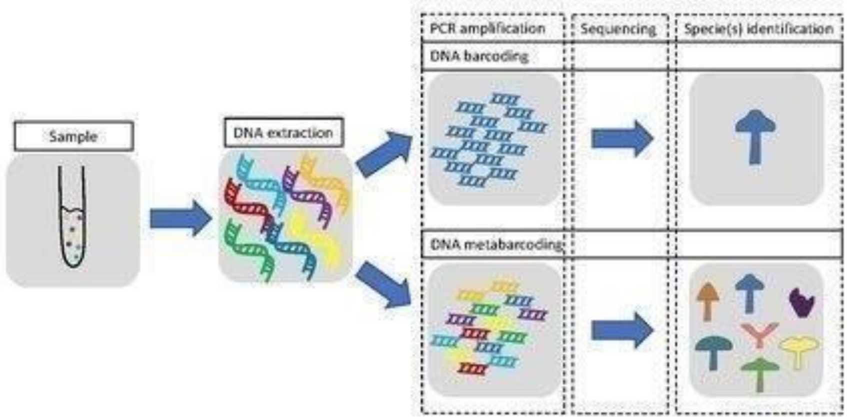


Figure 1.3.2: DNA barcoding method (deWaard, 2019)

All things considered, species recognizable proof has been founded on morphological information and executed in dichotomous ID keys. Examples can likewise be perceived by arrangement similitudes in systematically kept up with succession data sets, on account of straightforward admittance to progressively reasonable DNA sequencing. Even a small piece of DNA is informative for allow conspecific species grouping. As a result, a solitary sub-atomic marker is frequently adequate for DNA "barcoding," in which a novel grouping of a particular marker is alluded to as an animal groups scanner tag. (Ajmal Ali et al., 2014a)

1.3.3 Dissect

Pathogens such as Plasmodium parasites and Dengue viruses enter and leave the mosquitoes midgut and salivary organs. Dissection of mosquito midgut and salivary gland tissues necessitates the preparation of a 1X Phosphate Buffered Saline (1X PBS) solution and the anesthesia of mosquitos by putting them to a temperature of 4°C until immobilized. The mosquitos are kept up with anesthetized by placing them in a Petri dish loaded up with ice. Other tools needed include a light microscope with a 10x objective, a pipettor, finetipped forceps, a glass slide, and needle-tip probes.

Procedures for midget dissection are, to drop a drop of 1X PBS onto a glass slide that has been put under the light microscope. Stabbing the mosquito thorax with a needletip probe, transfer the insect on the prepared slide. While holding the mosquito with the probe, grip the second to last abdominal segment with the forceps and carefully take off the mosquito abdomen in a single motion. The midgut should be kept connected to the immobile thorax. Remove the abdomen. Detach the midgut from the thorax with forceps.

Figure 1.3.3: Dissecting the mosquito (Openwetware, 2006)

For the salivary gland, Drop a drop of 1X PBS onto a glass slide that has been placed under a light microscope. Using a needle-tip probe, pierce the thorax of a mosquito. Using your fingers, remove the legs of the insect. Place the mosquito on the slide. Using forceps, remove the mosquito's head. While holding the mosquito thorax with the probe, gently press down on the thorax with another probe. The salivary organs are situated in the foremost district of the chest and can be isolated by breaking the connections that connect the organ to the chest with a needle-tip test. Salivary glands have three lobes: two lateral lobes and one medial lobe.

1.4 Historical Background

Grinding glass for eyeglasses and magnifying glasses was widely used in the 13th century.

Several Dutch lens makers build machines that magnified things in the late 16th century, but Galileo Galilei perfected the first microscope in 1609.

Figure 1.4.1: Galileo Microscope (1609) (j store daily, 2018) Zacharias Janssen and Hans Lipperhey, both Dutch spectacle manufacturers, are credited with being the first to invent the concept of the compound microscope. They discovered that by putting various types and sizes of lenses on opposite ends of tubes, tiny things were magnified. When Anton van Leeuwenhoek learned that particularly shaped lenses enhanced the size of a picture, he started cleaning and crushing focal points later in the sixteenth hundred years. (University of cambridge , n.d.)

He invented glass lenses that could magnify a thing several times over. Because of the high quality of his lenses, he was able to see countless minute organisms, germs, and fine details of everyday items for the first time in history. Leeuwenhoek is viewed as the dad of microscopy and was instrumental in the formation of cell hypothesis.

The microscope had been in operation for nearly a century when the next big advancement was made. It was difficult to utilize early magnifying lens. Light refracted as it passed from the perspectives, modifying the presence of the picture.

When Chester Moore Hall invented the achromatic lens for use in spectacles in 1729, the quality of microscopes increased. Many individuals would continue to increase the microscope's visual sharpness by using these customized lenses.

Many advancements occurred in both the lodging plan and the nature of magnifying lens over the eighteenth and nineteenth hundreds of years. Microscopes have become sturdier and more compact. A significant number of the optical issues that tormented before forms were settled by focal point overhauls. (microscope.com, n.d.) From this point on, the history of the microscope broadens and extends, with people from all over the world working on comparable advancements and lens technologies at the same time.

August Kohler is credited with developing a technique for giving uniform magnifying instrument light, which empowered examples to be shot. Ernst Leitz created a method for employing numerous lenses on a moveable turret toward the finish of the focal point cylinder to consider varying amplifications with a solitary magnifying lens. Many advancements occurred in both the lodging plan and the nature of magnifying lens over the eighteenth and nineteenth hundreds of years. Ernst Abbe built a a magnifying instrument to permit additional light-range tones to be noticeable, and in a couple of years, Zeiss would have the means to produce the UV microscope. The advent of the microscope enabled scientists and intellectuals to investigate the microscopic animals that existed in their surroundings.

While concentrating on the historical backdrop of the magnifying lens, it is crucial to remember that before these minute animals were found, the reasons for sickness and illness were just theorized and stayed a secret. The magnifying lens permitted people to leave the world overwhelmed by the undetectable and enter an existence where infection causing specialists were seen, perceived, and, over the long haul, forestalled. Charles Spencer established that light affected how pictures were perceived. It required almost hundred years to plan a magnifying lens that worked without the need for light.

Max Knoll and Ernst Ruska developed the primary electron magnifying lens during the 1930s. Electron magnifying instruments can give pictures of the littlest particles, but they cannot be utilized to investigate live creatures. A light magnifying lens can't contend with its amplification and goal.

Figure 1.4.2: First Electron Microscope (1930) (j store daily, 2018) However, to observe living specimens, a conventional microscope is required.

Scanning probe microscopy, which originated with Gerd Benning and Heinrich Rohrer's scanning tunneling microscope in 1981, allows specimens to be seen at the atomic level. Later, in 1986, Benning and his colleagues invented the atomic force microscope, ushering in a genuine age of nano research. The history of the microscope spans decades, yet Leeuwenhoek's basic design has remained constant since the 1600s. The twentieth century saw considerable advancements in the area of microscopy, resulting in a variety of microscopy methods that are now widely used. These are some examples: (Microscope Master, n.d.)

Ernst Ruska and Max Knoll devised and built the Transmission Electron Microscope (1931) based on Leo Szilard's concepts. Instead of light, electrons were utilized in this microscope. Frits Zernike created the phase contrast microscope in 1932 for imaging translucent specimens. Using interference rather than absorption of light, this microscope can image materials without the need for stains. Ernst Ruska invented the scanning electron microscope, which functioned by transferring electrons over the surface of the sample.

Marvin Minsky approach Confocal imaging rule (1957) and utilizes the examining point of light to create fairly more prominent goal than light magnifying lens. It is easy to view virtual slices through thick specimens with this approach.

Godfrey Hounsfield and Allan Cormack created first CAT scanner (1972) technology that incorporates the joining of different X-beam pictures (with the help of a PC) to make cross-sectional perspectives and 3D pictures.

John Venables and CJ Harland found Electron backscatter patterns in 1973 this procedure is used to offer quantitative microstructural data on materials like metal, minerals, and ceramics, among others.

Thomas and Christoph Cremer created the confocal laser scanning microscope in 1978. Scanning Tunneling Microscope (1981) - Gerd Binnig and Heinrich Rohrer invented this technology for studying atom interactions in 1981.

Green Fluorescent Protein (1992) - While Osamu Shimomura, Frank Johnson, and Yo Saiga developed Green fluorescent protein in 1962, it was cloned in 1992 and its derivatives are employed in fluorescence microscopy.

Knoll and Ruska created a transmission electron microscope (TEM), which sends an electron beam (rather than light) through the object. The following interaction of the electron beam with the specimen is captured and converted into a picture. Then, in 1942, Ruska improved on the TEM by creating the first scanning electron microscope (SEM), which sends an electron beam across the specimen. Ruska's methods are still used to build current electron microscopes, which can attain magnification levels of up to 2 million times! The growth of the mass market was the second important development for microscopes in the twentieth century. This practice began in the nineteenth century when Leitz claimed to have sold 50,000 microscopes to the United States and has since intensified in the 20th Century.

(microscope.com, n.d.)

China: With the expansion of its optical manufacturing capacity, China has become a key supplier of daily microscopes and currently supplies optical components to some of the main microscope brands. This market trend has lowered microscope prices, allowing microscopes to move beyond the sphere of research scientists and into ordinary commercial and individual use. (microscope.com, n.d.)

Figure 1.4.3: 21st Century Microscope (j store daily , 2018)

1.5 Problem Statement

The branch of zoology dealing with the scientific study of insects is called entomology. Their job is to study the insects so mostly they will be outdoor to carry out their work. Entomologists mostly will take a sample that is alive for research purposes. A microscope is one of the important pieces of equipment for species identification. All those available microscopes are very hard to bring along with them into the urban and forest areas and more human power is needed if they decided to bring along the microscopes with them. Even though if the normal microscope was brought to the field but still entomologist needs a stable place to position the microscope for following procedures. Besides, it is difficult to use a normal microscope in the field because it’s hard to find an electric power source there.

Species identification is a study of identifying a captured species under an existing DNA barcode. By carrying out that study, entomologists can find new variant species, and endangered species to help them prevent extinction, a key prerequisite to numerous biological issues and much more research purposes.

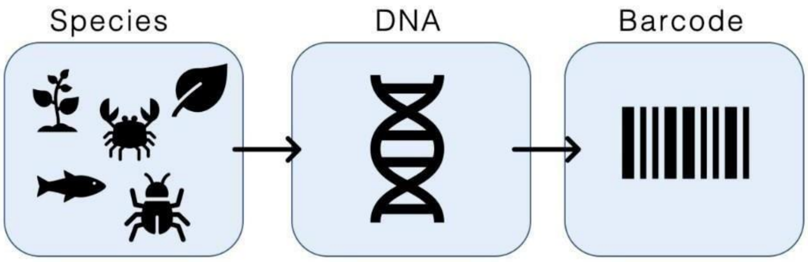


Figure 1.5: Simplified procedure of species identification (bite size bio , 2019)

Therefore, microscopes it's vital equipment for an entomologist. Moreover, mosquitoes are needed alive for species identification and to run multiple tests. Since capturing mosquitoes are not an easy task, the already captured mosquitoes cannot let to die that easily. Since not all the labs are near to the field, the journey from the field to the lab to get access to the microscope makes the mosquito sample does not remain fresh and might die. Because of that, all those mosquitoes captured samples must be used to run all those tests on the spot. Mosquitoes that are alive able to look under microscope by using needle to pin down it's leg so it will prevent it from moving.

1.6 Compare Ideas / Method

30x Pocket Microscope - They provide excellent picture clarity. It's the most popular sort of pocket microscope, and it's reasonably priced at around Rm 25. They are excellent learning tools. They are compact and lightweight, with battery-powered lights. It is primarily designed for children to use (Kids Microscope) however it is NOT a toy. It can also be used to represent jewels.

LED pocket microscopes — They feature a USB-powered LED light source built-in, making them more powerful and efficient. It is less expensive and simpler to use. They feature a magnification capacity of 45x and a plastic body, so they won't shatter if they fall. They have crisp visuals and long-lasting LED light. The SE Mini lighted pocket microscope is the most frequent model. Because it is so compact, it is suitable for carrying in a pocket. It is incredibly inexpensive, costing less than Rm 40. Pocket Microscope 1000x – It has a significantly higher magnification power than the previous two. With such a high magnification power, it is suitable for use in the field, but it may also be used by youngsters and hobbyists. The Carson MicroMax 60x1000x Lighted Microscope, which includes an incorporated LED, is the most prevalent model. It is incredibly light and simple to use. They feature intense illumination combined with outstanding optics, resulting in bright, crisp pictures. The eyepiece is composed of rubber, making it easy to use while viewing. They are also reasonably priced, starting at Rm 65.

1.7 Advantages & Disadvantages

1.7.1 Advantages

Light microscopy is an important technique in current cell biology for various reasons, including its ability to see biology in living cells. These are some examples:

- Portable microscopes are easy to use since they are easy to set up and can be handled by anybody with minimum training and understanding.
- Portable microscopes are substantially less expensive than other types of magnifying lens, including electron magnifying instruments . As a result, they are perfect for low-budget school, college, or research projects. Good quality copies may be acquired for very cheap sums of money, with some examples costing as little as Rm50. Replacement components are inexpensive and simple to get.
- Room — Because portable microscopes are typically compact, they do not take up much laboratory space. Where room is limited, numerous microscopes can be set up so that research can be conducted concurrently as part of a larger project.
- Effectively movable — Since these magnifying instruments are light and convenient, they might be deployed in the place with minimal expense and effort. This makes them especially appropriate for field of investigations, like the foundation of versatile research centers in epidemic areas.
- Non-perturbing — Since light is non-horrendous when used to notice cell architecture, live cells can be photographed for extended periods. These microscopes can thus be used to efficiently study cell dynamics. (Medical Life Science , n.d.)

1.7.2 Disadvantages

- Modest resolution - While a light microscope is perfect for studying specific subcellular structures, its resolution is still very low. The perception is restricted to structures isolated by not exactly a portion of a frequency of light. Designs will become dim and challenging to recognize at this scale and employing additional lenses will do little to improve resolution. Alternative imaging techniques, such as super-goal microscopy and electron microscopy, are required to scan objects that would otherwise be undetectable. Portable microscopes cannot see nuclear designs and moment subtleties of proteins and nucleic acids.
- Inability to offer a 3D depiction of structures — While sound system microscopy may deduce three-dimensional shape from depth seen, versatile magnifying lens can't give inside and out data on the three-dimensional structure. Scanning tunneling magnifying lens and examining electron magnifying lens are suited for this purpose.
- Low magnification caps - Some portable microscopes, especially those at the lower end of the cost range, may accompany very low amplification covers (as low as 40x.) While utilized related to a 10x visual focal point, the most as a rule utilized focal point while working a compact magnifying lens is 10x, which provides a magnification of 100x.
- Inability to work in complete murkiness - Under some situations, portable light microscopes must be utilized. One of the factors that makes it practically hard to operate one is murkiness. To address this issue, counterfeit light sources or inherent illuminators can be added to the device.

1.8 Objectives

To help species identification as soon as possible to prevent the mosquitoes from dead for remote fieldwork. A microscope that can bring along with the fellow entomologist to help their species identify the mosquitoes on the exact spot they've obtained them. A portable microscope with some additional features and advantages is the purpose of this study.

1) To design a low-cost portable microscope using structured Pugh's method.

2) To fabricate a prototype of a low-cost portable microscope

1.9 Scope

The scope of this project has some limitations. First, the customer requirement for a portable microscope is obtained through a survey. The distribution of the survey to the fellow entomologist in Melaka. Next, the design of the portable microscope is based on the responses from the survey, using Solidworks 2020.

Use the House Of Quality(HOQ) technique to exhibit how buyer needs are firmly connected with the procedures and strategies that organizations might utilize to meet those objectives. To do scoring method to create an overall comparison, combine the findings of several evaluation methodologies.

CHAPTER 2

LITERATURE REVIEW

2.1 Type of Microscope

2.1.1 High Resolution

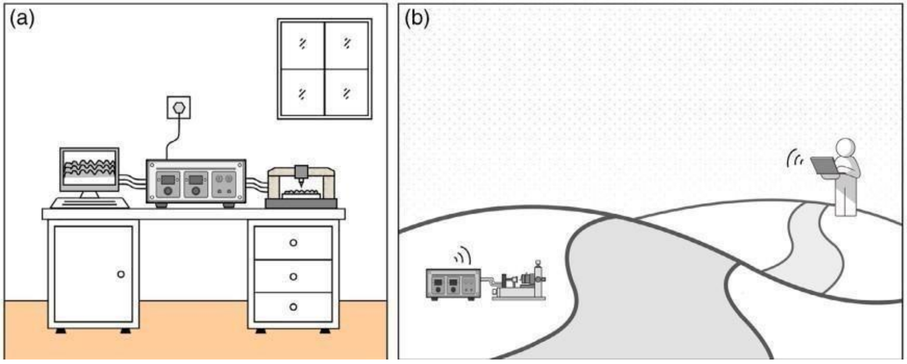
High-resolution optical microscopes are required for microscopic imaging, but they are costly and cumbersome. For smallness, the picture sensor's closeness to a business magnifying instrument objective focal point. The use of an image sensor with a tiny pixel size aids in reducing information loss, resulting in high-resolution pictures. A microscope is an important instrument in the study because it allows for the observation of micro-sized objects and biological forms.(Purwar et al., 2019) A color microscope is capable of producing lens-less color pictures with a field of view of more than 20 mm2. The color components of an RGB picture are transformed into YUV color space during image processing. To validate sub-micron spatial resolution, a USAF test chart was used to assess the resolution of our super-resolution color microscope.(Greenbaum et al., 2013) Long optical channels incorporating a succession of lenses and filters are used in modern commercial high-resolution microscopes. Modern microscopes are extremely expensive and heavy, limiting their use to underfunded research institutions. (Purwar et al., 2019)

A high-resolution microscope also can be used with a fiber-optic array (FOA) with a preamplification lens. This microscopy is excellent for monitoring cells in microfluidic devices in real-time. The preAL-FOA approach yielded the highest resolution. (W. Wang et al., 2018)

Oblique plane microscope (OPM) has a custom glass-tipped tertiary goal that improves resolution, the field of vision, and usability over prior models. This microscope delivers lateral and axial resolutions similar to the square brightening method of grid light-sheet microscopy, yet at the same in a more user-friendly and adaptable configuration, thanks to its high numerical aperture optics. (Sapoznik et al., 2020)We show high-goal imaging of clathrin-intervened endocytosis, vimentin, the endoplasmic reticulum, layer elements, and Natural Killer-interceded cytotoxicity using this capability. Moreover, biological processes that sounds troublesome or inconceivable to capture using a standard light-sheet microscope geometry, such as cell movement via tight regions within a microfluidic device and subcellular photoactivation. (Sapoznik et al., 2020)

2.1.2 Wifi Controlled

The Wifi-controlled portable atomic force microscope (AFM) is a horizontal probe, regulating circuitry, computerized to simple (D/A) and simple to computerized (A/D) interfaces, a microprocessor (Raspberry Pi, RPi), and a laptop comprise the AFM. The suggested AFM makes use of a pocket-sized power source to power the controlling circuits, D/A and A/D interfaces, and the Raspberry Pi, which creates network areas of interest and creates filtering signals. Both the AFM probe and the electronic controlling system are portable due to the unique design and integration of the entire system. Experiments in the constant height and constant force modes are carried out at a distance of 50 m from the proposed AFM to evaluate its performance. (Y. Wang et al., 2019)

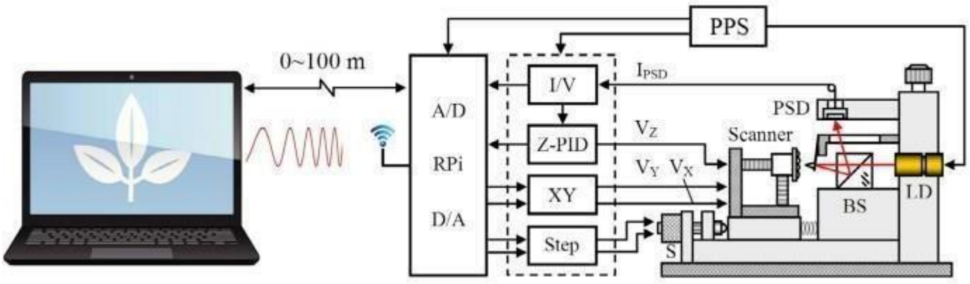


{Figure 2.1.2.1: Calculated graph of (a) traditional AFM dependence on indoor AC mains supply and line association and (b) WiFi-controlled versatile AFM }(Y. Wang et al., 2019)

WiFi-controlled AFM has a greatest sweep scope of 3.6 3.6 m2 and a nanometer order resolution. Meanwhile, picture contrast, stability, and repeatability are all good. In comparison to ordinary AFMs, the AFM proposed in this paper does not require a commercial AC mains supply or a high-voltage DC power supply, and it can perform WiFi-controlled AFM scanning and imaging at distances of 50 m or more without requiring a wire or network cable connected to a laptop or a desktop computer. Given these advantages, WiFi-controlled AFMs are projected to have a broader variety of applications, particularly in isolated areas, outdoor research, and fieldwork investigations.(Y. Wang et al., 2019)

{Figure 2.1.2.2: Schematic diagram of the system of a WiFi controlled portable AFM}

(Y. Wang et al., 2019)



2.1.3 Mobile based microscope

Despite much-suggested research, the practical uses of mobile phone-based tiny microscopes remain fairly restricted. Unfortunately, tiny microscopes still have certain limitations. Miniature microscope image performance is typically lower than that of standard bench-top devices. Reversed camera lens-based small microscopes may produce high-resolution and low-distortion microscope pictures, but they have a constant magnification ratio, which is problematic when compared to standard microscopes with switchable object lenses. Another issue is that cell phone tiny microscopes are difficult to use. Microscopic imaging necessitates careful control of the working distance between the microscope and the sample via a mechanism or shell, but it is often cumbersome to establish and accurately alter the working distance.(Wan & Tao, 2021) If sophisticated adjustment structures are required, the advantages of mobility and convenience of small microscopes would be lost. Deployment. Furthermore, in some cases, more than one small microscope is required. When it comes to synchronous scanning and mosaic imaging, it is necessary to apply them. Surface measurement of huge samples from the real world is tough to achieve. Since various cell phone cameras can't be utilized to accomplish the point with the depicted plans arranged intently and actually one next to the other. The widespread availability of mobile phones and their related digital cameras provide the opportunity to provide minimal expense, convenient symptomatic microscopy to underserved and low-asset locations. However, due to the particular design of the integrated camera lens, mobile phone microscopes made by attaching amplifying optics to the telephone's camera module have been not able to take advantage of the entire picture sensor, compounding the trade-off among goal and field of vision inherent in optical systems. This trade-off is most noticeable in symptomatic applications, where the time and cost of image-based diagnosis are proportional to the region of the example that can be examined at an acceptable resolution. (Switz et al., 2014) A simple and low-cost technique for cell phone microscopy that utilizes a switched cell phone camera lens attached to an undamaged mobile phone to permit high-quality imaging across a far greater field of view than normal microscopy. The results show how to utilize a mobile phone microscope with a reversed lens to distinguish red and white platelets in blood spreads and soil-sent helminth eggs in feces tests.

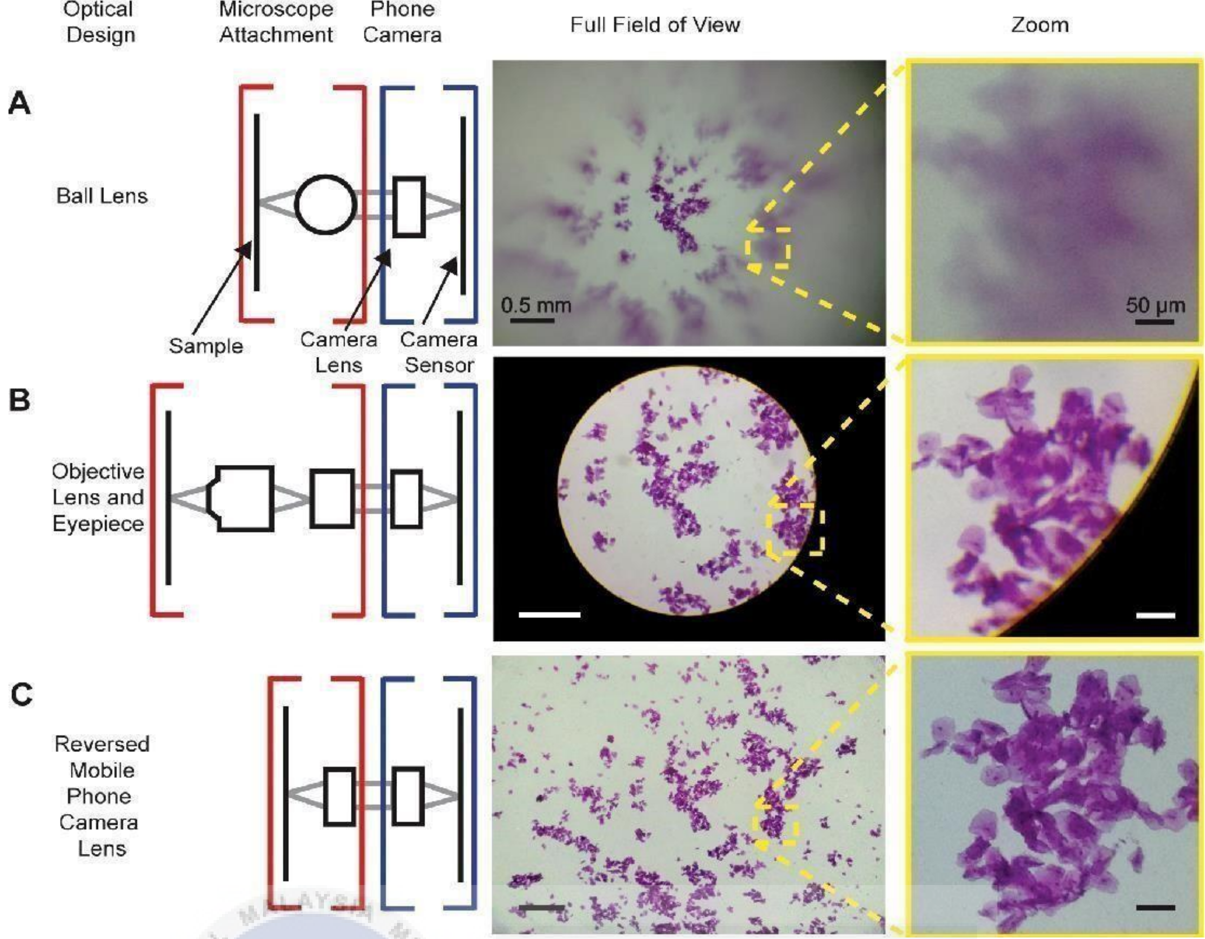


Figure 2.1.3: Results of different types of the lens with the phone camera(Wan & Tao, 2021)

Mobile phone microscopes are compared. A) Animation schematic of a ball focal point cell phone magnifying lens (left panel). Outside of the phone, red brackets show microscope attachment optics (a ball lens), while within the phone, blue sections show cell phone camera optics (a focal point bunch and CMOS sensor). Picture of stained cheek epithelial cells obtained using a 6 mm ball lens in the middle panel. Right panel: Enlargement of the region indicated in the middle panel by the dashed line. B) Left panel: A cartoon schematic of a conventional finite objective microscope attached to a mobile phone, which includes a goal and an eyepiece. Picture of stained cheek epithelial cells obtained using a 4X/0.10 NA objective and a 20X eyepiece in the middle panel.

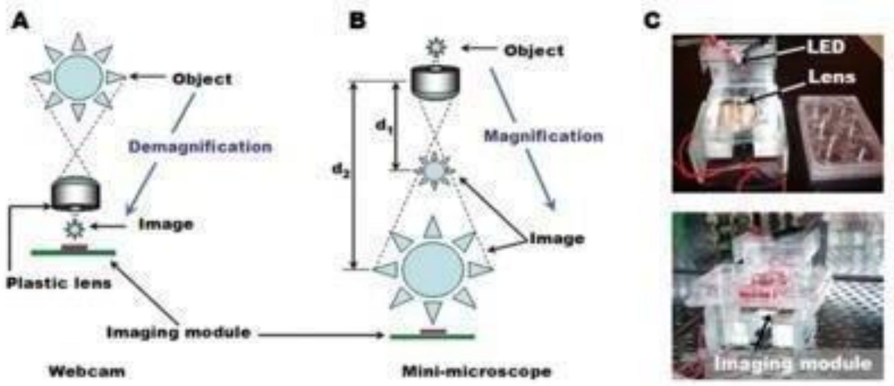
Right panel: Enlargement of the region indicated in the middle panel by the dashed line. Although the picture is in focus in the middle of the field of vision, some image deterioration owing to field curvature is seen near the field's periphery. C) Left panel: Animation schematic of the switched focal point magnifying lens reported in this article, with opposing identical lens groups outside and within the phone (red brackets) (blue brackets). Image of stained cheek epithelial cells taken using the opposing lens group arrangement in the middle panel. Right panel: Enlarged version of the region indicated in the center panel by the dashed line. Even though the image is concentrated in the middle of the field, no field curvature is visible. (Switz et al., 2014)

2.1.4 Commercial webcam-based microscope

A smaller than normal magnifying lens for in-situ cell following was made by modifying off-the-rack parts of a business webcam. A complementary metal oxide semiconductor (CMOS) imaging module, a tiny plastic lens, and a white LED light source to comprise the mini-microscope. For picture acquisition and processing, the CMOS imaging module was linked to a laptop computer through a USB connector. Because of its small size (8 10 9 cm), the current microscope is portable and can easily fit inside a standard incubator, allowing for real-time observation of cellular behavior. Furthermore, the mini-microscope may be utilised to image cells in standard cell culture carafes such Petri dishes and multiwell plates. To illustrate the mini-functioning, microscope's we observed the cell movement of mouse 3T3 fibroblasts in a scratch experiment in media containing three different concentrations of foetal bovine serum (5, 10, and 20%) and found that the responses differed contingent upon serum levels. (Kim, Koo, et al., 2012)

Figure 2.1.4: Results of traditional webcam based microscope and mini microscope (Kim, Koo, et al., 2012)

{(A) The plastic lens in a traditional webcam serves to demagnify the objects. (B) The plastic lens of the mini microscope was reversed and utilized for magnification.



Not set in stone by the distance between the picture module and the focal point. (C) For in situ cell observing, the smaller than normal magnifying lens is viable with For in situ cell checking, the little magnifying instrument is viable with standard cell culture equipment and conveniently fits within a cell culture hatchery.(Kim, Koo, et al., 2012)}

In addition, embryonic stem cells within polyethylene glycol microwells used a mini microscope to study the creation of stem cell aggregates in real-time. Furthermore, a lab on-a-chip microfluidic system is used for microdroplet creation and analysis in conjunction with a mini-microscope to study droplet development under different stream conditions. Given its modest expense, vigorous imaging, and mobility, the described platform may be beneficial for a variety of applications requiring continuous cell imaging utilizing lab-on-achip gadgets.(Kim, Koo, et al., 2012)

2.1.5 Lenses Technology

Under white lighting conditions, ordinary magnifying instrument objective focal points are diffraction restricted; they cannot discern sub diffraction details smaller than 250-300 nm. To overcome this constraint, new inventions are necessary. Demonstration of a novel superlensing objective lens with a resolution of 100 nm, a resolution enhancement of two times over standard objectives. Using a bespoke lens adapter, a standard magnifying instrument objective focal point is joined with a superlensing microsphere focal point. The novel objective lens was successfully shown in engineering and biological materials, counting a Blu-beam plate test and adenoviruses, providing mark free super-goal imaging of 100 nm highlights. Our findings pave the way for the development of a general optical super-lens, which has the potential to revolutionise the field of optics.(Yan et al., 2017)

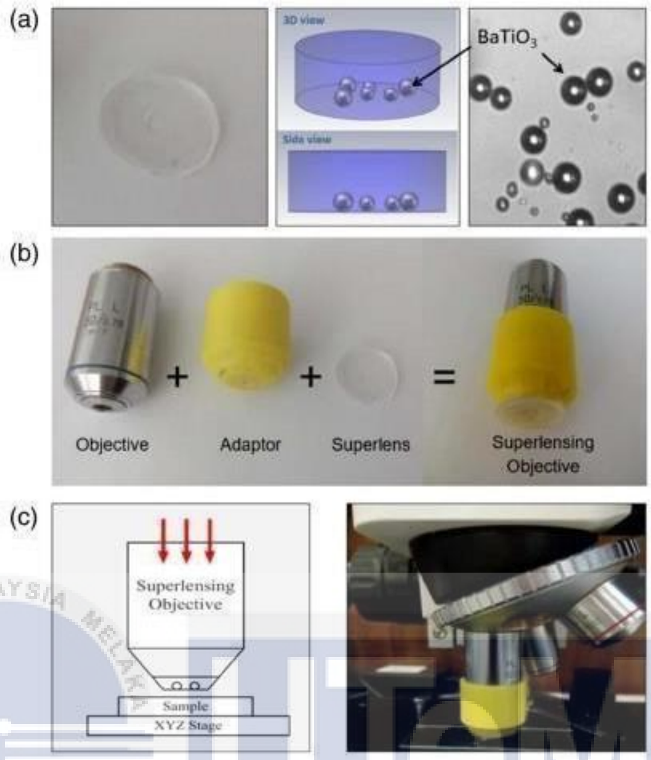


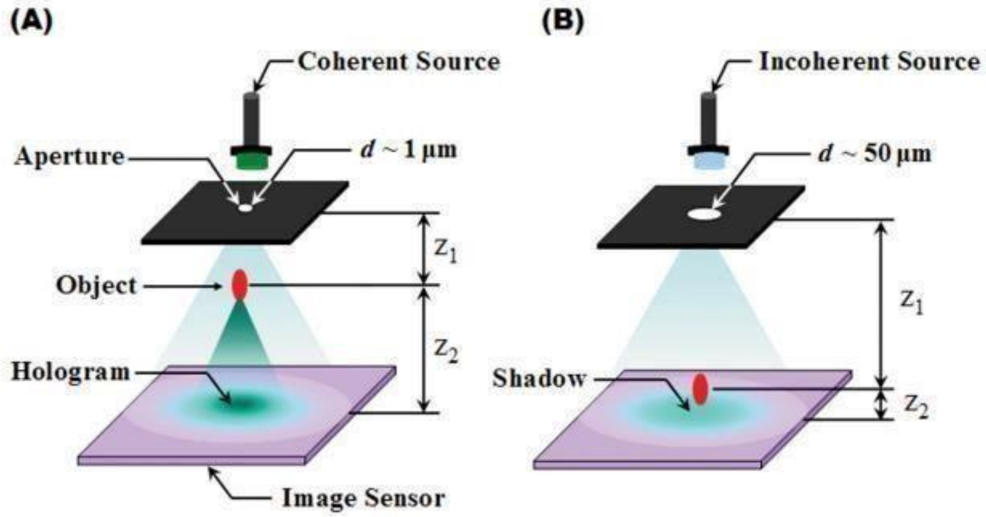
Figure 2.2.1: Objective lens with superlensing (Yan et al., 2017)

(a) A monolayer of BaTiO3 microspheres was encapsulated to form a BaTiO3 super lens.
(3-80 m in width) inside a PDMS substance

(b) Incredibly objective was made by integrating a standard magnifying instrument objective focal point (for instance, 50, NA: 0.70, or 100, NA: 0.95) utilizing a BaTiO3 microsphere

(c) Experimental arrangement of a superlens with a 3D manufactured adapter for highresolution imaging with a designed objective mounted on a regular whitelight optical microscope

Exhibited a novel form of microscope objective lens, a superlensing objective lens, which combines a regular objective lens with a coverslip-like microsphere super lens.



The new lens is easier to use and can picture the sample with high goal in both static and checking modes. Under white light illumination, a resolution of 100 nm has been shown. The created superlensing objective focal point can possibly be commercialised, transforming an existing microscope into a nano scope.(Yan et al., 2017)

Besides, lens-free (or lensless) imaging is gaining popularity as a low-cost, small, and lightweight detection approach with a wide range of biological applications. Lens-free imaging may produce high-resolution pictures on a field-portable platform, making it perfect for low-cost point-of-care systems aimed at resource-constrained environments. Different methods of activity for focal point free imaging prior to featuring various late natural utilizations of this creating stage innovation.(Kim, Bae, et al., 2012)

Figure 2.2.2: Results of coherant and incoherant source (Kim, Bae, et al., 2012)

(A) and lens-free on-chip imaging systems that are incoherent or partly coherent (B). The distance between the gap and the item planes is z1, the distance between the item and the picture sensor planes is z2, and the aperture diameter is d.

DIH uses a tiny opening and a rational light source (e.g., a laser) to place the item closer to the light source. A comparatively bigger opening and a confused or somewhat lucid light source are employed in incomprehensible or to some extent reasonable focal point free on-chip imaging devices, and the object is situated a lot nearer to the picture sensor plane.}

Certain new lens-free technologies and their medicinal applications Lens-free photography, in general, offers a field-portable, cost-effective, and fast imaging toolset, and its applications are growing. Recent developments in lens-free imaging have demonstrated a larger FOV and greater resolution, which have direct implications in high-throughput biosensing. As a result, lens-free imaging can bridge the layered hole between lab-on-achip parts and microscopy, resulting in a potent approach to a portable point-of-care diagnostic system. (Kim, Bae, et al., 2012).

2.2 Species Identification

Species have been defined using morphological characteristics. This procedure is time demanding and requires well-trained taxonomists. More significantly, morphology makes enigmatic species and examples from juvenile stages difficult to identify. One of the top 100 invasive species, the sweet potato whitefly (Bemisiatabaci), is a mysterious animal categories complex with north of 39 putative species. Two B. tabaci complex species, Mediterranean (MED) and Middle EastAsia Minor 1 (MEAM1), are worldwide invasive and have different pesticide resistance. 2. Rapid differentiation of B. tabaci complex species is required for proper quarantine and pest management techniques to be implemented.(Hsieh et al., 2020) Throughout the course of recent many years, educating and research financing in scientific categorization have declined due to its traditional method of practise, which has frequently led the discipline to a point of contention, giving rise to a number of problems and challenges, and thus the taxonomist has become an endangered species in the era of genomics. Taxonomy has recently regained popularity as a result of breakthrough techniques to taxonomy such as DNA barcoding (a clever innovation to give quick, precise, and robotized species IDs utilizing short orthologous DNA successions). A full data set may be retrieved from a single specimen via DNA barcoding, regardless of physical or life stage characteristics. (Ajmal Ali et al., 2014b)

The primary concept of DNA barcoding is based on the notion that highly conserved segments of DNA, whether coding or non-coding areas, fluctuate only slightly during species history. Cytoplasmic mitochondrial DNA (e.g., cox1), chloroplast DNA (e.g., rbcL, trnL-F, matK, ndhF, and atpB rbcL), and nuclear DNA have all been proposed as useful in DNA barcoding (ITS, and housekeeping genes e.g. gapdh). Plant DNA barcoding is currently at the pinnacle of species identification, ultimately aiding in the molecularization of taxonomy, a critical need of the hour. The 'DNA barcodes' offer promise in terms of providing a practical, standardised species-level identification tool that may be used for biodiversity assessment, life cycle and ecological research, forensic investigation, and a variety of other applications.(Hsieh et al., 2020)

For DNA extraction the samples must stay alive to get better result

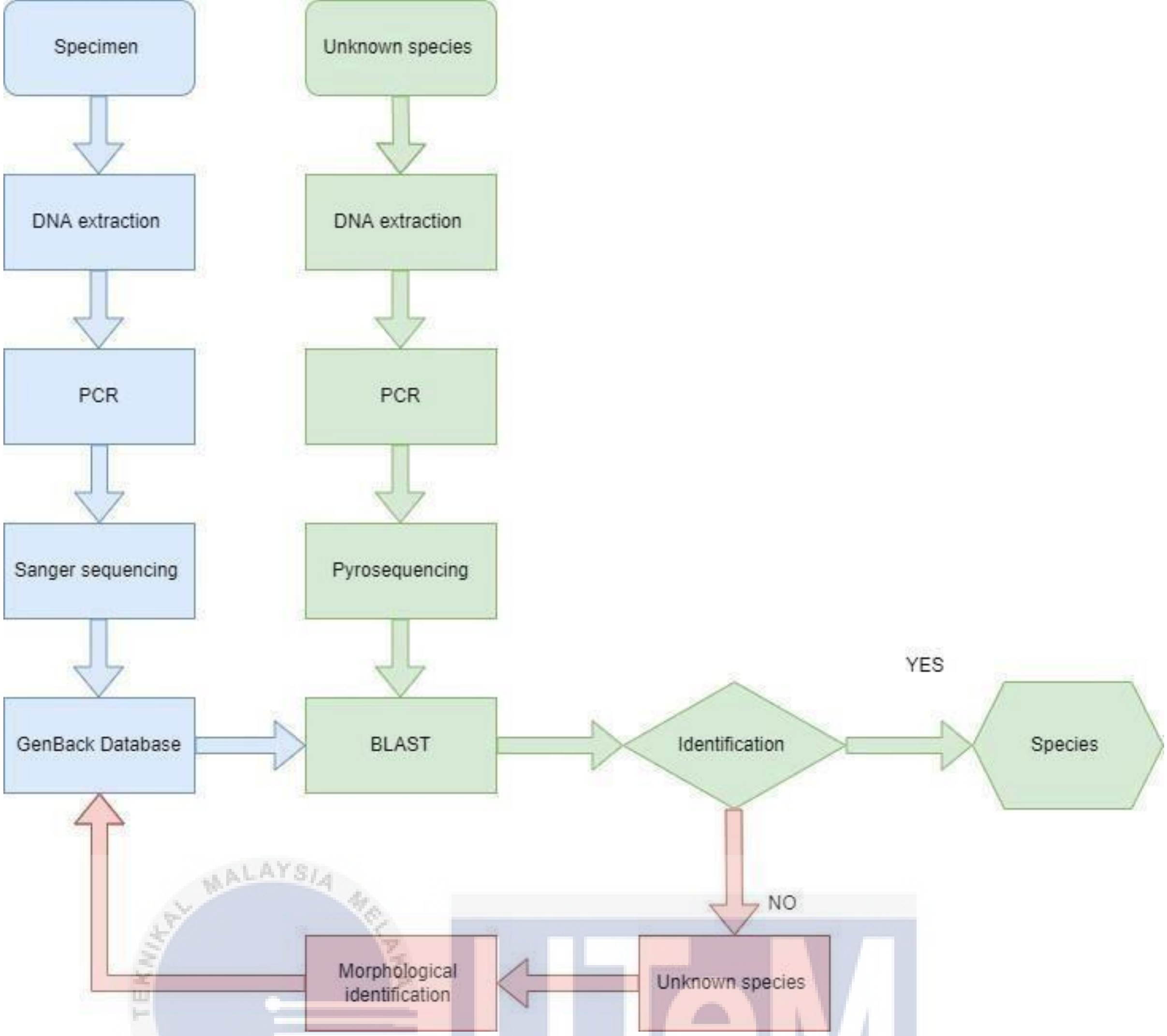


Figure2.3 : work process of smaller than normal standardized tag pyrosequencing for a fast

animal types distinguishing proof framework

2.3 Pugh Method

The Pugh Matrix is a decision matrix based on criterion scoring that determines which of numerous probable options should be chosen. This strategy has become an essential component of Six Sigma methodology. Consultants generally employ the Pugh matrix following the completion of VOC (Voice of the Customer) surveys and the development of a QFD (Quality Function Deployment). Other names for the Pugh Matrix include choice matrix / grid, selection matrix / grid, issue matrix, opportunity analysis, criterion rating form, and criteria-based matrix.

The Pugh matrix enables the consultant to arrange multiple criteria (or aspects) of a solution for simple comparison. A consultant can use this matrix to create an ideal solution, which is a hybrid of other powerful solutions. This matrix also enables a team-based method for disciplined concept generation and selection.

1) Determine the necessary user requirements or criteria. The example uses fairly broad criteria. A concrete example would be more specific.

2) Create weights for each need. This is optional for scoring weighting. You may achieve this by employing various weighting algorithms.

3) Develop multiple plausible solutions options.

4) Choose one of the choices as a baseline to determine the present situation.

5) Against the baseline, rate each option as good, negative, or equal in terms of satisfying the criteria.

6) Total the values from each choice, multiplying each value by its weight if the optional scoring method was applied. (See also step 2)

7) Combine the finest features of each choice to produce the greatest hybrid solution. (Frey et al., 2007)

2.4 Bare Leg Catch

The Bare Leg Catch (BLC) has long been the gold standard method for monitoring vector populations, including people sitting with their lower legs exposed and capturing mosquitoes that come to feed on them throughout the night. The BLC is a straightforward, elegant, and effective instrument. It is the most direct measure of mosquito bites, may be used indoors or outdoors, and provides information on the moment of bite. Data on the temporal and spatial distribution of mosquito bites is important in many areas where mosquitoes bite outside or early in the evening, and it may be even more important in areas where malaria vectors that traditionally feed indoors late at night may be shifting their behaviours in the face of intense pressure. Furthermore, mosquitos are often kept alive until processing. This trait permits several laboratory procedures that are difficult to perform on specimens that have been killed or have abdomens full of blood or eggs. These mosquitos can be dissected to determine parity as a measure of mosquito age4, 5 or oocyst counts as an indicator of mosquito infection rates. Insecticide resistance tests, which are the most direct indicator of the efficacy of insecticides used for vector control, may also be performed on live mosquitos.

Figure 2.5: Activity Bare Leg Catch at Kem Sungai Besi, Cheras KL

The BLC, on the other hand, has at least two drawbacks. One is that, in order to get trustworthy data, the BLC necessitates close monitoring of employees who must stay awake for the most of the night performing a duty that can be quite monotonous.

Another downside is that it raises ethical and safety concerns. The World Health Organization now advises that all people living in malaria-endemic regions have universal Insecticide Treated Net (ITN) coverage. As a result, hiring people to stay up all night collecting host-seeking mosquitos exposes them to malaria that they could have avoided if they had been protected by an ITN. In the past, vector control initiatives were limited, if not totally absent, and most individuals in malaria-endemic areas were thought to have enough acquired immunity against malaria that exposure to malaria-infected mosquitoes while performing BLCs posed little to no additional risk. With malaria transmission declining in many locations, malaria infection may be harmful to adults who may have lesser acquired immunity due to less malaria exposure than in the past. Furthermore, under universal ITN policy, intentionally exposing adults to malaria infection is no longer allowed. One option to continue obtaining vital information only available through BLCs while protecting adults from malaria infection is to equip collectors with malaria chemoprophylaxis to prevent malaria infection even if exposed to an infected mosquito. Chemoprophylaxis has been demonstrated to be particularly efficient in both non-immune tourists and semiimmune populations living in malaria endemic areas in avoiding malaria. (Ismail et al., 2018)

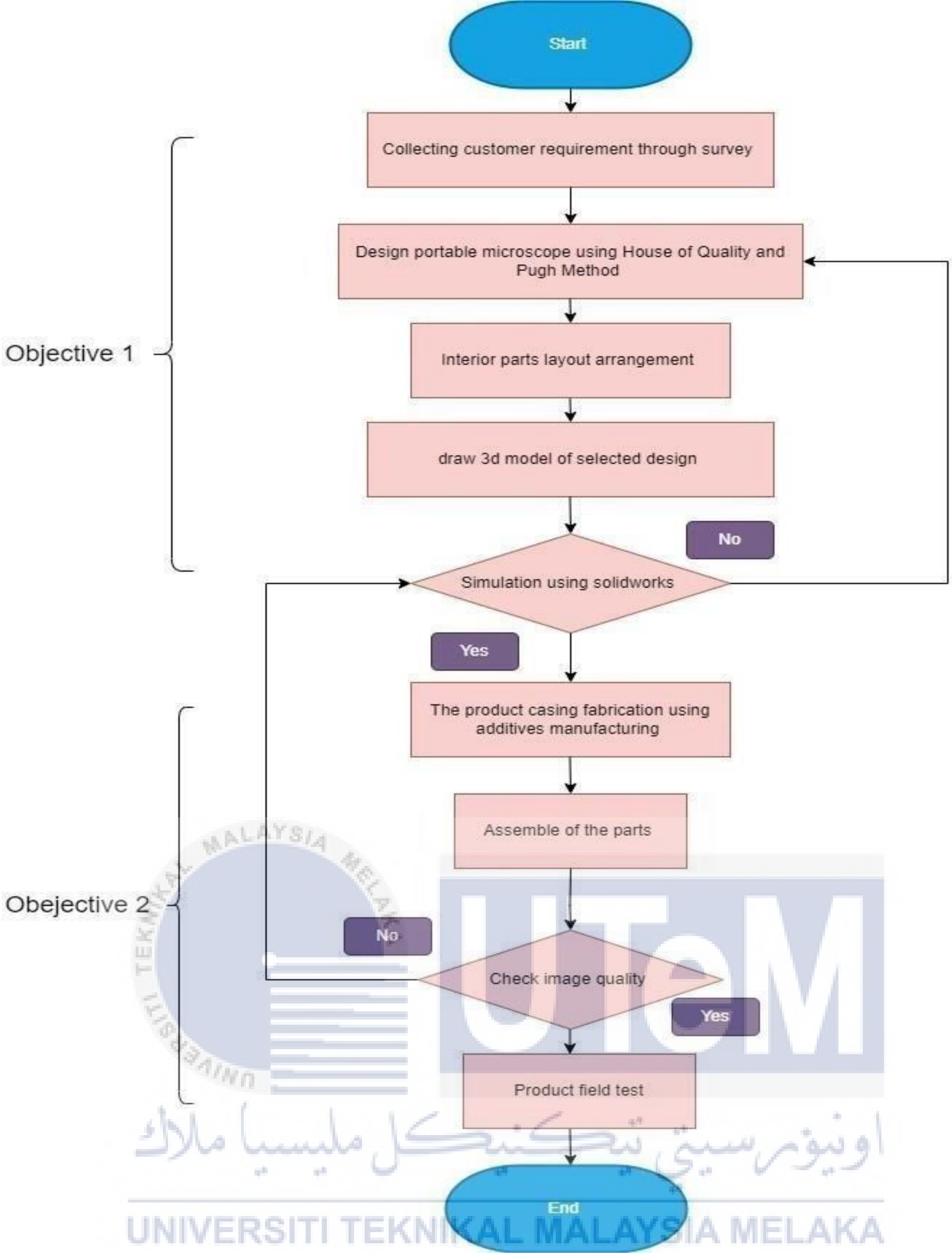
CHAPTER 3

METHODOLOGY

3.1 Introduction

This part portrays the philosophy applied to accomplish the targets of the review. The procedure objective is to portray the means that will use to complete the review connected with the examination point and furthermore to indicate the hypothetical efficient investigation of the review. The House of Quality (HoQ) and the Pugh Method are the parts of this chapter to choose the best design. From those parts, it makes sense of how the 'Compact Microscope' was made by thinking about the designing and client necessities. This part segment additionally will talk about the idea plan, last plan, and limit condition. The philosophy is significant in mechanical plan since it will show the means of the plan cycle. The figure below is the process involved in the Methodology for designing the Portable Microscope'

Figure3.1: The methodology flowchart for portable microscope


Start
Collecting customer requirement through survey
Design portable microscope using House of Quality and Pugh Method
Interior parts layout arrangement
draw 3d model of selected design
No
Simulation using solidworks
Yes
The product casing fabrication using additives manufacturing
Assemble of the parts
No
Check image quality
Yes
Product field test
End
Objective 1
Obejective 2

3.2 Design survey questions

The goal of this research is to create a structure and mechanism for the portable microscope. For this survey was given to fellow entomologist, Melaka. The survey is divided into three sections. The first section is demographic data, which includes six questions about gender, working experience, years of experience using a microscope, how frequently the microscope will be used in a month, ever used a portable microscope, and the rate the idea of the portable microscope. Section B includes 7 questions about how often 'bare leg catch' is carried out in a year, does capture mosquitoes needed alive to run more tests, prefer portable microscope with the help of a smartphone, preferred power source, rating the 'eye comfort' criteria and preferred power of magnification. There are ten sets of questions in Section C as shown in Table 3.3. Each question will have a fivepoint scale ranging from least to most important. The efficiency of the product, easy to use, eye comfort, durable material, lightweight, robustness, affordable, and multifunction are among the features that are been evaluated.

<table>
<tr><td colspan="4">DEMOGRAPHIC ASPECT</td></tr>
<tr><td colspan="4">SECTION A</td></tr>
<tr><td rowspan="5">GENDER</td><td rowspan="2">MALE</td><td rowspan="5">YEARS OF EXPERINCE AS ENTOMOLOGIST ?</td><td>1-5 YEARS</td></tr>
<tr><td>6-10 YEARS</td></tr>
<tr><td rowspan="3">FEMALE</td><td>11-15 YEARS</td></tr>
<tr><td>16-20 YEARS</td></tr>
<tr><td>ABOVE 21 YEARS</td></tr>
<tr><td colspan="2" rowspan="4">YEARS OF EXPERIENCE USING A MICROSCOPE?</td><td colspan="2">1-5 YEARS</td></tr>
<tr><td colspan="2">6-10 YEARS</td></tr>
<tr><td colspan="2">11-15 YEARS</td></tr>
<tr><td colspan="2">ABOVE 16 YEARS</td></tr>
<tr><td colspan="2" rowspan="5">HOW FREQUENTLY DO YOU USE A MICROSCOPE IN A MONTH?</td><td colspan="2">1-4 TIMES PER MONTH</td></tr>
<tr><td colspan="2">5-8 TIMES PER MONTH</td></tr>
<tr><td colspan="2">9-12 TIMES PER MONTH</td></tr>
<tr><td colspan="2">13- 16 TIMES PER MONTH</td></tr>
<tr><td colspan="2">20- 23 TIMES PER MONTH</td></tr>
</table>

	ABOVE 23 TIMES

EVER USED A PORTABLE MICROSCOPE BEFORE THIS?	YES
	NO
HOW MUCH DO YOU RATE THE IDEA OF USING A MICROSCOPE? 5= STRONGLY AGREE 4= AGREE 3= AVERAGE 2= DISAGREE 1= STRONGY DISAGREE	5
	4
	3
	2
	1

Table 3.2.1: Survey questions section A

SECTION B	
HOW FREQUENT 'BARE LEG CATCH' WILL BE CARRIED OUT IN ONE YEAR?	1-4 TIMES PER YEAR
	5-8 TIMES PER YEAR
	9-12 TIMES PER YEAR
	13- 16 TIMES PER YEAR
	17-20 TIMES PER YEAR
	21-24 TIMES PER YEAR
DOES CAPTURED MOSQUITO NEED TO STAY ALIVE TO RUN MORE TESTS? (FOR EXAMPLE SPECIES IDENTIFICATION)	YES
	NO
DO YOU PREFER A PORTABLE MICROSCOPE WITH THE HELP OF A SMARTPHONE? 	YES
	NO
PREFERED POWER SOURCE FOR THE PORTABLE MICROSCOPE?	BATTERY AAA

	PHONE

	POWER BANK
HOW MUCH ARE THE 'EYE COMFORT' CRITERIAIS IMPORTANT WHILE USING A MICROSCOPE? 5= VERY IMPORTANT 4= IMPORTANT 3= NEUTRAL 2= UNIMPORTANT 1= VERY UNIMPORTANT	1
	2
	3
	4
	5
PREFERED POWER OF MAGNIFICATION	50X 

Table 3.2.2: Survey question section B

	160X 
	500X 
	1000X 

PRODUCT SPECIFICATION					
SECTION C					
CRITERIA	1 (NOT IMPORTANT)	2 (LESS IMPORTANT)	3 (NEUTRAL)	4 (IMPORTANT)	5 (VERY IMPORTANT)
1. EFFICIENCY OF THE PRODUCT					
2. AFFORDABLE					
3. EYE COMFORT					
4. EASY TO USE					
5. LIGHTWEIGHT					
6. MULTIFUNCTION					
7. ROBUST					
8. ABILITY TO ZOOM IN & OUT					

Table 3.2.3: Survey questions section C

3.3 House of quality

Several criteria have been considered for this ‘portable microscope’ to assist entomologists in their needs. As a result, the House of Quality method can be used to analyze it. The House of Quality (HOQ) is an item arranging grid that exhibits how client prerequisites are connected to the strategies and cycles that organizations can use to meet those necessities. Next, A client's necessities and prerequisites are laid out, then, at that point, used to construct and focus on help contributions and items. Figure 3.2 showed the House of

Quality (HoQ) for the Portable Microscope.

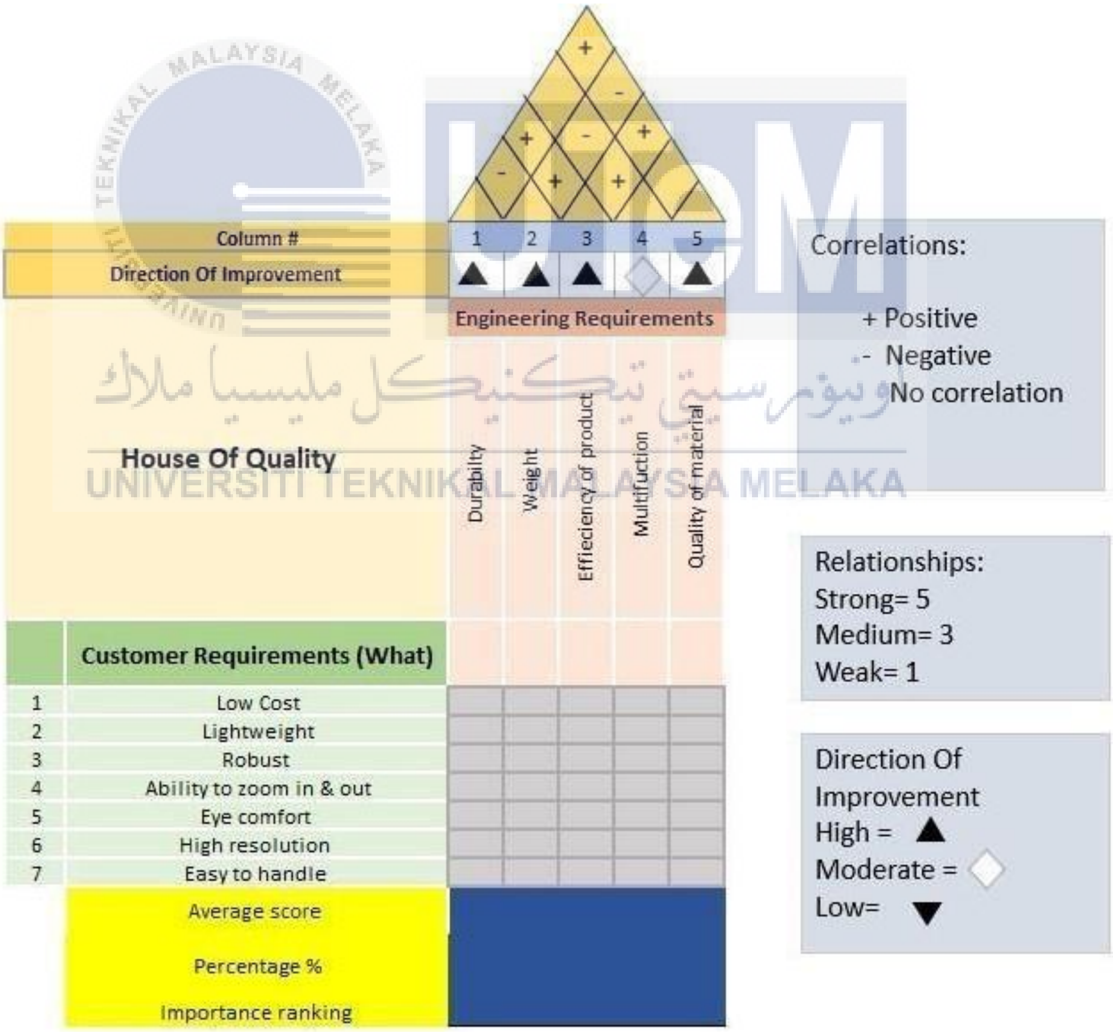


Figure3.3: House Of Quality for Portable Microscope

3.4 Conceptual Design

The technology, operational principles, and shape of a product are all described in the concept design. Three concept designs have been produced to satisfy the project's specifications. Although every design adheres to the same fundamental idea, every implementation is unique. All the benefits and drawbacks will be discussed in this subtopic.

3.4.1 Conceptual Design 1

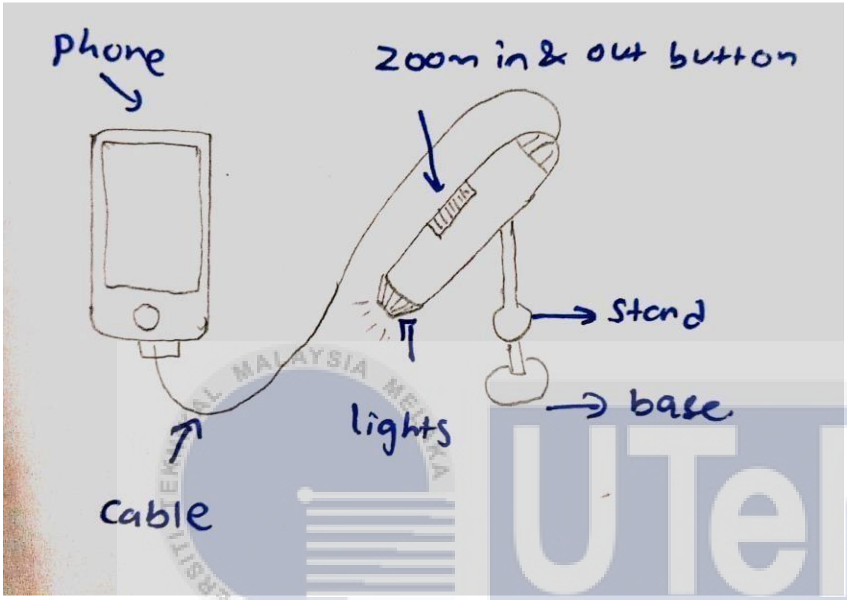


Figure 3.4.1: Conceptual Design 1

Part	Base	Connecting wire	Stand	Zoom in & out button
Material	3003 Aluminium	Copper and aluminium	3003 Aluminium	Plastic
Advantages	-Does not rust or corrode. -Lightweight -Easily adjustable	- high flexibility -low resistance	- Easily adjustable -Lightweight	-Lightweight -Low cost

Table 3.4.1: The details of concept design 1

Based on the table, the details of conceptual design 1 was shown. Few important parts were included in the table. Such as base, connecting wire, zoom in & out and stand. Base are made of 3003 aluminium. The base is the main reason to hold the microscope with stability. The material of stand will help to prevent the base from rusting since it’s not made of metal. Besides, aluminium also light weighted and cheap comparing to metal. Next, connecting wire. The material made of connecting wire to the phone is copper and aluminium. Copper and aluminium are chosen because they have low resistance and high flexibility. Wires need the capacity to endure the strain caused by repeated flexing motions. Furthermore, stand made of aluminium 3003. This material cheaper than metal and got good resistance of rust. Moreover, such parts are required to be lightweight and hard. Aluminium 3003 are good in both excellent cold formability and weldability. Compared to the 1000 series alloys, it offers superior mechanical qualities, especially at high temperatures. Lastly, zoom in and out button. It was made of plastic. The advantage of using that material is it’s easily purchasable with reasoning price. The plastic material will help to make the overall microscope lesser in weight.

3.4.2 Conceptual design 2

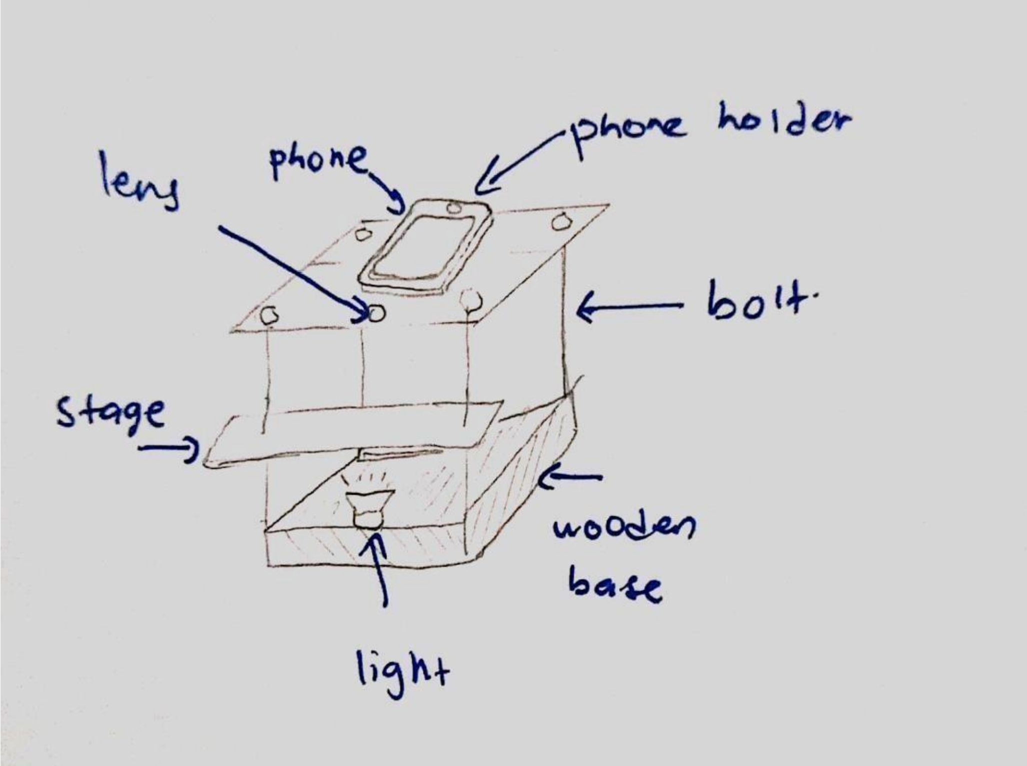


Figure 3.4.2: Conceptual design 2

Part	Phone holder	Stage	Base	Torchlight
Material	Acrylic clear sheet	Acrylic	Douglas fir	Acrylonitrile butadiene styrene
Advantages	-lightweight -cheap	-cheap -transparent -lightweight	-cheap -lightweight	-small in size -chargeable

Table3.4.2: The details of conceptual design 2

Based on the table, the details of conceptual design 2 were shown. A few important parts were included in the table. Such as a phone holder, stage, base, and torchlight. The phone holder is made of an acrylic clear sheet. This material is lightweight, so it won't add up so much weight to the phone. More weight would more likely cause collapses of the structure. Acrylic clear sheets are also cheaper and easily available when compared to other materials. Next, the material for the stage would be acrylic. As mentioned earlier, for the stage it is also important to have those advantages. Since the stage is required to be strong and also lightweight so the stage is easily moved to get clear results. Acrylic is also transparent which allows the lights to pass through. So lighting is an important part of the microscope. The next part is the base. The base is made of plywood(douglas fir wood). Plywood has a high strength and stiffness-to-weight ratio, making it a highly economical material to utilize. When coated with a preservative, plywood does not corrode and may be utilized as a durable and affordable material. Last but not least, the torchlight. The mini torchlight is made of Acrylonitrile Butadiene Styrene. The torchlight is small in size and contributes to becoming under the term portable. A major thing about portable is to assemble and disassemble it easily and also fast.

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3.4.3 Conceptual design 3

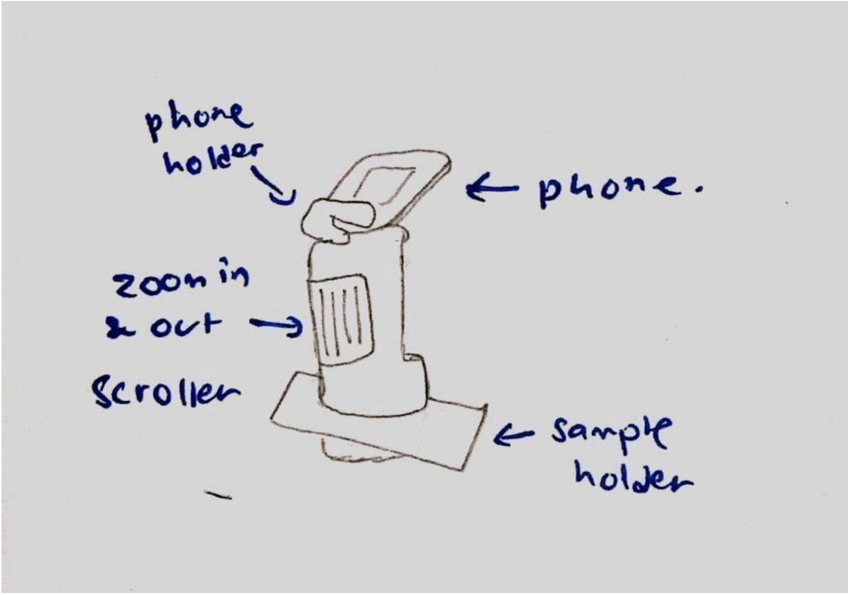


Figure 3.4.3: The conceptual design 3

Part	Phone holder	Zoom in & out scroller	Sample holder
Material	Acrylonitrile butadiene styrene plastic	Acrylonitrile butadiene styrene plastic	Acrylonitrile butadiene styrene plastic
Advantages	-superior stiffness and strength	-easily machined and thermoformed	-good dimensional stability

Table3.4.3: the details of conceptual design 3

ABS has butadiene, which gives hardness and strength, and acrylonitrile, which offers chemical and thermal stability. The resulting polymer has a lovely, glossy sheen thanks to the styrene. ABS is simple to utilize in 3D printing and injection molding thanks to its low melting point. The produced plastic can tolerate intensive usage and unfavorable climatic circumstances because to its high tensile strength, excellent resistance to physical impacts, and chemical corrosion. ABS is simple to mould, sand, and shape, and its glossy surface finish makes it ideal for use with a variety of paints and glues. ABS polymers readily accept colour, enabling completed goods to be dyed in precise hues to adhere to specified project requirements.

3.5 Final design of low-cost portable microscope

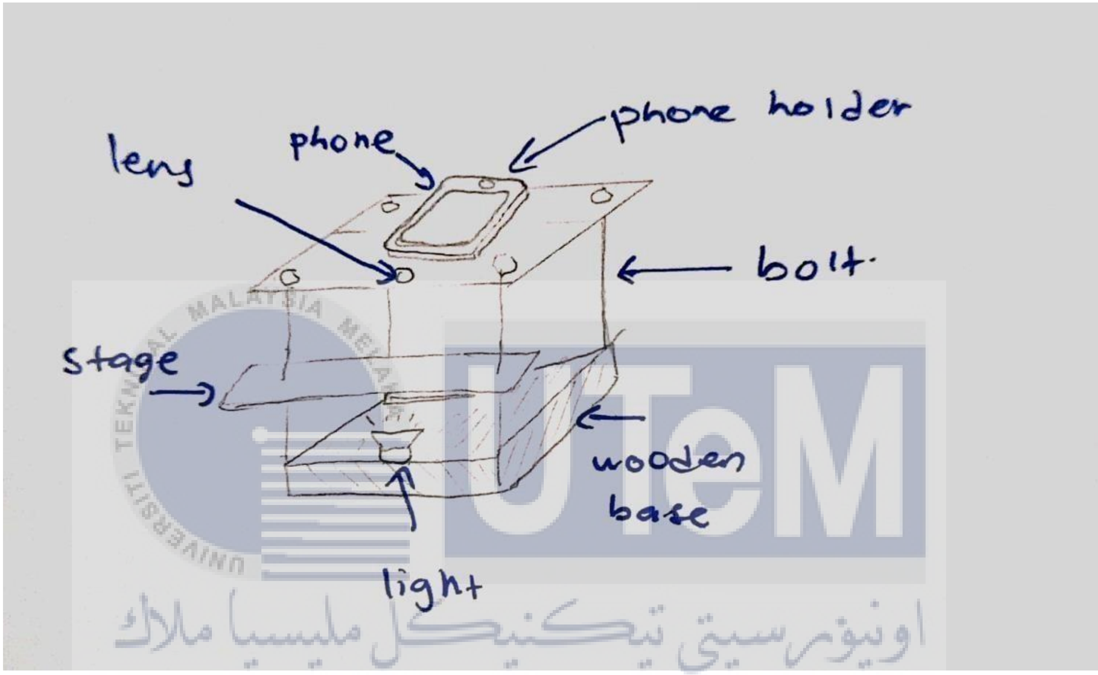


Figure 3.5: conceptual design 2 as the final design of the LCPM

The best design for the low-cost portable microscope, based on each concept design that has been drawn, is design 2 because it meets the criteria desired by the entomologist requirement and also the budget. The conceptual design 1 & 3 have the good ability to zoom in & out but when it comes to low cost both designs do not come under that requirement. It's because the fabrication of the casing for the main body of the microscope needs to use 3d printing. Even though Acrylonitrile butadiene styrene(ABS) has so many great advantages but it's kinda costly. Spending money on the fabrication of the body would affect the budget for other parts to be built. Conceptual design 2 doesn't need any special or modern machine to fabricate the main body. Just simple machines and tools are enough and yet it's cost-saving too. Material like plywood and acrylic clear sheets are cheap and easily available in most places. When compared to conceptual 2 with design 1, design 2 doesn't need any wires to connect for showing the result of the microscope on the smartphone. Design 2 just required a camera which all smartphones have nowadays to show the results. Conceptual design 3 will face problems in placing the microscope statically if the big-sized smartphone is attached to the microscope but conceptual design 2 has a very stable base and even if a bigsized phone like iPhone 14 pro max has 16cm in height and 7.7cm in width. Even it can support the phone holder too.

3.6 Pugh method

The Pugh Matrix is a choice network in view of rules that utilize scoring to conclude which of various expected arrangements or options ought to be picked. This method can be carried out after the results from the distributed survey. From the results of the survey, 3 best conceptual designs with fulfilling all the customer requirements will be given scores.

The one conceptual design with an overall high score will be chosen from it.

Table 3.6.1: the pugh method table

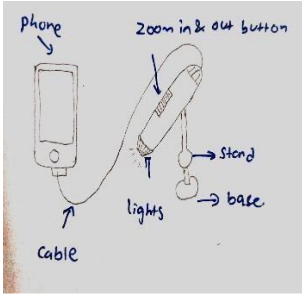
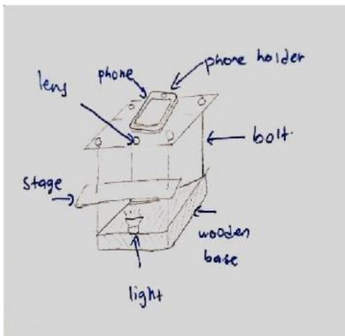
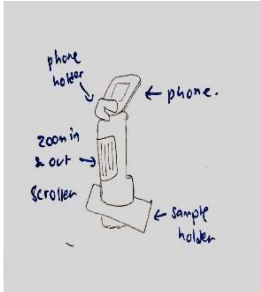
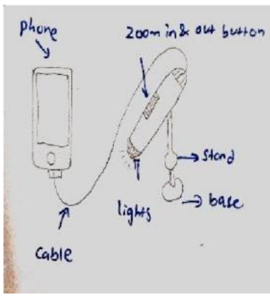
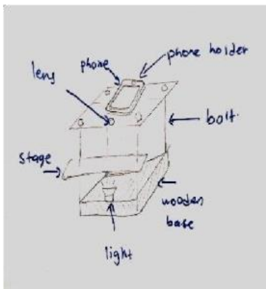
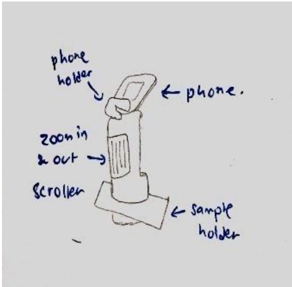
	OPTION		
CRITERIA	DESIGN A 	DESIGN B 	DESIGN C 
EFFICIENCY OF THE PRODCUT			
AFFORDABLE			
EYE COMFORT			
EASY TO USE			
LIGHTWEIGHT			
MULTIFUNCTION			
ROBUST			
ABILITY TO ZOOM IN & OUT			
TOTAL +			
TOTAL -			
TOTAL SCORE			

Table 3.6.2: the weight decision matrix of low cost portable microscope

Weighted decision matrix							
		Options					
							
Criteria	Weighting	Design A		Design B		Design C	
		Score	Total	Score	Total	Score	Total
The efficiency of the product	5						
Affordable	5						
Eye Comfort	5						
Easy to use	5						
Lightweight	5						
Multifunction	5						
Robust	5						
Ability to zoom in & out	5						
Total		Total		Total		Total	

Following the summarization of the survey results, the weighted decision matrix will be generated. Three of the criteria obtained the greatest scores among the others, thus all of them were given a weighted value of 5, as shown in Table. Each design's overall score may be determined. when all the values have been accounted for. The value of any design is assessed by taking into account all of the design criteria.

3.7 Fabrication of low-cost portable microscope

To create this low-cost portable microscope, a variety of procedures and equipment must be used. Because of this, this section will describe the steps that must be taken as well as the tools that were used.

3.7.1 The steps of low-cost portable microscope

The first step of the fabrication is marking the dimension on the plywood. Marking was made in pencil because just in case an error is made means will be able to erase it easily. With a length of 16cm and 6cm width, 2 sets of marking were made. Next, with the length of 16cm length and 3 cm width were marked for 4 sets. Next, with the length of 3cm length and 6cm width, 4 sets were marked. Besides, the acrylic sheet perspex is marked with 12.5cm length and 6cm width. Then the hole sized 0.8cm in diameter at each corner and a hole sized 2.2cm was marked in the middle of one part of the rectangle. The figure 3.7.1 shows the marking was made using a pencil, try square, and ruler.

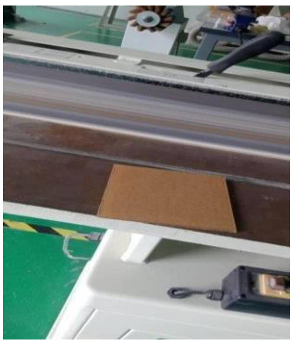
Next, the cutting of the plywood was made using a vertical band saw machine. The figure **3.7.2** shows the process of using that machine to cut the plywood. Before using that machine, all personal protective equipment was checked, and the machine manual was gone through.

Figure3.7.1: marking in the plywood

Figure 3.7.2: cutting the plywood using vertical band saw

After cutting the wanted parts in plywood and acrylic sheet perspex, the freshly cut edge was smoothed by using a horizontal belt sanding machine. It is so important because the vertical band saw got some malfunctions in the blade, so it made the cutting not so neat. so, to get all the freshly cut parts in shape the horizontal belt sanding machine was used.

Figure 3.7.3shows the horizontal belt sanding machine.



Next, all those smoothed parts were assembled according to the drawing with super glue. Figure shows the brand of glue used to assemble. Since the plywood thickness is small, assembly using nails would damage the plywood. The nail will poke out of the plywood.

The same type of glue is used to attach the hinges with plywood and with acrylic sheet Perspex. Screwing the hinge with the acrylic sheet Perspex will crack it so super glue is used.

Figure 3.7.4: 502 super glue

The next step is the drilling process that was made at marked points. The bench drilling machine was used to bore holes. G-clamp is used to tighten the position of the vice since it is not stationary when the drilling machine is running. Figure 3.7.5 shows the bench drilling machine used for drilling. A hole saw is used since the laboratory doesn't have a drill bit with that diameter. Figure 3.7.6 shows the hole saw that was used.

Figure 3.7.5: bench drilling machine

Figure 3.7.6: hole-saw drill bit

The drilled holes were smoothed using a wood rasp. It is important because not only it will look neat but also will help prevent the bolts to get stuck in those holes. Figure 3.7.7 shows the wood rasp used for smoothening the drilled holes.

Figure 3.7.7: wood rasp

Lastly, the whole wooden base is painted shellac to make the wooden base look neat and smooth. Figure 3.7.8 shows the shellac used and the painting process of the wooden base. The table shown is the summary of the steps of fabrication of the low-cost portable microscope.

Figure 3.7.8: Painting Shellac

Steps	Explanation
1.	Mark the dimension • Mark the plywood that needed to be cut • Mark the acrylic Perspex • Mark the holes needed to be drilled
2	Cutting the parts using the vertical band saw machine • Cut the plywood according to the required dimension • Cut the acrylic Perspex sheet according to the required dimension
3	Smoothen the freshly cut parts using the horizontal belt sanding machine
4	Assemble all the parts using super glue according to the drawing. Let it dry completely to proceed next step. Assemble the hinge too using superglue
5	Drill the holes at marked spots • 4 holes with the same diameter for the bolts at the acrylic Perspex • 1 small sized hole for the lens • 4 same diameter holes for bolts at the wooden base • One big sized hole for light using holesaw drill bit
6	Use wood rasp to shape the parts and chamfer
7	Paint the wooden base with shellac to look neat

Table 3.7.1: The steps of fabrication of LCPM

3.8 Product Field Test

The finished product must be tested in the field. Since it's about mosquitoes, the field test will be carried out in an area where mosquitoes can be easily captured. Kem Pati Machap Umboo, Alor Gajah, Melaka is the nearest field. The field test is about testing the completed product. The success of the product is based on succeeding in all the customer's requirements.

Location	Kem Pati Machap Umboo Jalan alor gajah - selandar, Kampung Permai, 78000 Alor Gajah, Melaka.
Longitude & laltitude	2.3787307605748023, 102.27951074400671
Google map location	

Table 3.8: Details of Kem Pati Machap Umboo ,Alor Gajah, Melaka

CHAPTER 4

RESULT AND ANALYSIS

4.1 Introduction

This section of the low cost portable microscope design outlines the low cost portable microscope manufacturing process from start to finish, and it can be used by entomologists.

The survey data collection, the House of Quality (HoQ), the Pugh Method, and the Simulation of the portable microscope. Each of these sections has assessed the data in light of the users' preferences and developed content that reflects those preferences. The simulation component of the process is also critical in understanding the scenario before, during, and after the creation of this low cost portable microscope product. After the product is developed, Solidworks software is used to simulate and analyse its strength and evaluate how long it will last in usage.

4.2 Data Collection of Survey

The survey was conducted through Google form and distributed to Melaka Entomologists who have years of experience in that field. The online survey got 17 respondents. Below are the results obtained from the online survey and an explanation of every question. The House of Quality (HOQ), as described by the American Society for Quality in 2021, is a product planning matrix that demonstrates how consumer criteria correspond directly to the strategies and tactics businesses might employ to meet those objectives. Technical and competitive benchmarking data may be used to construct Home of 69 Quality diagrams, which have a shape that resembles the outline of a house. The main instrument for facilitating group decisionmaking during Quality Function Deployment (QFD) of Low cost portable microscope is thought to be HOQ.

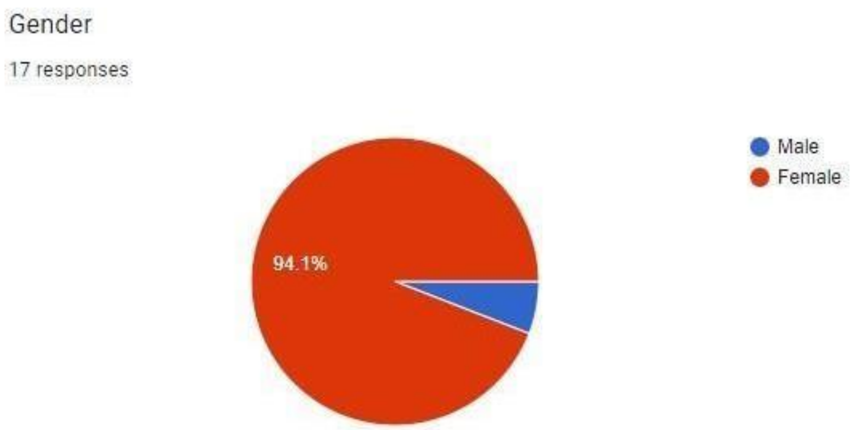


Figure 4.2.1: survey result for gender

Figure above shows that 94.1% percentage of the respondents are female which is 16 persons and the remaining 1% of the respondent is male which is 1 person.

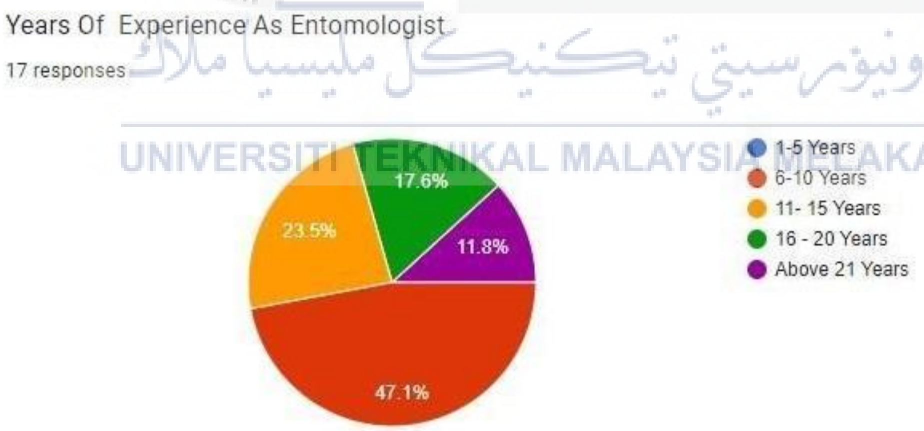


Figure 4.2.2: result for question years of experience as entomologists.

Figure above shows us that 8 respondents (47.1%) have working experience as entomologists in between 6 and 10 years. 4 respondents (23.5%) have working experience as entomologists in between 11 and 15 years. 3 respondents (17.6%) have working experience as entomologists in between 16 and 20 years. Lastly, 2 respondents (11.8%) have working experience as entomologists above 21 years.

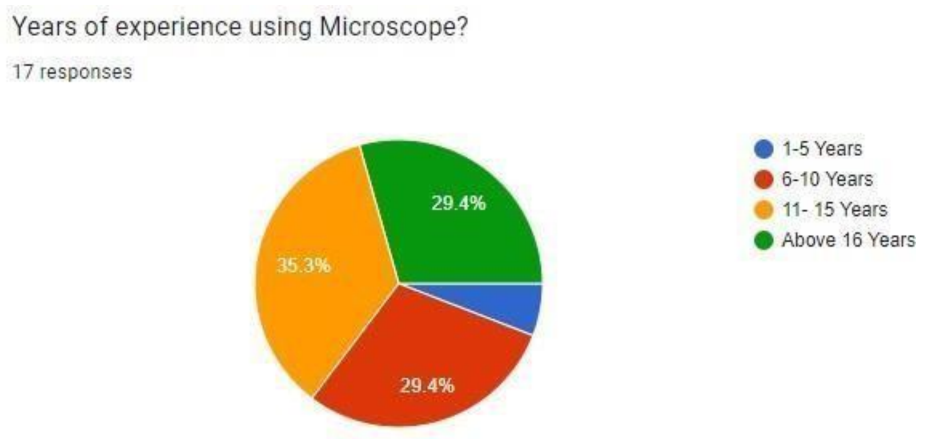


Figure 4.2.3: results for years of experience using microscope

Figure above shows that 6 respondents (35.3%) have 11 to 15 years of experience using the microscope. 5 respondents (29.4%) have 16 and above years of experience in using the microscope. 5 respondents (29.4%) have 6 to 10 years of experience. 1 respondent (5.9%) have 1 to 5 years of experience.

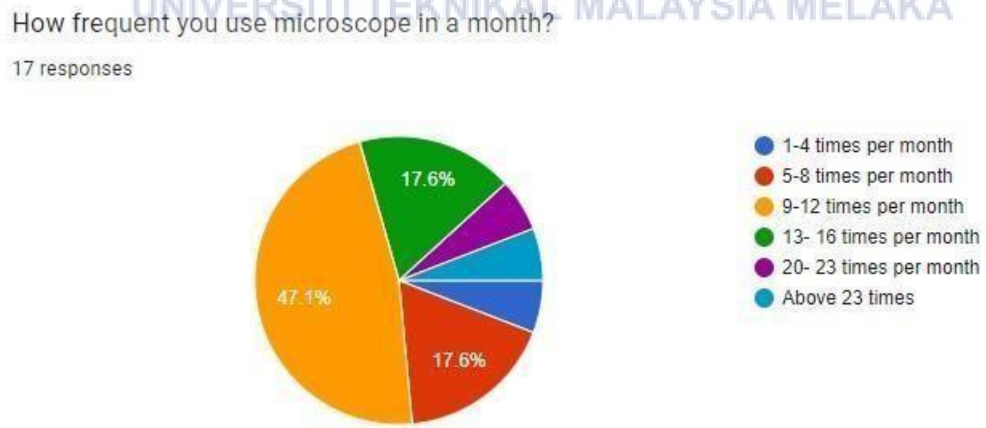


Figure 4.2.4: results of how frequent usage of the microscope in a month

Result above shows that 8 respondents (47.1%) said that the microscope will be used

9 to 12 times a month. 3 respondents (17.6%) said that 13 to 16 times. 3 respondents (17.6%) answered 5 to 8 times. 1 respondent (5.9%) answered 1 to 4 times, 20 to 23 times and above 23 times.

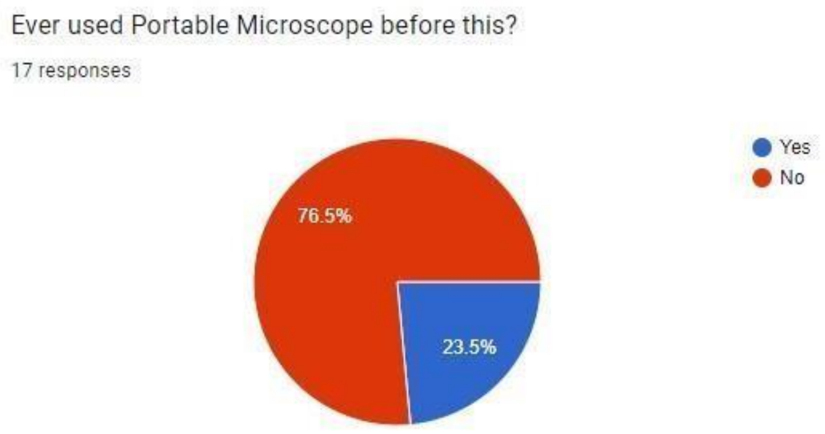


Figure 4.2.5: the result of ever used portable microscope before this

Figure above shows that 13 respondents (76.5%) have not used portable microscope before this. 4 respondents (23.5%) have used portable microscope before this.

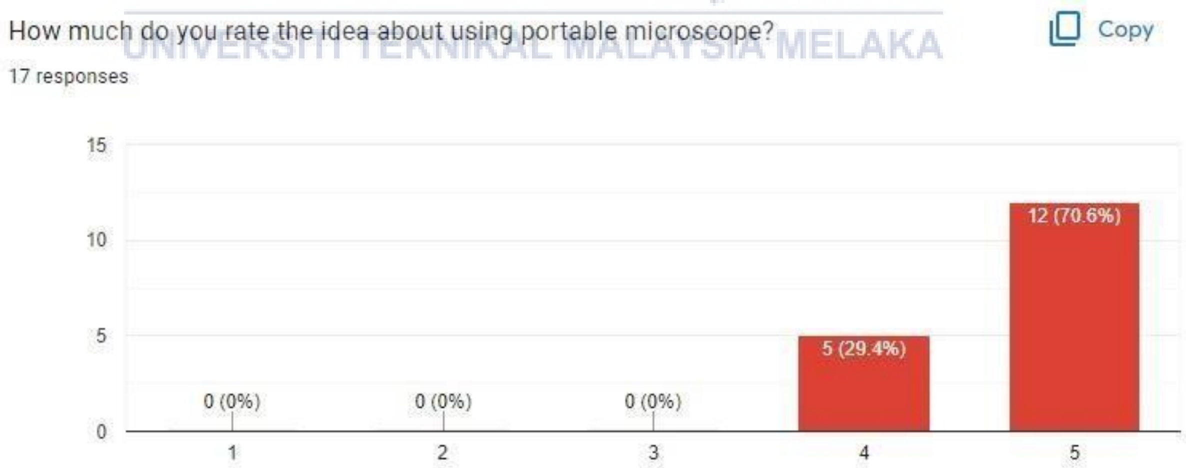


Figure 4.2.6: result of rating the idea of using portable microscope

Figure above represents those 12 respondents (70.6%) answered 5 meanwhile 5 respondents (29.4%) answered 4.

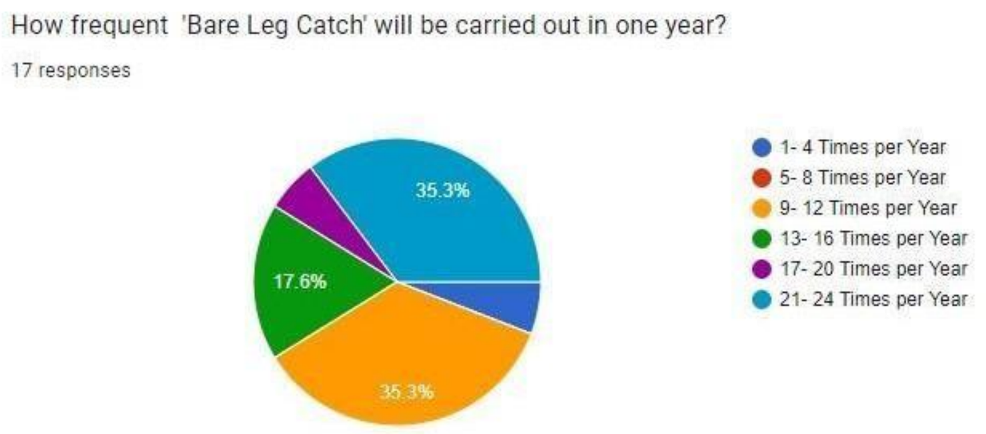


Figure 4.2.7: result of how frequent blc will be carried out

Figure shows us that 6 respondents (35.3%) answered 9 to 12 times 'bare leg catch' will be carried out in one year. 6 respondents (35.3%) answered 21 to 24 times per year. 3 respondents (17.6%) answered 13 to 16 times. 1 respondent (5.9%) answered 17 to 20 times and 1 to 4 times.

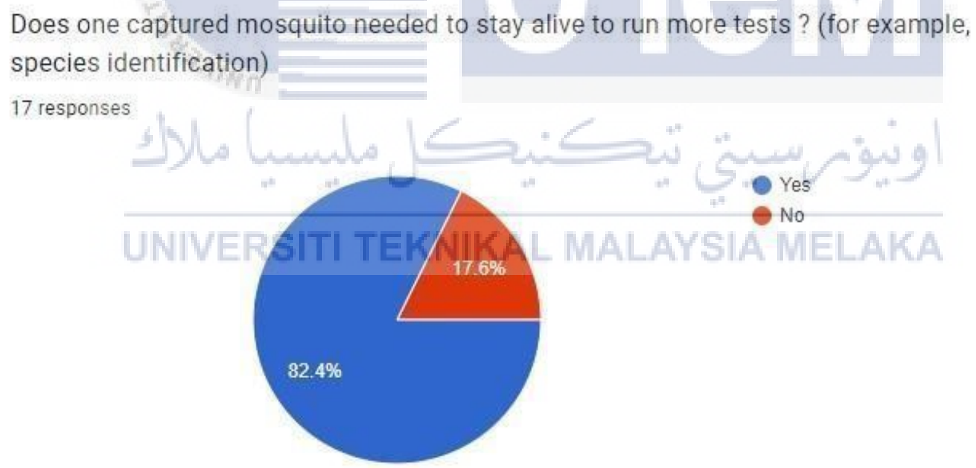


Figure 4.2.8: result of captured mosquito needed to stay alive to run more tests.

Figure above shows that 14 respondents (82.4%) answered yes for captured mosquito needed to stay alive to run more test. 4 respondents (17.6%) answered no.

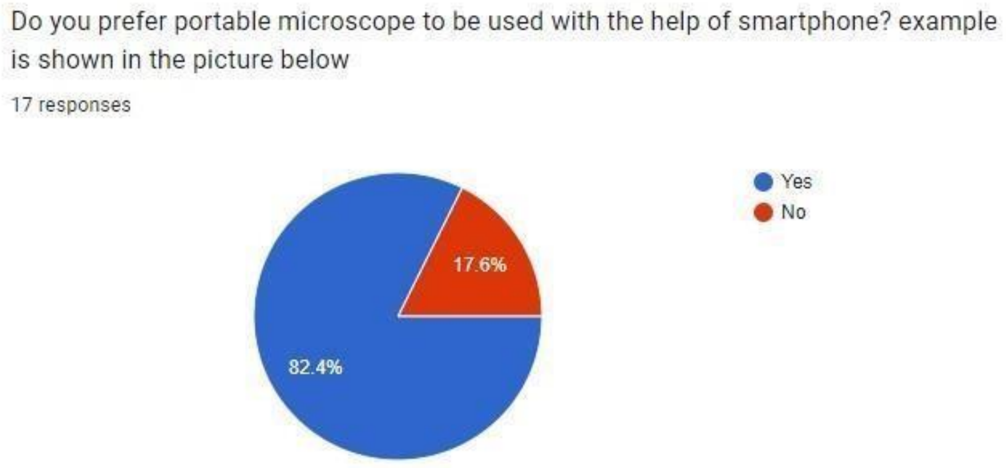


Figure 4.2.9: Result of a preferred microscope to be used with the help of the smartphone

Figure above shows that 14 respondents (82.4%) prefer the microscope to be used with the help of the smartphone. 4 respondents (17.6%) answered no.

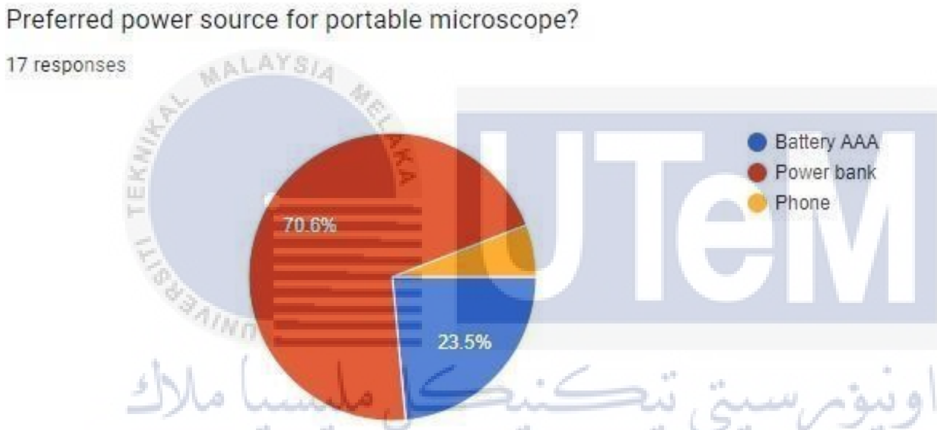
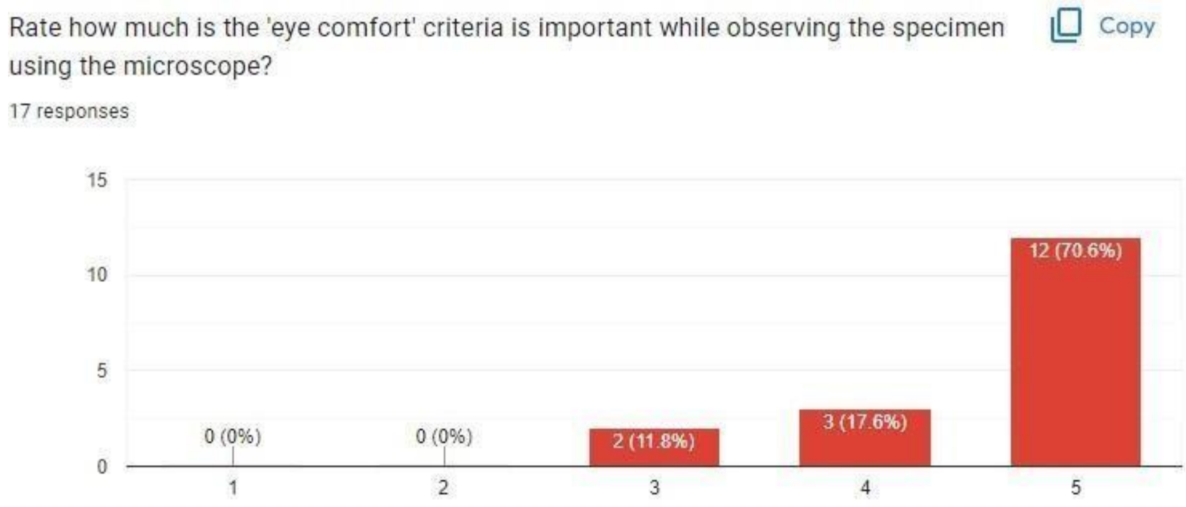


Figure 4.2.10: result for the preferred power source for portable microscope

Figure above shows that 12 respondents (70.6%) prefer power bank as the power source for the portable microscope. 4 respondents (23.5%) answered battery AAA.

1 respondent (5.9%) answered the phone.

Figure 4.2.11: results for rating the eye comfort criteria



The figure above shows that 12 respondents (70.6%) rated 5 for eye comfort criteria is important while observing the specimen using the microscope. 3 respondents (17.6%) rated 4 and 2 respondents (11.8%) rated 3.

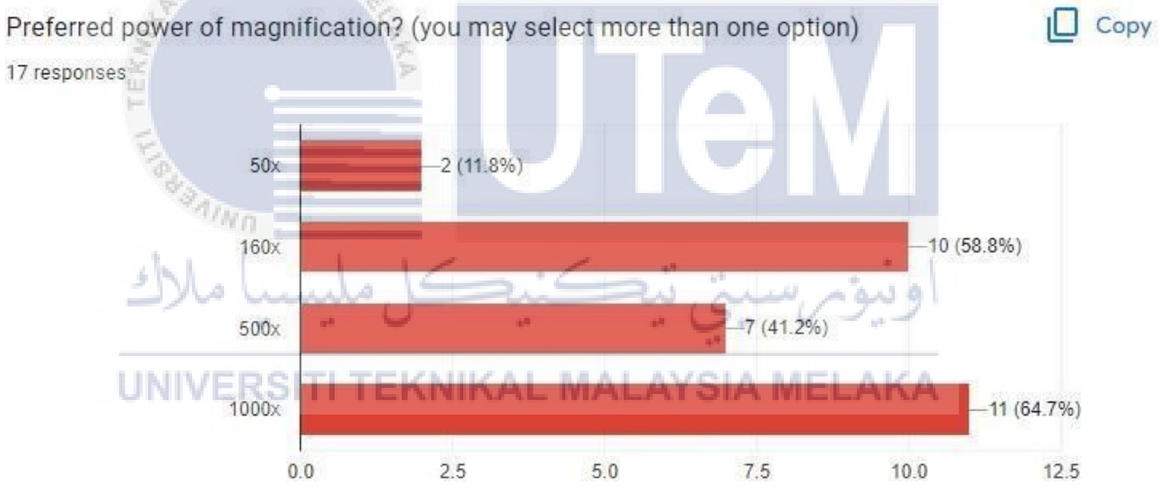


Figure 4.2.12: result of preferred power of magnification
Figure above shows that 2 respondents (11.8%) chose 50X power of magnification. 10 respondents (58.8%) chose 160X. 7 respondents (41.2%) chose 500X. 11 respondents (64.7%) chose 1000X.

Table 4.2.1: Result of the survey

PRODUCT SPECIFICATION					
SECTION C					
CRITERIA	1 (NOT IMPORTANT)	2 (LESS IMPORTANT)	3 (NEUTRAL)	4 (IMPORTANT)	5 (VERY IMPORTANT)
1. EFFICIENCY OF THE PRODUCT	0%	5.9%	0%	41.2%	52.9%
2. AFFORDABLE	0%	0%	23.5%	23.5%	52.9%
3. EYE COMFORT	0%	5.9%	11.8%	41.2%	41.2%
4. EASY TO USE	5.9%	0%	11.8%	23.5%	58.8%
5. LIGHTWEIGHT	0%	0%	23.5%	23.5%	52.9%
6. MULTIFUNCTION	5.9%	0%	17.6%	23.5%	52.9%
7. ROBUST	0%	0%	11.7%	64.7%	23.5%
8. ABILITY TO ZOOM IN & OUT	0%	0%	5.9%	41.2%	52.9%

4.3 HOQ

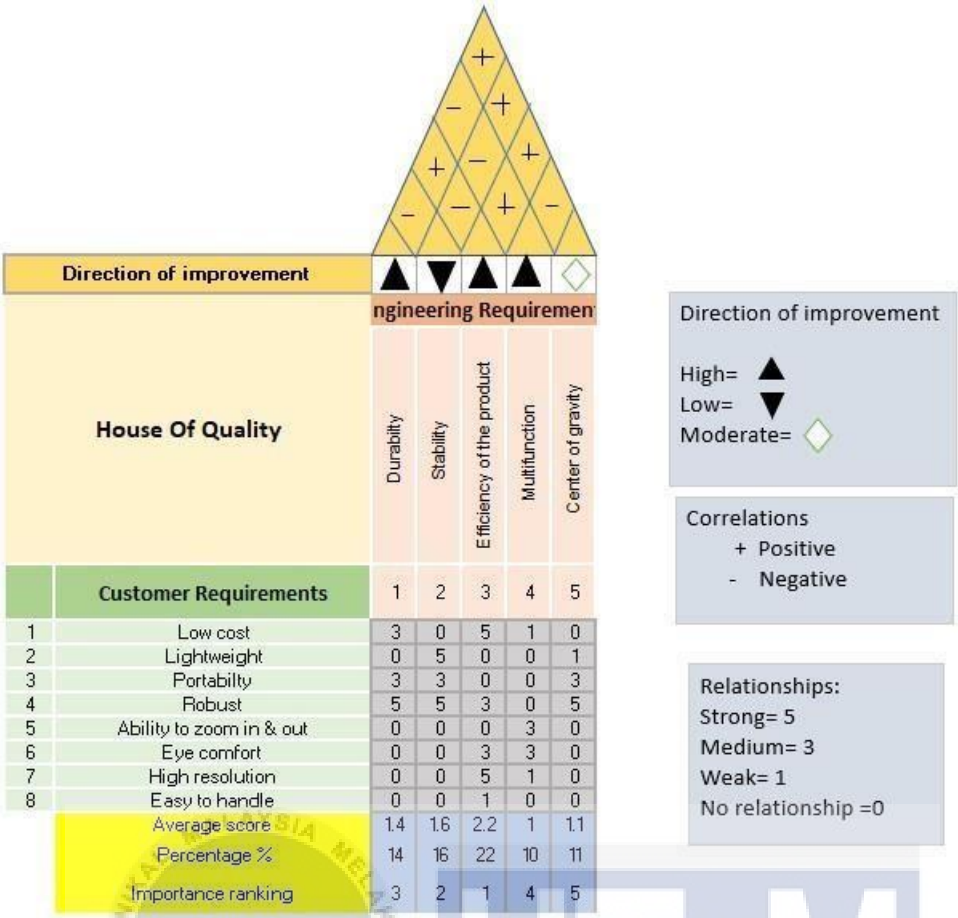


Figure 4.3: House of Quality of LCPM

Based on the house of quality of LCPM, it has 8 customer requirements such as low cost, lightweight, portability, robust, ability to zoom in & out, eye comfort, high resolution, and easy to handle. Meanwhile, engineering requirement has 5, such as durability, stability, the efficiency of the product, multifunction, and centre of gravity. First, low cost has a medium relationship with durability because low-cost means materials that are bought for lower prices. Cheap materials mostly are weak materials or non-quality materials. So it might contribute to the durability of the product. It also has a strong relationship with the efficiency of the product because the cost of materials can affect the outcome of the project. Meanwhile, it's weak with multifunction.

Next, lightweight has a strong relationship with stability. The higher the weight of an object, the more stable it will become. Next, portability has a medium relationship with durability, stability, and centre of gravity. It is because portability won't give that much impact on those 3.

Next, robust has a strong relationship with durability, stability, and centre of gravity. It is because the robustness of an object is based on durability, stability, and the centre of gravity. It also has a medium relationship with the efficiency of the product because it won't give much impact on it. Next, the ability to zoom in & out has a medium relationship with multifunction because it will come under multifunction and also help during using a microscope. Next, eye comfort has a medium relationship with the efficiency of the product and multifunction. Eye comfort will help the product outcome but is not so effective and it also makes the product multifunction. Next, high resolution has a high relationship with the efficiency of the product because higher resolution help to get better results so it automatically comes under the efficiency of the product. It has a lower relationship with multifunction because it won’t give that much high impact or comes under multifunction. Next, easy to handle has a low relationship with the efficiency of the product because it just gonna saves some time in handling it.

4.4 Pugh Method

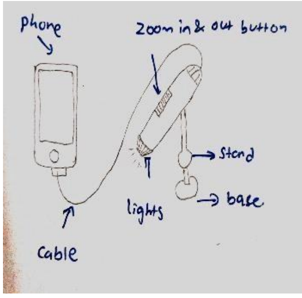
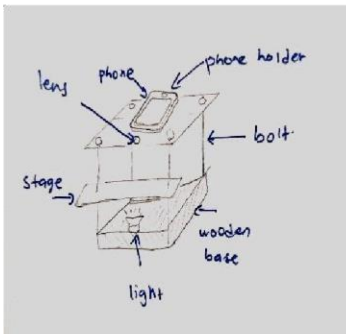
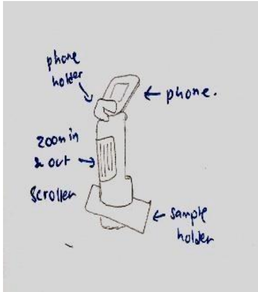
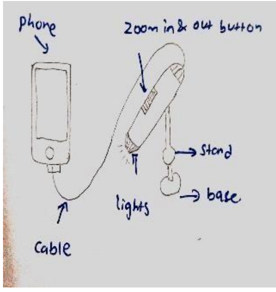
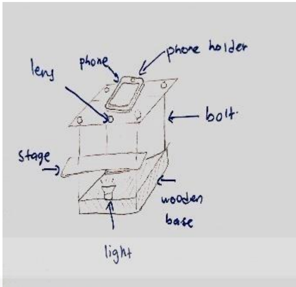
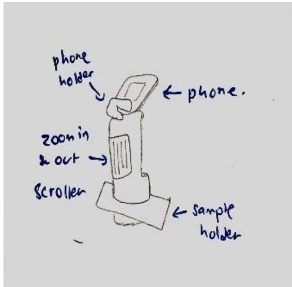
	OPTION		
CRITERIA	DESIGN A 	DESIGN B 	DESIGN C 
EFFICIENCY OF THE PRODUCT	+	+	+
AFFORDABLE	-	+	-
EYE COMFORT	+	+	-
EASY TO USE	+	+	+
LIGHTWEIGHT	+	+	+
MULTIFUNCTION	-	+	–
ROBUST	+	+	-
ABILITY TO ZOOM IN & OUT	+	+	+
TOTAL +	6	10	4
TOTAL -	2	0	4
TOTAL SCORE	4	10	0

Table 4.4.1: the Pugh method table

Design concept 2 earns a high number of positives (+) according to the Pugh Method since it satisfies the requirements set out by Entomologists. Design Concept 3 comes last, followed by Design Concepts 1 and 2. Some requirements have negative markings (-) because the demands of The Design Concept cannot be fulfilled. With this knowledge, we can decide which design concept in Table 4.4 is the best.

Table 4.4.2: the weight decision matrix of low-cost portable microscope

Weighted decision matrix							
		Options					
							
Criteria	Weighting	Design A		Design B		Design C	
		Score	Total	Score	Total	Score	Total
The efficiency of the product	5	5	25	5	25	4	20
Affordable	5	3	15	5	25	5	25
Eye Comfort	5	5	25	5	25	3	15
Easy to use	5	3	15	5	25	4	20
Lightweight	5	5	25	5	25	5	25
Multifunction	5	5	25	5	25	4	20
Robust	5	3	15	5	25	3	15

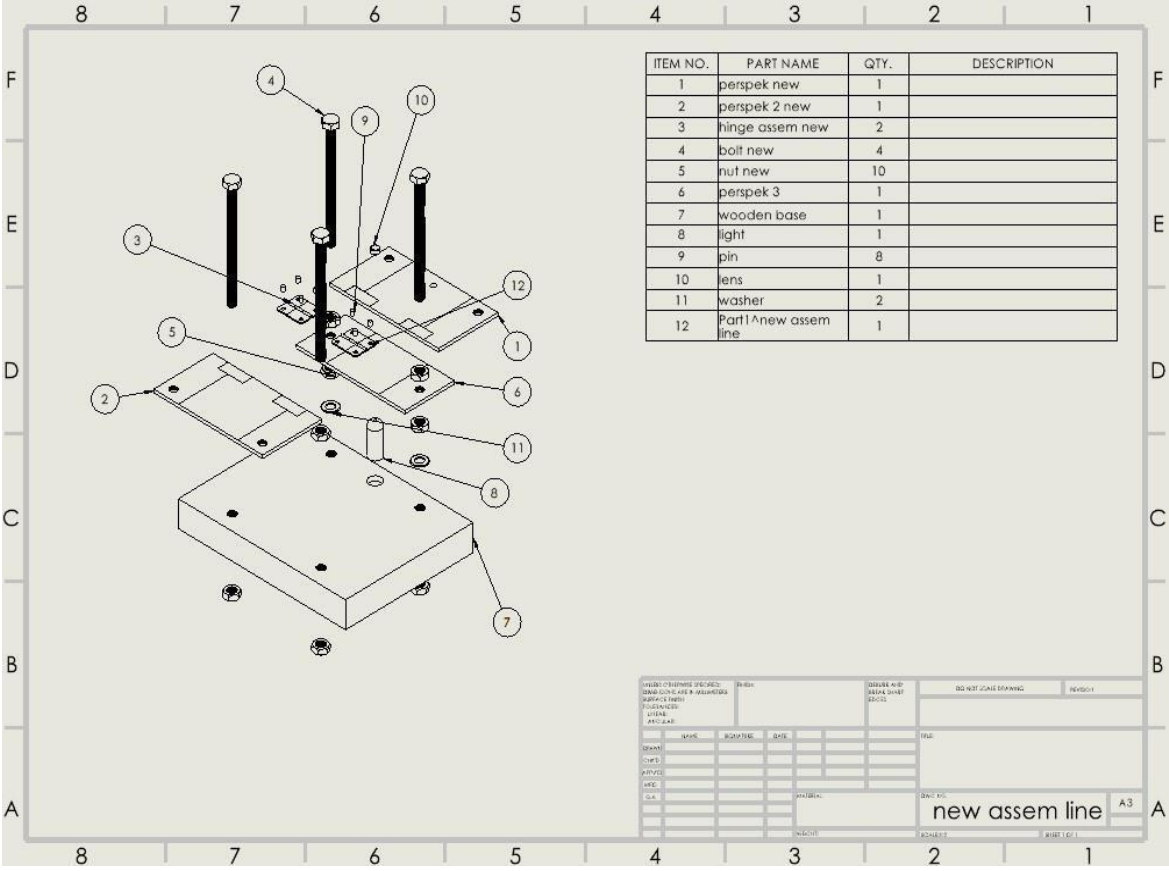
Ability to zoom in & out	5	5	25	5	25	5	25
Total		Total	170	Total	200	Total	165

After the survey data has been summarised, the weighted decision matrix can be created. As shown in Table, all criteria received a score of 5 in the weighting because three of them scored the highest. After all of the values have been taken into account, the total score for each design can be calculated. The value of each design is determined by considering all of the design criteria. After each design's value has been assigned, design B receives the highest overall score, followed by design A and design C. Because of the criteria score, there is a slight difference in the total score of design A and design C. In comparison to design C, design B receives a higher score for product efficiency and ease of use. The main reason that design B received the highest score is that the product is lightweight, multifunctional, and affordable.

4.5 The drawing of LCPM

Through the use of computer-aided design (CAD), users may create products and geometrical things digitally rather than by hand. Using CAD software, one may create and modify an item to see how it will seem and function after being built. In large CAD drawings are used in a wide variety of industrial and manufacturing applications. This technology is commonly employed in graphic design and the arts, giving artists greater creative flexibility than is possible with other platforms. These drawings are also used in the design of automobiles and airplanes, as well as other industrial products and machinery. LCPM simulation is produced using CAD software.

Figure 4.6: The assembly drawing part of LCPM



4.5.1 Sketching module

The user may generate and sketch object sketches using the sketching module. It serves as the starting point for the designers to produce a preliminary sketch in order to generate concepts and present the intended things. Before Solidworks software can proceed to create the product, all dimensions parts of the shower tank must be in sketch drawings. The new Solidworks programme has a smart dimension tool that enables the item to be measured quickly to satisfy a certain need, accelerating, and simplifying the drawing process.

4.5.2 Part module

To create a basic 2D sketch for a part in Solidworks, use the advance sketching command manager and add geometry like circles, lines, trims, convert entities, and mirror entities.

Then, use tools like extruded boss, revolved boss, fillets, extruded cut, swept cut, holes, and others to turn the 2D sketch into a 3D model. Each component must be sketched out using those several steps.

4.5.3 Assembly module

To create a full 3D item, all of the component components from the part module are assembled in the assembly module. Because they produce geometric characteristics between the assembly components, mate features are crucial for assembling one or more parts. The Mates property manager in Solidworks provides several choices for part combination, including coincident, concentric, distance, gear, screw, and others.

4.5.4 Drawing module

The last portion is a drawing module that creates drawings from parts or assemblies in a variety of formats, including ANSI, ISO, DIN, and others. Each component automatically creates perspectives and adding dimensions to the picture as needed is simple. The LCPM's isometric view model, which includes top, side, and front views, is displayed in Table 4.9. Figures 4.6.1, 4.6.2, 4.6.3, and 4.6.4 show those in more detail.

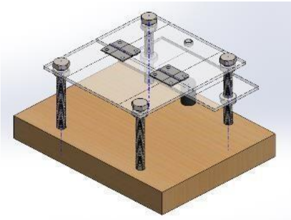
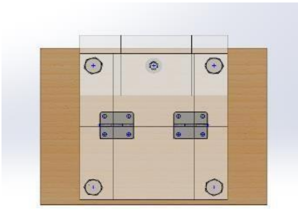
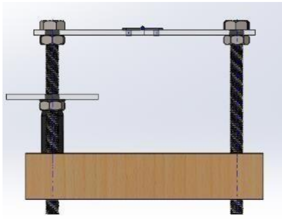
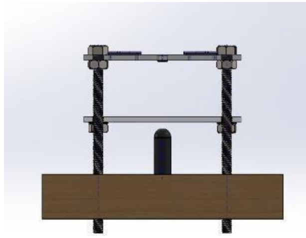
Isometric	Top	Side	Front
 Figure 4.6.1: Isometric view of LCPM	 Figure 4.6.2: Top view of LCPM	 Figure 4.6.3: Side view of LCPM	 Figure 4.6.4: Front view of LCPM

Table 4.6.4: LCPM’s view from various side

4.6 Simulation of Low-Cost Portable Microscope (LCPM)

After the parts of the LCPM were drawn in Solidworks 2022 with the exact dimension and applied exact material since each part was made of different types of materials The simulation was done with Solidworks 2022 simulation software.

4.6.1 Pre-process of LCPM

The pre-process of LCPM starts with drawing the parts according to the dimension and extruding them to make them 3D. After all the drawing processes were done, each part selected its materials to get more accurate results in simulation. Next, all the parts were assembled according to the drawing.

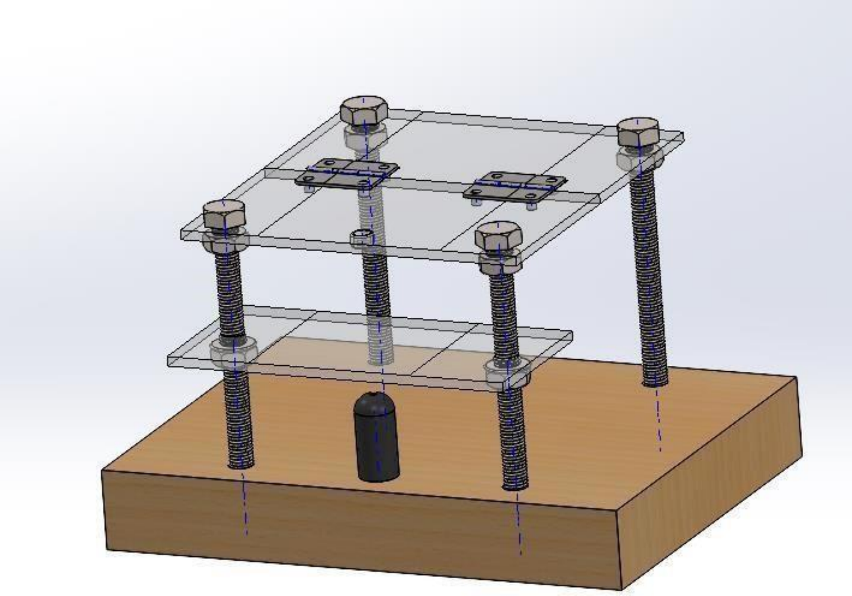
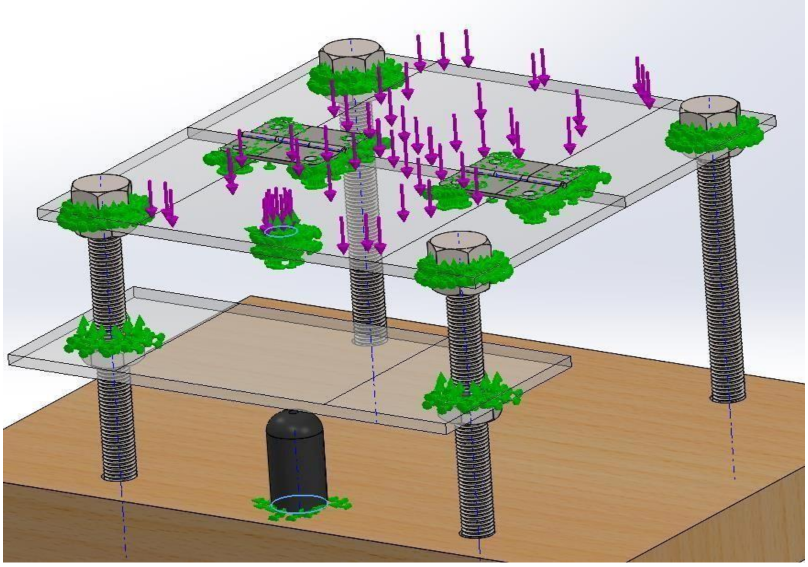


Figure 4.5.1.1: Full assembly of LCPM in Solidworks

Since force only will be applied at top of the Perspex, so the force will be applied at the middle area on the top place, which represents the placement of the smartphone. The force applied is 1.37N. That amount of force was selected because the average weight of the smartphone is 140g. When converted into N, the answer will be 1.37N. The fixed geometry is to prevents the chosen edges or vertices from shifting in either of the plane's two perpendicular directions. On the section plane's normal direction, no limits are imposed. This process is to help to obtain accurate results of the simulation. The green marked spots are where the fixed geometry was applied and the purple marked spots are where the force been applied.

Figure 4.5.1.2: placement of fixed geometry and force applied



From then, Free Body Diagram steps may be taken to inform Simulation about how the model would act in the actual world. The assignment of loads, fixtures, contacts, and connectors is the process's most crucial stage. The model is discretized or meshed as the last stage in the pre-process. A variety of mesh choices are available in SOLIDWORKS, including the Solid, Shell, and Beam mesh types. However, the mesh in this simulation is solid mesh.

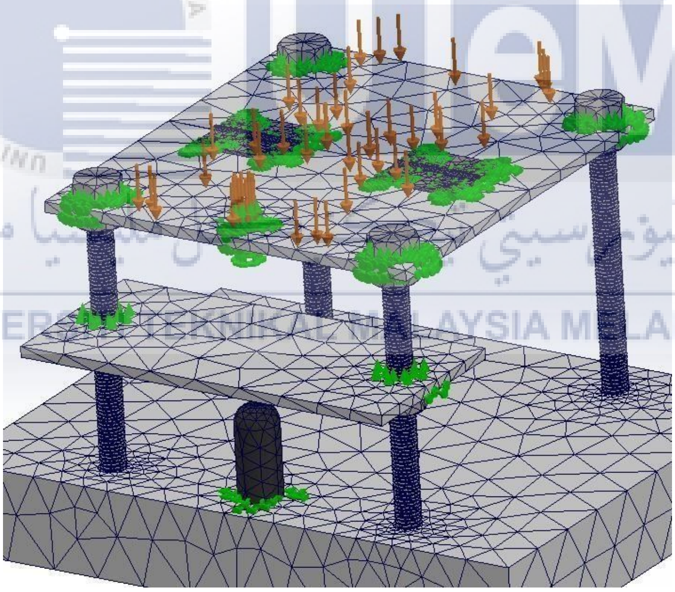


Figure4.5.1.3: the LCPM has meshed in Solidworks

Mesh Details

Study name	Static 3* (-Default-)
DetailsMesh type	Solid Mesh
Mesher Used	Blended curvature-based mesh
Jacobian points for High quality mesh	16 points
Max Element Size	1.47697 cm
Min Element Size	0.0738483 cm
Mesh quality	High
Total nodes	211314
Total elements	121508
Maximum Aspect Ratio	167.06
Percentage of elements with Aspect Ratio < 3	36.2
Percentage of elements with Aspect Ratio > 10	15.1
Percentage of distorted elements	0
Number of distorted elements	0
Remesh failed parts independently	Off
Time to complete mesh(hh:mm:ss)	00:10:02

Figure4.5.1.4: Mesh details of LCPM

Mesh Summary

Mesh Details:
Study name: Static 3* (-Default-)
Mesh type: Solid Mesh
Mesher Used: Blended curvature-based mesh
Jacobian points for High quality mesh: 16 points
Max Element Size: 1.47697 cm
Min Element Size: 0.0738483 cm
Mesh quality: High
Total nodes: 211314
Total elements: 121508
Maximum Aspect Ratio : 167.06
Percentage of elements\with Aspect Ratio < 3 : 36.2
Percentage of elements\with Aspect Ratio > 10 : 15.1
Percentage of distorted elements : 0
Number of distorted elements:0
Remesh failed parts independently: Off
Time to complete mesh(hh;mm;ss): 00:10:02
Computer name:

Size assignment details:
1. <SolidBody 1(Boss-Extrude1)> : [0.0738483cm : 1.47697cm]
2. <SolidBody 1(Fillet4)> : [0.0738483cm : 1.47697cm]
3. <SolidBody 1(Fillet6)> : [0.0738483cm : 1.47697cm]
4. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
5. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
6. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
7. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
8. <SolidBody 1(Fillet4)> : [0.0738483cm : 1.47697cm]
9. <SolidBody 1(Thread2)> : [0.0738483cm : 1.47697cm]
10. <SolidBody 1(Split Line1)> : [0.0738483cm : 1.47697cm]
11. <SolidBody 1(Split Line1)> : [0.0738483cm : 1.47697cm]
12. <SolidBody 1(Boss-Extrude2)> : [0.0738483cm : 1.47697cm]
13. <SolidBody 1(Split Line1)> : [0.0738483cm : 1.47697cm]
14. <SolidBody 1(Split Line1)> : [0.0738483cm : 1.47697cm]
15. <SolidBody 1(Boss-Extrude2)> : [0.0738483cm : 1.47697cm]
16. <SolidBody 1(Split Line1)> : [0.0738483cm : 1.47697cm]
17. <SolidBody 1(Boss-Extrude3)> : [0.0738483cm : 1.47697cm]
18. <SolidBody 1(Boss-Extrude1)> : [0.0738483cm : 1.47697cm]
19. <SolidBody 1(Boss-Extrude1)> : [0.0738483cm : 1.47697cm]
20. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
21. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
22. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
23. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
24. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
25. <SolidBody 1(Thread1)> : [0.0738483cm : 1.47697cm]
26. <SolidBody 1(Split Line1)> : [0.0738483cm : 1.47697cm]
27. <SolidBody 1(Boss-Extrude1)> : [0.0738483cm : 1.47697cm]
28. <SolidBody 1(Boss-Extrude1)> : [0.0738483cm : 1.47697cm]

Figure4.5.1.5: Mesh summary of LCPM

4.6.2 Post-process of LCPM

In an LCPM simulation, the post-process is the outcome of the simulation, the most typical of which are stress, displacement, strain, and factory of safety. The minimum value is 1.000 X 10^{-30}. The maximum displacement value obtained is 2.719 X 10^{-3}. It means 0.0027mm. So, the structure can withstand the force applied to the plane. Since the material has already been applied, the result is trustable can refer to it before starting the fabrication process.

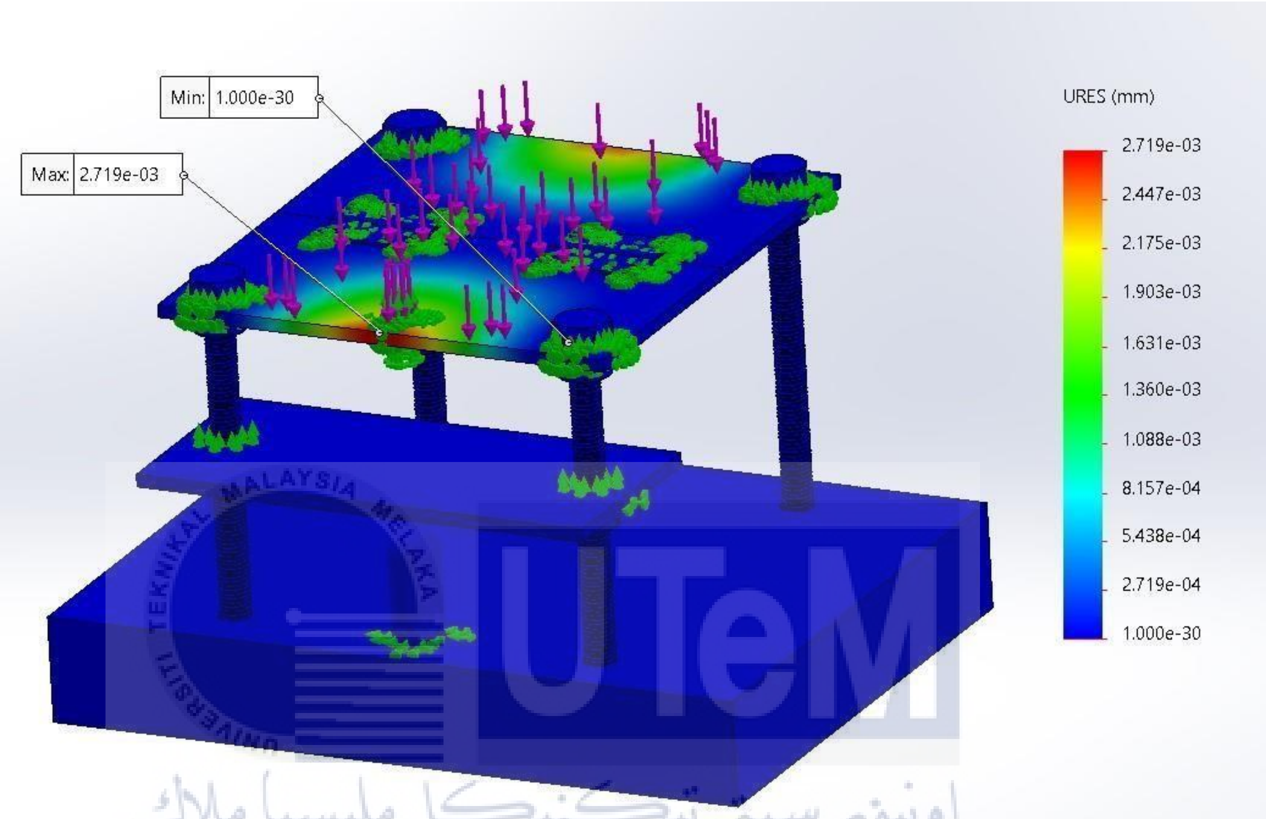


Figure 4.5.2.1: the result of simulations in terms of Displacement

For the stress, the maximum value is 2.5999 X$10^{5}$and the minimum vale is 0. The pressure that a material feels in reaction to a load is known as stress. Based on the stiffness, the load disperses itself across a material. The LCPM's state during the simulation was shown by the F. Because it demonstrates that the LCPM is still in good shape, the yield strength of this material is appropriate for the product. The tension beyond which a material's deformation is plastic is represented by its yield strength. Any irreversible deformation brought on by a stress larger than the yield strength. Due to the linearity of elastic deformation, yield strength is sometimes referred to as the highest stress that may be applied without departing from the

88 proportionalities of stress and strain. When employing yield strength, the safety factor may be computed as the ratio of the highest permissible stress to the corresponding stress (von-Mises). The design must be more than 1 to be considered acceptable. (A value of less than 1 indicates some persistent deformation.) Areas of potential yield are readily identified by the findings of the safety factor. Regardless of how high or low the figure is, the highest location of stress in the corresponding stress findings is highlighted in red. When the factor of safety is one, the material is nearly at yield.

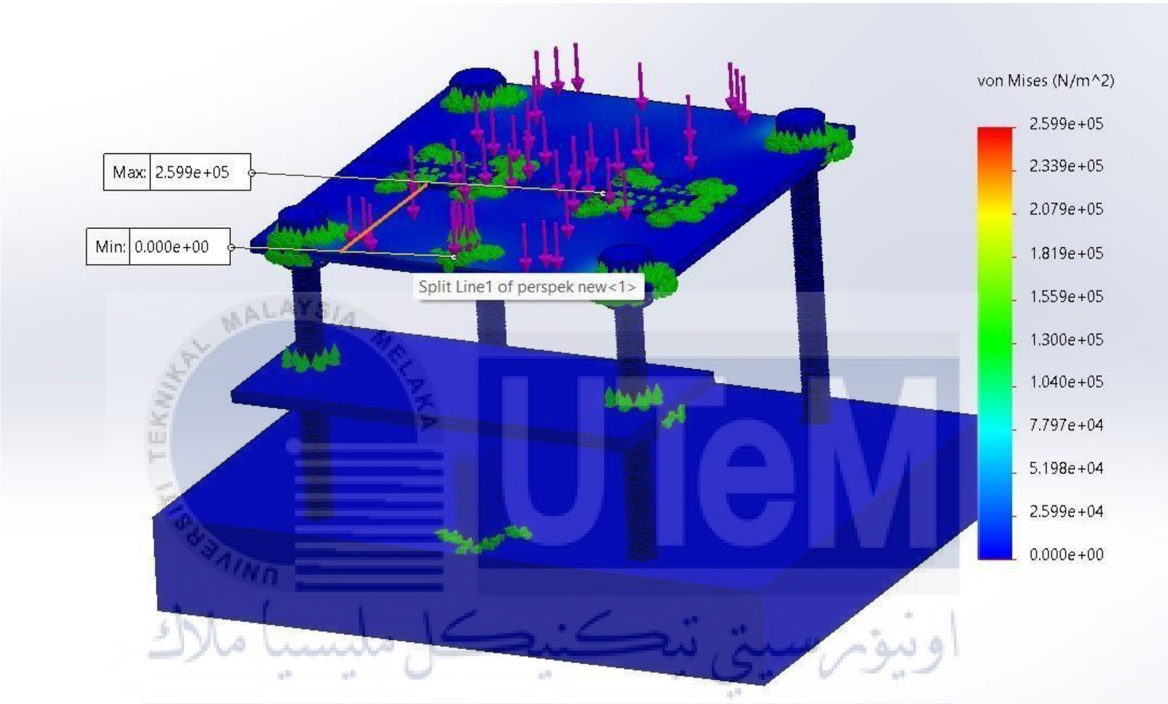


Figure 4.5.2.2: result of simulation in term of stress

Strain is calculated by dividing the amount of deformation the body experiences in the direction of the applied force by the body's starting dimensions. The maximum value is $1.045\ X\ 10^{-5}$ and the minimum value is 0.0^{0}.

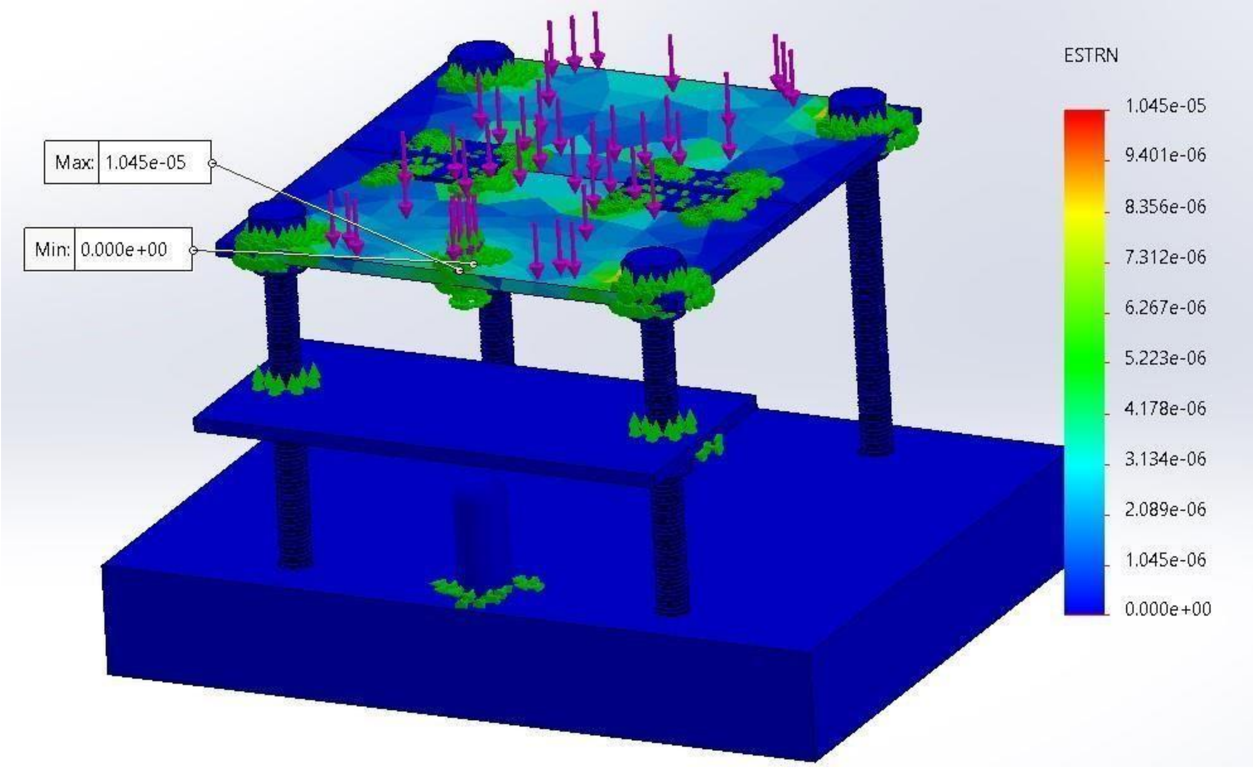


Figure 4.5.2.3: result of simulation in term of strain

4.7 The fabrication of LCPM

The LCPM just required easy steps and tools to fabricate. The machines that included in fabrication is vertical band saw, horizontal belt sanding machine and bench drilling machine.

Based on the steps of making this LCPM, it requires diligence and focuses in each process. For example, marking for cutting the parts. The plywood and acrylic Perspex didn’t in good shape. They didn’t cut it sprightly, and it was tilted when bought from the hardware store. So, marking it became a challenging part. In addition, the cutting process should also be emphasized so that there is no waste of material and avoid any injury to the manufacturer.

4.7.1 The real LCPM

After successfully carrying out all the fabrication steps, figure below shows the view of LCPM from various angle. The LCPM is ready to test with an actual sample. Since mosquitos are quite difficult to capture, the trial was carried out using ant as sample. Figure 4.7.1.2 shows the result obtained.

Figure 4.7.1.1: Front view of LCPM

Figure 4.7.1.2: Top view of LCPM

Figure 4.7.1.3: Isometric view of LCPM

4.7.2 The list parts of LCPM

The cost is the sum of money used to create this LCPM prototype. The price of this coEBN prototype is displayed in Table 4.15. The cost is determined by internet pricing, such as those from hardware stores, online shopping sites, and other online marketplaces.

Part	Amount needed	Cost for every price (RM)	Cost (RM)
Hex nut	12pcs	0.30	3.60
Hex bolt	4 pcs	2.10	8.40
Flat washer	4 pcs	0.20	0.80
Hinge	4 pcs	0.50	2.00
Acrylic	1sq ft	10.00	10.00
Laser light	1pcs	3.00	3.00
Plywood	1ft X 4ft	2.50	10.00
Superglue	1pcs	2.00	2.00
		Total	RM 39.80

Table 4.7.2: The list part of LCPM

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

As mentioned in chapter 1, the objectives of the project are to design a low-cost portable microscope using the Pugh method and to fabricate a prototype of a low-cost portable microscope. Both objectives were successfully achieved. The criteria of the customer requirements and the engineering requirements are also taken for the best quality of the product. Pugh methods were really helpful in selecting the perfect design to finalize. The most significant finding that emerges from this study is the design of the LCPM because the design gives the entomologists easy to do their work to dissect the mosquitoes effectively. For fabrication few challenges have been faced. When compared to a normal laboratory microscope, LCPM has so many advantages. It will save the cost and time of the entomologist.

5.2 Recommendation

There are a few recommendations for LCPM, first the type of wood selected for the base. The material should be thicker so that the base is more durable. Moreover, the base can’t be assembled using nails because the thickness of the plywood is small. Instead of using glue, the nails would help to give stronger assemble. The holes drilled in the wooden base give a bad image when all the parts were kept inside the wooden base. Instead of using a laser lens, a better lens can be used to get a better result. With the suitable type of needle is available, the clear picture of the whole body of the mosquito will be able to see.

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6035768ed36d/ of Aedes albopictus in northern peninsular Malaysia,

https://www.mendeley.com/catalogue/643ce9b7-7860-3a55-9efdca40366e743d/
https://www.mendeley.com/catalogue/a3b852bc-2540-3c98-86cb-

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51ed880d5eaa/ https://link.springer.com/article/10.1007/s00163-008-

0056-z

https://www.mendeley.com/catalogue/d22117a1-c20c-3507-ac3c-

9d3d115ec373/

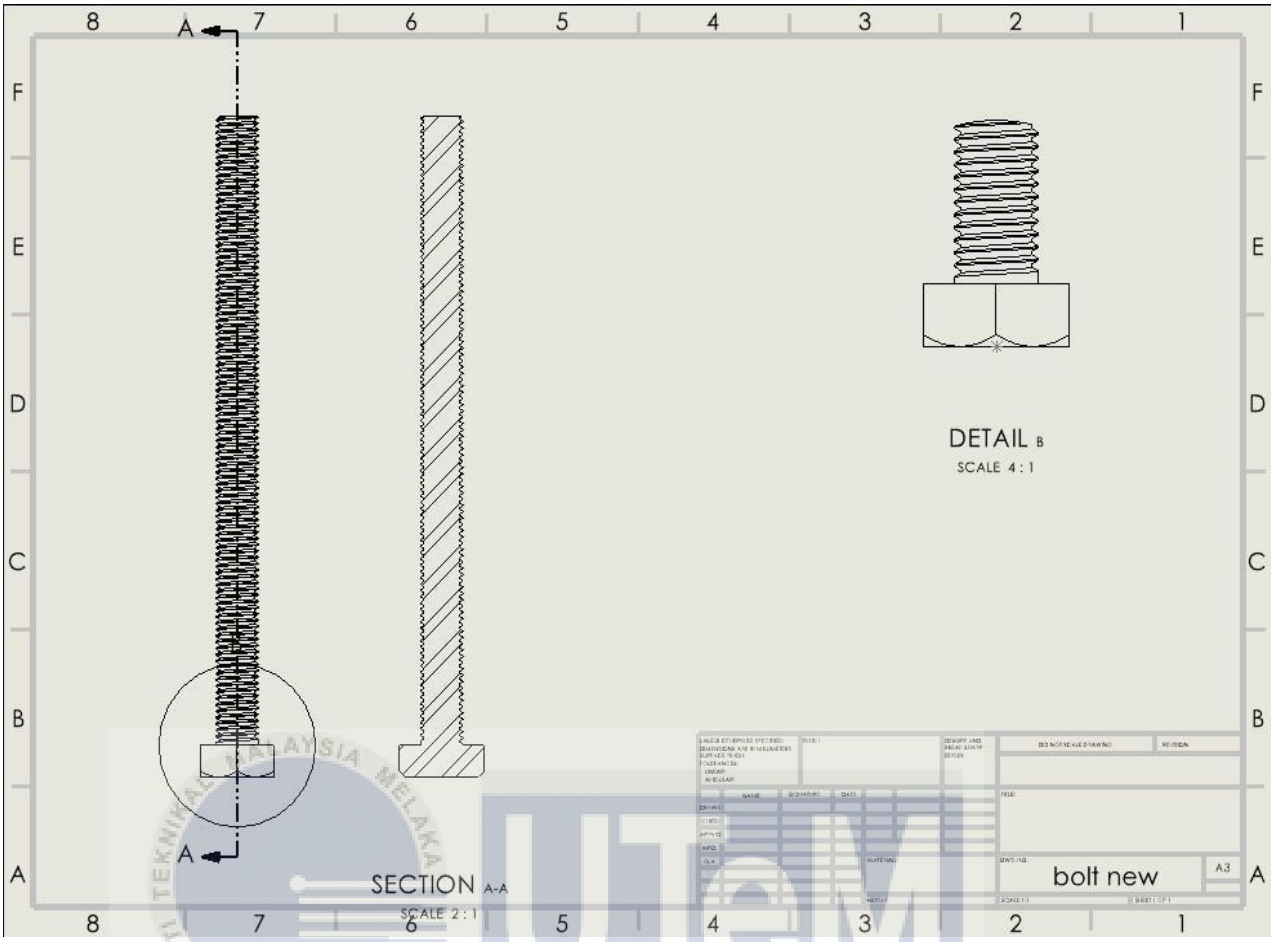
https://www.news-medical.net/life-sciences/Portable-Microscopes-Advantagesand-Disadvantages.aspx

Population analysis of Aedes albopictus
Tropical. Biomed. 32 (1) (2015)

APPENDIX 1- Gant Chart

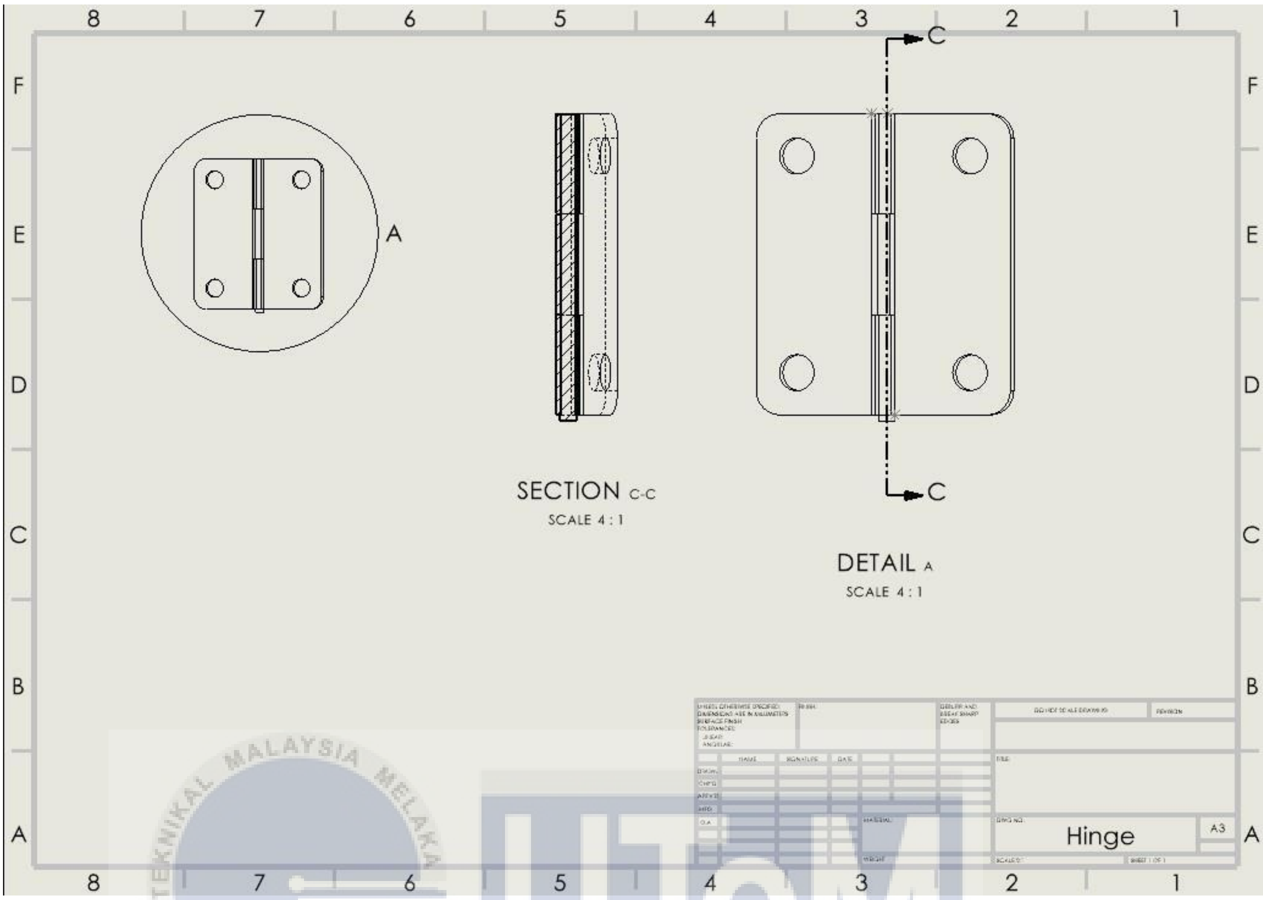
TASK ID	TASK	%DONE	WEEK													
				2	3	4	5	6	7	8	9	10	11	12	13	14
3.7	FABRICATION OF LCPM	100%														
4.0	RESULT AND DISCUSSION	100%														
4.1	INTRODUCTION	100%														
4.2	DATA COLLECTION OF SURVEY	100%														
4.3	HOQ	100%														
4.4	PUGH METHOD	100%														
4.5	SIMULATION OF LCPM	100%														
4.6	DRAWING OF LCPM	100%														
4.7	THE REAL LCPM	100%														
4.8	CONCLUSION AND RECOMMENDATION	100%														
4.9	CONCLUSION	100%														
5.0	RECOMMENDATION	100%														
	CORRECTION	100%														
PSM2 REPORT SUBMISSION																
PSM 2 F2F PRESENTATION																

APPENDIX 2- Drawing of Bolt

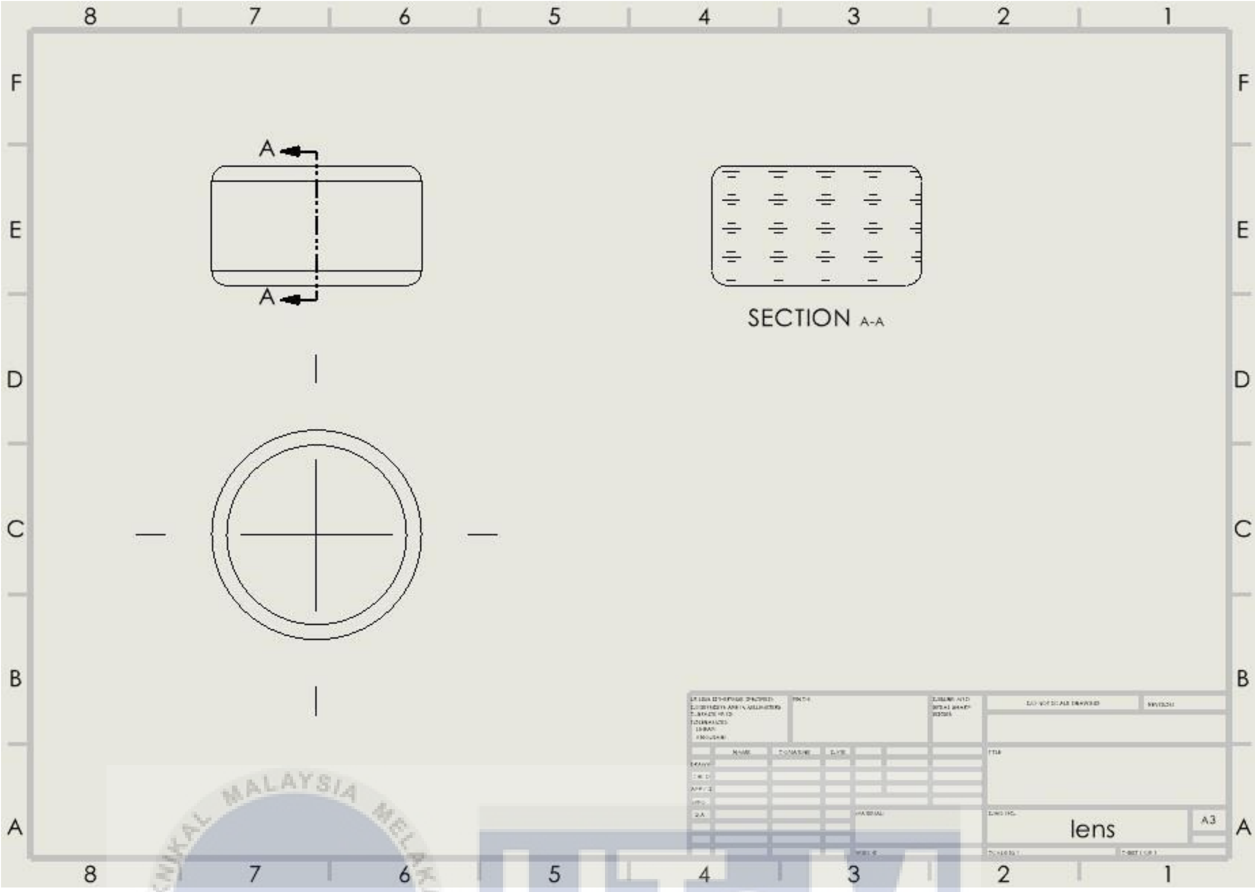


]

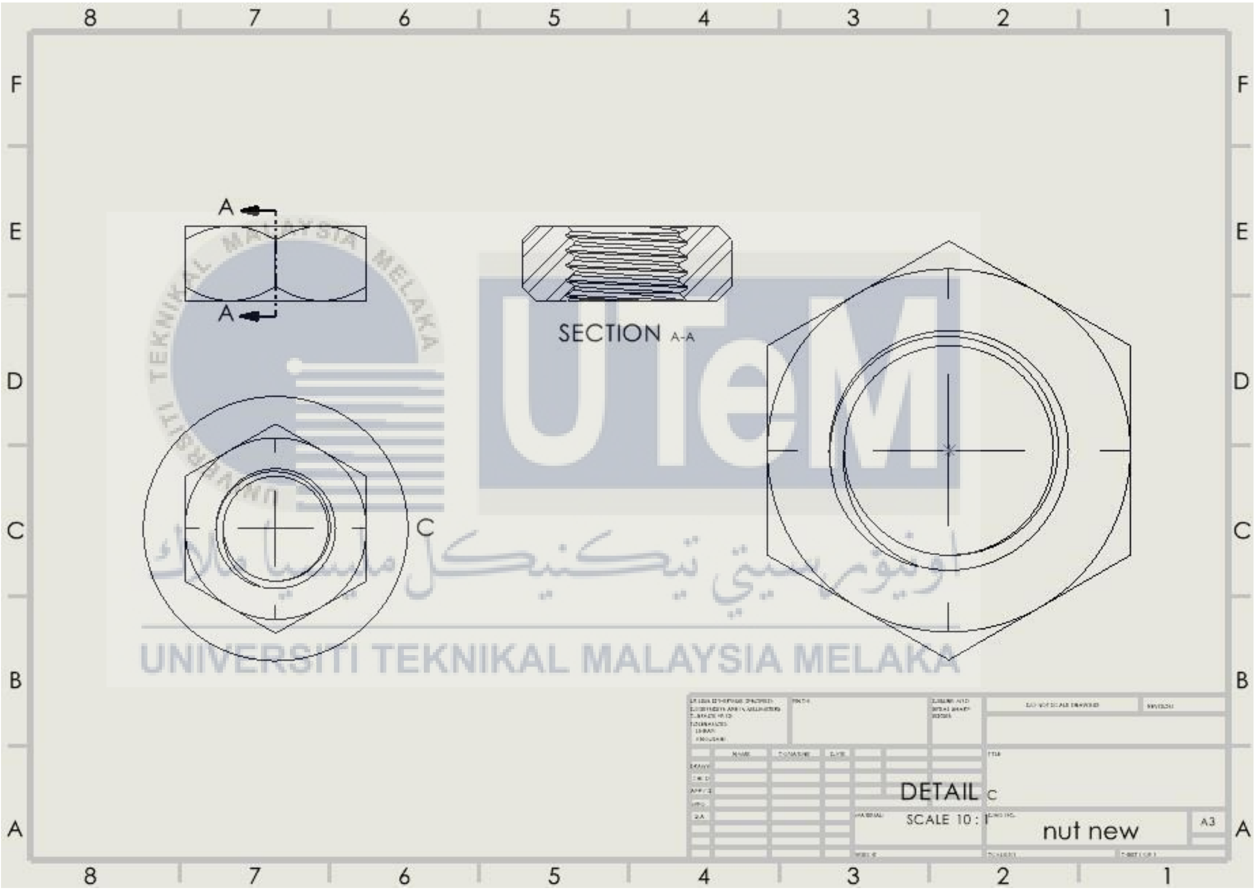
APPENDIX 3- Drawing of Hinge



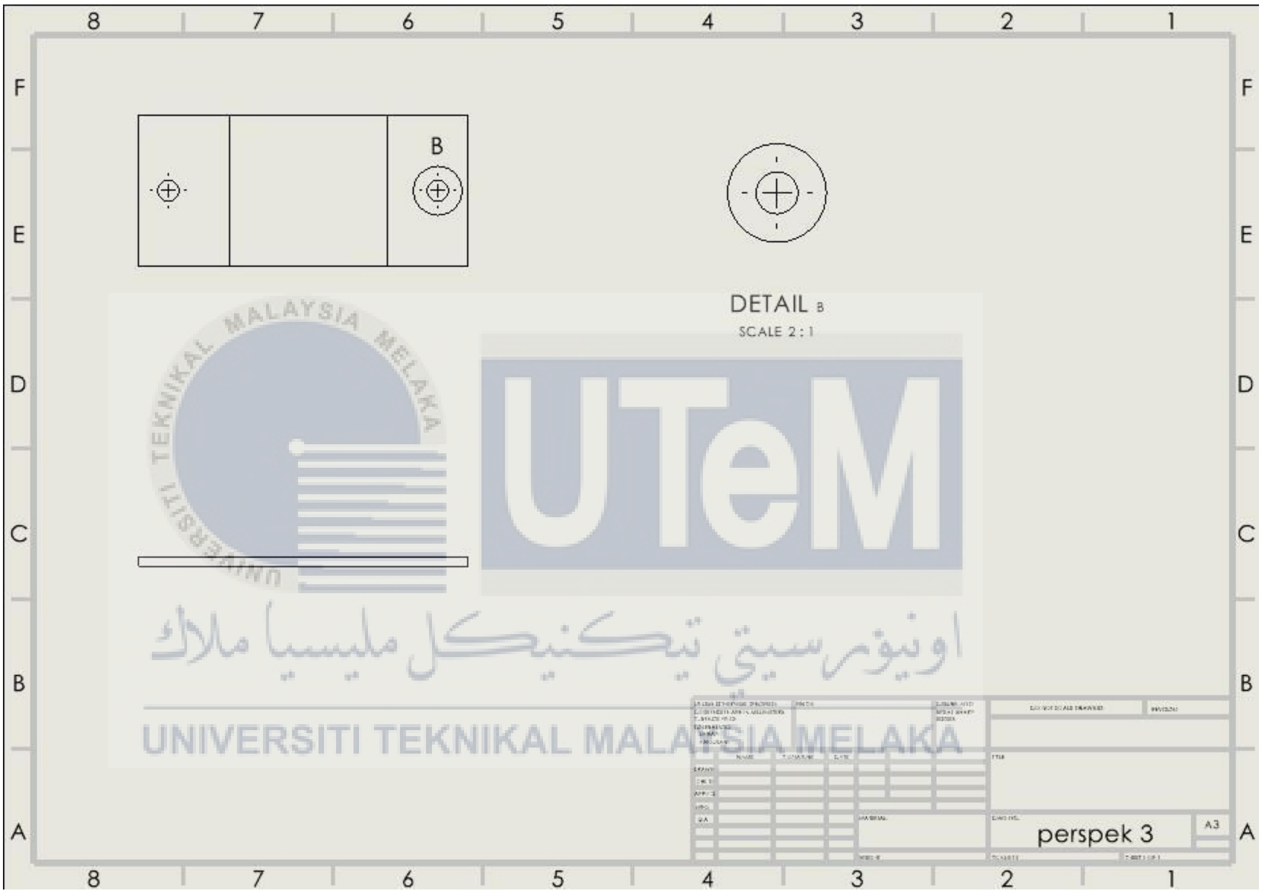
APPENDIX 4- Drawing of Lens



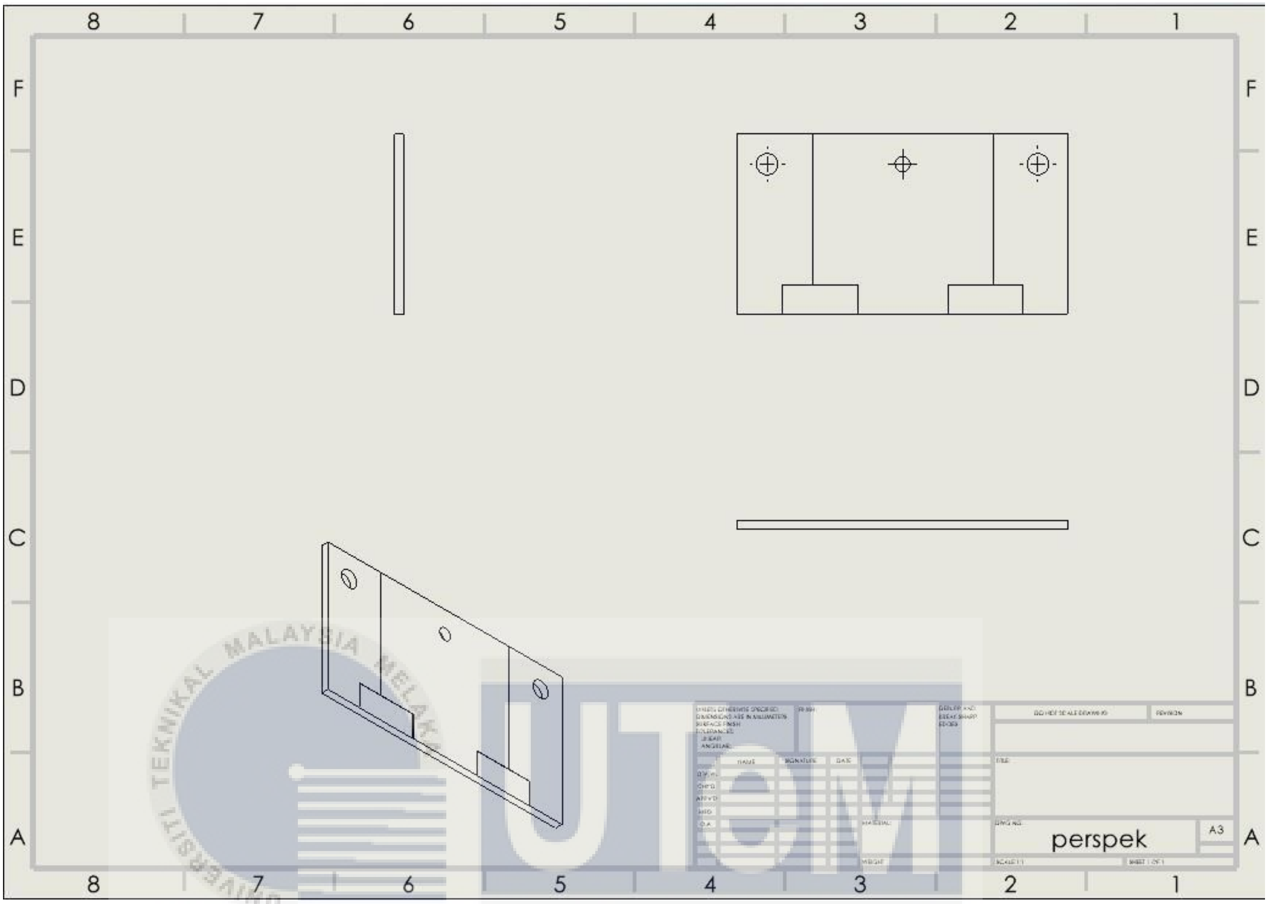
APPENDIX 5- Drawing of Nut



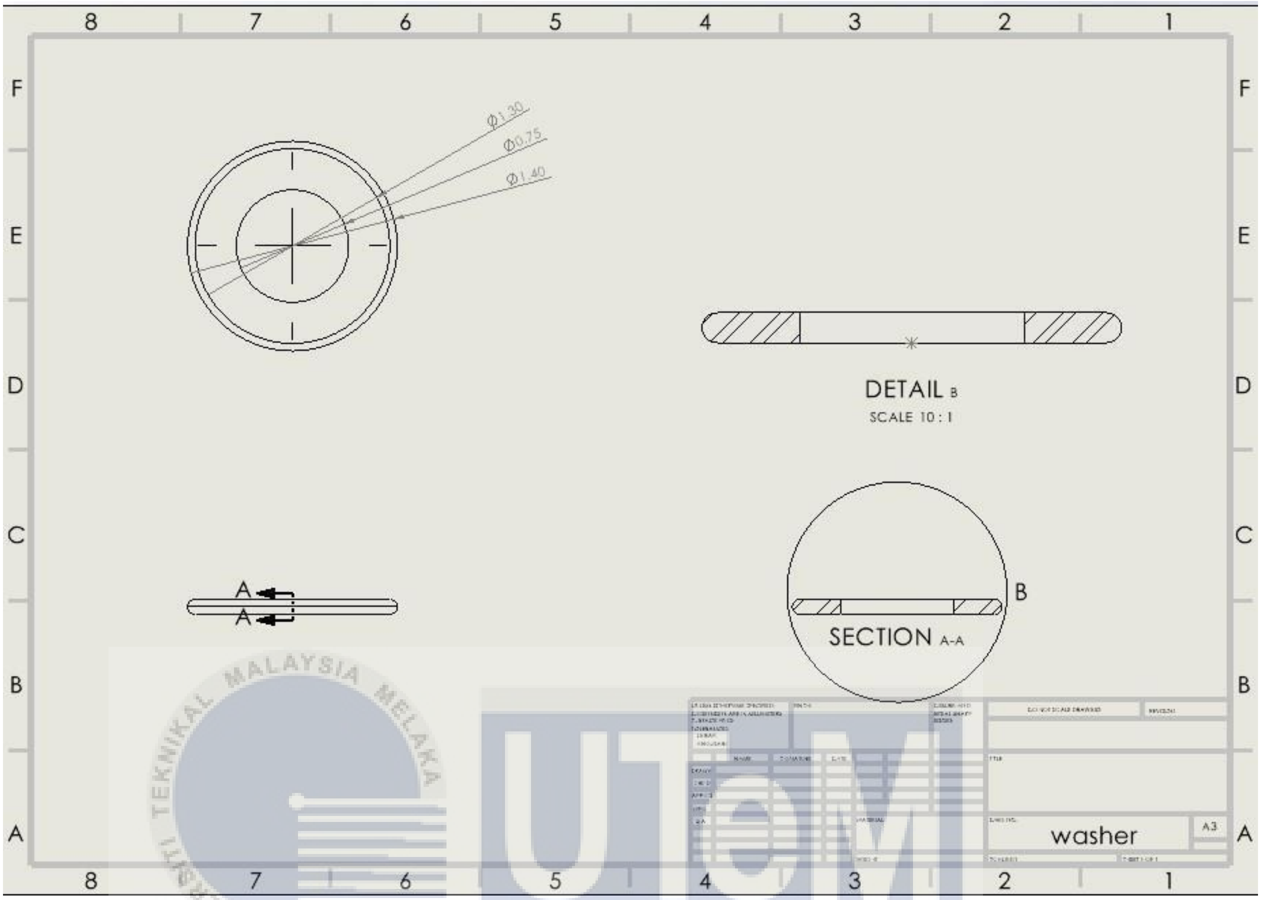
APPENDIX 6- Drawing of Perspex



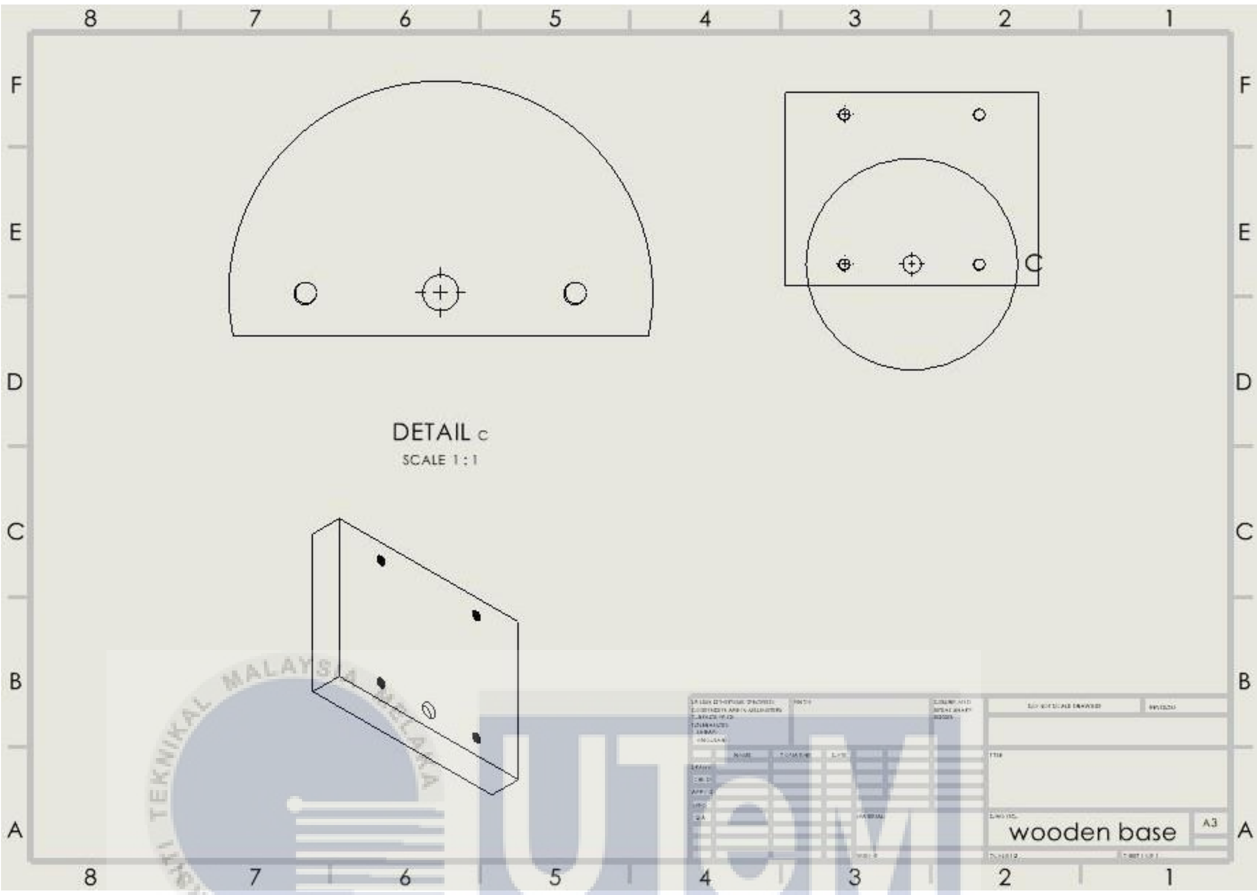
APPENDIX 7- Drawing of Perspex 2



APPENDIX 8- Drawing of Washer



Appendix 9- Drawing of Wooden Base



APPENDIX 10- Exploded view of LCPM