

POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

“HAND-FREE LEG CRUTCH”

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JABATAN KEJURUTERAAN MEKANIKAL

HANDS-FREE LEG CRUTCH

**In partial fulfilment of the requirements for
Diploma in Mechanical Engineering
Politeknik Sultan Salahuddin Abdul Aziz Shah**

JABATAN KEJURUTERAAN MEKANIKAL

JUN 2020

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PENGHARGAAN

Bersyukur ke hadrat Ilahi serta selawat ke atas junjungan besar kita iaitu Nabi Muhammad SAW dapatlah kami menyiapkan projek akhir dengan cemerlang dalam tempoh masa yang telah ditetapkan tanpa menghadapi sebarang masalah yang sukar diselesaikan semasa pengajian Diploma Kejuruteraan Mekanikal sesi Jun 2020. Ucapan setinggi-tinggi penghargaan dan jutaan terima kasih yang tidak terhingga kepada penyelia kami iaitu Asnizah binti Sahekhaini kerana banyak membantu dan memberi segala tunjuk ajar, nasihat, dorongan serta kritikan membina kepada kami sehinggakan kami berjaya menyiapkan laporan projek akhir ini, terutamanya apabila kami hampir hilang semangat kerana buntu untuk memikirkan cara yang sepatutnya untuk menyelesaikan masalah yang di hadapi.

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ABSTRACT

In today's modern era, many devices have been created to facilitate human movements such as hoverboards, electric scooters, electric bicycles, and more. But for individuals with leg injuries who have to use crutches, their movements still require a little more energy and effort. With this, hands-free leg crutch was created. The hands-free leg crutch is a support system to help base individual support especially the leg. A normal leg crutch requires the use of a shoulder to support a person's leg which will cause pain in the shoulder. Hence, the project is called 'Hands-Free Leg Crutch'. The purpose of this project is to provide leg support to users without having to hurt their shoulders. In addition, users can perform various tasks while using this product and easier to move freely without any restrictions as to when using a regular leg crutch. For this hands-free leg crutch, it has adjustable legs. This will allow the user to adjust the height of the crutch to suit the height of the individual. Next, a small cushion is placed on the knee area to soften the surface to avoid pain. Also, this stick is held to the leg using Velcro straps as these straps can be stretched and fastened easily. It will facilitate the application process on the feet. Finally, this hands-free leg crutch is made of aluminium. Aluminium is used because this material is cheaper but still offer a strong material. This product is expected to be beneficial to users that are in need of leg support that is affordable.

ABSTRAK

Pada era moden kini, banyak alat yang dicipta untuk memudahkan pergerakan manusia seperti *hoverboard*, skuter elektrik, basikal elektrik, dan banyak lagi. Tetapi bagi individu yang mengalami kecederaan pada kaki yang terpaksa menggunakan tongkat, pergerakan mereka masih memerlukan tenaga dan usaha sedikit lebih. Dengan ini, tongkat kaki bebas tangan dicipta. Tongkat kaki bebas tangan adalah sistem sokongan untuk membantu asas sokongan individu khususnya kaki. Sebuah tongkat kaki yang normal memerlukan penggunaan bahu untuk menyokong kaki seseorang yang akan menyebabkan kesakitan pada bahu. Oleh itu projek ini dipanggil '*Hands-Free Leg Crutch*'. Tujuan projek ini adalah untuk memberi sokongan kaki kepada pengguna tanpa perlu menyakitkan bahu mereka. Selain itu, pengguna dapat melakukan pelbagai tugas semasa menggunakan produk ini dan lebih mudah bergerak dengan bebas tanpa ada batasan seperti ketika menggunakan tongkat kaki biasa. Untuk tongkat kaki bebas tangan ini, ia memiliki kaki boleh laras. Ini akan membolehkan pengguna untuk menetapkan ketinggian tongkat kaki tersebut bersesuaian dengan ketinggian individu. Seterusnya, sedikit kusyen diletakkan pada bahagian tempat lutut untuk melembutkan permukaan bagi mengelakkan rasa sakit. Selain itu, tongkat ini dipegang pada kaki menggunakan tali Velcro kerana tali ini boleh meregang dan diikat dengan mudah. Ia akan memudahkan proses pemakaian pada kaki. Akhir sekali, tongkat kaki ini diperbuat daripada aluminium. Aluminium digunakan kerana bahan ini lebih kuat dan murah. Produk ini diharapkan dapat memberi manfaat dengan membantu pengguna yang memerlukan.

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CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

A **crutch** is a mobility aid that transfers weight from the legs to the upper body. It is often used by people who cannot use their legs to support their weight, for reasons ranging from short-term injuries to lifelong disabilities.

Since antiquity humans have fashioned support devices to hold themselves up when they became sick or injured. Support device use dates back to 2830 BC. A carving on the entrance of an Egyptian tomb depicts a figure leaning on a crutch-like staff.

Crutch design has evolved from the basic "T" used by Tiny Tim in *A Christmas Carol* to lightweight aluminium braces with ice-gripping tips or energy-storing tips that function as shock absorbers and are slip-resistant.

For lower-limb injuries such as a broken leg, broken ankle, sprained ankle, knee injuries, and other injuries, as well as after surgery on the leg, knee, ankle, or foot, crutches remain useful today to decrease discomfort, reduce recovery time, and assist walking. Often when you get a cast put on your leg or foot you will be required to use crutches for a period of time. Crutches may also be used by amputees, and people with other disabilities that make walking difficult.

But as time passes by, people started to criticise that using a crutch still makes it hard to walk and they aren't free as they were before when using one. So, the final year project is to solve that problem and make a solution for that. As a start, this chapter consist of the problem statement, the objectives of the project, and the scope of the project.

1.2 PROBLEM STATEMENT

Crutch is a tool that is used to help people to walk easier. In this era, there are lots of people using crutches in different reasons. Some people are using crutches because their leg is injured. Some others are using crutches for sports such as Paralympic sports where the disabled people are competing in sports, and others are using crutches for support such as hill and mountain climbers. They are using crutches to help them climb up and down the mountain. Even the reason to use crutches is different, the crutch works the same. Crutches can replace the leg works to support the whole body to move. The problem of using crutches is also the same. Person that is using crutches will overcome same problem especially the crutch for medical purpose. Crutches work by supporting the whole body when a person is walking or standing up to replace leg for a different reason.

Some of the problems that the person will overcome when using a crutch is, their daily activities are disrupted because their hands are used to support them while moving especially individuals with leg injuries. This is due to the leg are unable to be used as usual. The commonly used crutch will also cause the user to feel pain in the shoulder because of the pressure applied to the shoulder to support the entire body that is usually be done by leg. A good crutch is supposed to make the user feel comfortable when using it. In addition, commonly used crutches will also limit the movement of user because the commonly used crutch makes user feel tired and pain in the shoulder. Due to this condition, user tend to rest longer, and the movement is limited.

The problem is mostly caused by a stick designed to support the user's body using the hand when the user suffers a foot injury. This method is suitable if the consumer injury is serious but somewhat inappropriate if the consumer injury is only a minor injury. Next, the stick part used to hold the user on the hand part has a very tapered and hard surface. This not only causes the user to feel pain in the shoulder, it also causes the lower arm of the user to feel sore. In addition, a cane is a tool used as a replacement for a foot when injured using a hand to control its movement. This will cause the user's daily activities to be disrupted due to limited movement as a result of the hands that need to be used to operate the stick.

1.3 OBJECTIVES OF STUDY

The objectives of the study as follows below;

Design:

- i. To design a product that can be used as an alternate way to walk among users who faced injury at their leg.

Develop:

- ii. To develop a crutch that is user-friendly tool to all person suffers leg injury and other type of lower body injury.

Test

- iii. To identify the capability of the crutch on tracking the strength by various types of pressure.

1.3 SCOPE OF STUDY

The purpose of scope study for this project as follows below:

- i. This study will be focused on: “identification of injury leg position to the adjustable crutch to the user”
- ii. System capability is limited to
 - user’s physical
 - type of leg injury
 - ability to walk
- iii. The device will be developed in light, user-friendly and safe to use

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Legs are made up of bones, blood vessels, muscles, and other connective tissue. They are important for motion and standing. Playing sports, running, falling, or having an accident can damage your legs. Common leg injuries include sprains and strains, joint dislocations, and fractures (broken bones). Minor leg injuries are common. Symptoms often develop from everyday wear and tear, overuse, or an injury. Leg injuries are most likely to occur during sports and recreational activities, work related task, work or projects around home.

This project is to help people to do what they used to do even when they are having injury without harming them. This will help the users to walk freely without using crutches to walk. This project is very useful and practical, low cost and also easy to set up because the design of this project is simple. The material that being used is aluminium. Aluminium is a common metal used for both industrial and non-industrial applications. In most cases, it can be difficult to choose the correct aluminium grade for your intended application. If your project does not have any physical or structural demands, and the aesthetics are not important, then almost any aluminium grade will do the job. Other material that being used is metal as platform and velcro as the strapping.

Next, joint method that will be used is screw, welding, bolts and nut. The most suitable welding method is by using MIG and TIG welding. The welding is being used at the platform to weld the metal. Next using screw to joint between metal and aluminium as the support between platform and metal to make the leg crutch stable and not nimble. Bolt and nut is used at the leg support that hold the leg at thigh. The Velcro straps is placed at that parts to holds the leg

2.2 CONCEPT / THEORY

The '**hands-free leg crutch**' is a tool used to help a person walk by not occupying their hands when they have a leg injury. Aluminum and 'stainless steel' are used to build this product. It is used by putting the leg on the platform and using strapping attached to the stick along with the leg. This will only allow the person to control the stick by using the foot and then result in a free hand. A person may avoid suffering from shoulder pain caused by crutch pressure by using this product. It is because of the positioning of the hands-free leg crutch on the thigh. In addition, since the hands of the individual are free to move without any restriction, the person can also easily do daily activities. Their hands will be busy moving the crutch if the person uses a normal crutch, but their hands will be free when using this leg crutch that is placed on the leg.

The height can also be adjusted on the legs for the hands-free leg crutch to fit all users, even though they have different heights. This helps it to be had by all relevant people without having to talk about height issues. Since the product created works by putting the leg on the platform, cushions are also placed on the platform to prevent the issue of leg pain, as is the case on the market with standard crutch that causes shoulder pain for users.

2.3 PREVIOUS STUDY

2.3.1 MATERIALS

CRUTCH

Crutches are a type of Walking Aids that serve to increase the size of an individuals. Base of support. It transfers weight from the legs to the upper body and is often used by people who cannot use their legs to support their weight (short-term injuries to lifelong disabilities). It is often used by people who cannot use their legs to support their weight, for reasons ranging from short-term injuries to lifelong disabilities. It is essential that crutches are measured and adjusted to suit every patient they are given to.

The materials used to make crutches must be sturdy in order to efficiently manage the weight of the users. Crutches are mostly made of tough metals, like aluminium or steel-reinforced aluminium for heavy-duty use. Traditionally, some underarm crutches are still made of wood. Some metal crutches can have a coloured paint finish. It is necessary that all crutches are fitted with an appropriate ferrule. The ferrules of metal crutches must incorporate a metal ring so as to prevent the base of the crutch cutting into the rubber of the ferrule.

There are three types of crutches; Axilla crutches, Elbow crutches and Gutter crutches.

- Axilla or underarm crutches: They should actually be positioned about 5 cm below the axilla with the elbow flexed 15 degrees, approximately. The design includes an axilla bar, a handpiece and double uprights joined distally by a single leg. They are adjustable in height both the overall height and handgrip height can be adjusted (adjustable approximately 48 to 60 inches (12 to 153 cm)).



- Forearm crutches: (elbow or Canadian crutches). Their design includes a single upright, a forearm cuff and a handgrip. The height of the forearm crutches is indicated from handgrip to the floor (adjustable from 29 to 35 inches or 74 to 89 cm).



- Gutter Crutches: (or adjustable arthritic crutches, forearm support crutches). These are additional types of crutches, which is composed of padded forearm support made up of metal, a strap and adjustable handpiece with a rubber ferrule. These crutches are used for patients who are on partial weight bearing like Rheumatoid disease.



Types of gaits:

- One crutch:

When using one crutch, the crutch may be placed on the side of the unaffected leg or used to bear the load of the affected leg.

- Four-point gait:

Those who can tolerate partial weight bearing on both legs usually use the four-point gait. The sequence is right crutch, left leg, left crutch, right leg. This is the slowest of all gaits but also the safest in that three of the four points are in contact with the ground at any given time.

- Two-point gait:

Those who can tolerate partial weight bearing on both legs but require less support than a four-point gait usually use the two-point gait. The sequence is right crutch with left leg and then left crutch with right leg.

- Three-point gait:

The three-point gait is usually used by those who cannot bear weight on one leg. Both crutches are advanced while bearing weight on the unaffected leg. Then the unaffected leg is advanced while bearing weight on the crutches.

- Swing-to gait:

A person with a non-weight bearing injury generally performs a "swing-to" gait: lifting the affected leg, the user places both crutches in front of himself, and then swings his uninjured leg to meet the crutches. A similar "swing-through" gait is when both legs are advanced in front of the crutches rather than beside them.

- Stairs:

When climbing up the stairs, the unaffected leg is advanced first, then the affected leg and the crutches are advanced. When descending stairs, the crutches are advanced first and then the affected leg and the unaffected leg.

LEGS STRAIGHTENER CORRECTION BANDAGE BELTS BAND

Knock knees is a term used to describe an inward angle of the thighs. This often leads to pain, cosmetic deformity, and premature knee arthritis. The Neoprene Bow Legs Knock Knees Corrector Belt Set is designed to correct bow legs and knock knees and can be used day and night. Elastic neoprene straps pull the knees to the right position, helping the legs to realign with comfort. The belts can be worn while sitting, working, lying or sleeping. Hook-and-loop closure design provides a comfortable fit.



Features:

1. Designed to correct bow legs and knock knees
2. Can be used day and night
3. Elastic neoprene straps pull the knees to the right position
4. Help the legs to realign with comfort
5. Can be worn while sitting, working, lying or sleeping
6. Hook-and-loop closure design for a comfortable fit

Specifications:

1. Material: Neoprene
2. Colour: Black
3. Adjustable: O-Type X-Type Leg

PU LEATHER

PU leather, or polyurethane leather, is an artificial leather made of thermoplastic polymer used for making furniture or shoes. 100% PU leather is completely artificial and is considered vegan. There are some types of PU leather called bicast leather that have actual leather but has a polyurethane coating on top. This type of PU leather takes the fibrous part of cowhide that are left over from making genuine leather and put a layer of polyurethane on top of it.



PU leather also goes by a few names. Whether you are looking for artificial leather or looking to avoid it, it is best to know the many names that make up artificial leather.

When looking at tags, artificial leather can be called:

- PU Leather
- Bicast Leather
- Split Leather
- Bonded Leather
- Reconstituted Leather
- Corrected Grain Leather

Pros & Cons of PU Leather

If you are on the fence when it comes to deciding if you want artificial over genuine leather, it is best to look at the pros and cons of PU leather.

PU Leather Pros:

- PU Leather costs less than genuine leather because it is easier to manufacture.
- PU doesn't absorb water which makes it easy to clean.
- 100% PU leather is vegan.
- PU leather can be made into a variety of colors and styles.
- Unlike leather, PU leather doesn't dry out over time.
- Better for sustainability because it uses fewer resources to make.

PU Leather Cons:

- Can look fake and synthetic.
- Isn't breathable like genuine leather.
- Can smell of chemicals or plastic.
- Easily wears over time and can crack, which means it doesn't last as long as real leather.
- Can puncture or tear easily unlike genuine leather.
- PU leather doesn't develop the same luster or patina as real leather over time.
- Not all PU leathers are vegan because some contain leftover genuine leather.
- Even though it uses fewer resources to make, plastics don't decompose and aren't the most eco-friendly.

PU leather is also known as polyurethane leather that is artificial. If you are someone looking for a cheaper option, something vegan, or comes in a variety of colours, PU leather will be a great option for you. But if you are looking for genuine leather, PU leather will be something you will want to avoid. There are numerous ways to tell the difference between PU leather and genuine leather to help you in your furniture buying process.

8" STAINLESS STEEL SEAMLESS PIPE

Pipe strength is generally measured in tensile strength, or the maximum amount of weight a pipe can support before it breaks. Yield strength comprises a type of tensile strength; it denotes how much a pipe can hold before it suffers permanent deformation -- or, the maximum weight a pipe can hold before it bends. Manufacturers and engineers measure yield strength in units such as pounds per square inch (PSI), kilo pound per square inch (KSI) and megapascals (MPa). The yield strength of a pipe depends upon the material used to make the pipe.



Yield strength on schedule 80 pipes runs a wide gamut depending upon the manufacturer and type of galvanized steel used. For instance, schedule 80 pipes produced by Wheatland Tubes exhibit a minimum yield strength of 30,000 PSI or 205 MPa, while One Steel produces schedule 80 pipes with a minimum yield strength of 250 MPa, or about 36,260 PSI. Rocky Mountain Steel Peering, meanwhile, produces schedule 80 piping with a minimum yield strength range of 35 KSI to 42 KSI, or 35,000 to 42,000 PSI. According to ASTM A653 standards, mild hot-dip galvanized steel must have a minimum yield strength of 36,300 PSI. To find the actual yield strength of your pipe, contact the manufacturer or an engineer.

This pipe will be use as platform for placing the thigh to the user based on the user. The pipe will cut in half but long based on the user's leg length. After it has been cut, the use of PU leather will be applied to the half-pipe to ensure it is comfortable and soft.

2.3.2 EQUIPMENTS

SCREW

A screw is a combination of simple machines—it is, in essence, an inclined plane wrapped around a central shaft, but the inclined plane (thread) also comes to a sharp edge around the outside, which acts a wedge as it pushes into the fastened material, and the shaft and helix also form a wedge in the form of the point. Some screw threads are designed to mate with a complementary thread, known as a female thread (internal thread), often in the form of a nut, or object that has the internal thread formed into it. Other screw threads are designed to cut a helical groove in a softer material as the screw is inserted. The most common uses of screws are to hold objects together and to position objects.

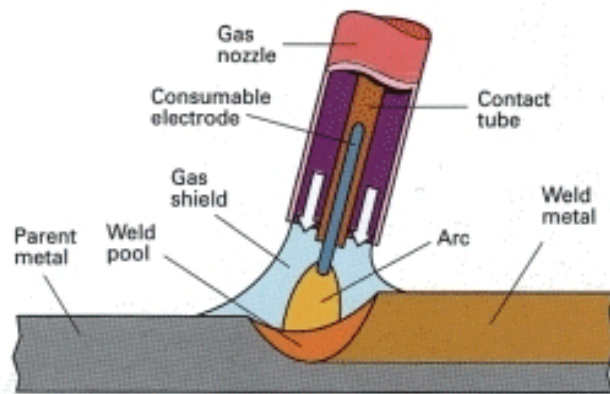


A screw will usually have a head on one end that allows it to be turned with a tool. Common tools for driving screws include screwdrivers and wrenches. The head is usually larger than the body of the screw, which keeps the screw from being driven deeper than the length of the screw and to provide a bearing surface. There are exceptions. Carriage bolts have a domed head that is not designed to be driven. Set screws often have a head smaller than the outer diameter of the screw. Headless set screws are also called grub screws. J-bolts have a J-shaped head that is not designed to be driven but rather is usually sunk into concrete allowing it to be used as an anchor bolt. The cylindrical portion of the screw from the underside of the head to the tip is known as the shank; it may be fully threaded or partially threaded. The distance between each thread is called the "pitch".

Screws are widely used in threaded fasteners to hold objects together, and in devices such as screw tops for containers, vises, screw jacks and screw presses. Other mechanisms that use the same principle, also called screws, don't necessarily have a shaft or threads. Screws will be used to connect 2 materials into the project due to inability to use MIG welding system to aluminium (shoulder crutch).

MIG WELDING

Metal Inert Gas (MIG) welding is an arc welding process that uses a continuous solid wire electrode heated and fed into the weld pool from a welding gun. The two base materials are melted together forming a join. The gun feeds a shielding gas alongside the electrode helping protect the weld pool from airborne contaminants. Metal Inert Gas (MIG) welding was first patented in the USA in 1949 for welding aluminium. The arc and weld pool formed using a bare wire electrode was protected by helium gas, readily available at that time. From about 1952, the process became popular in the UK for welding aluminium using argon as the shielding gas, and for carbon steels using CO₂. CO₂ and argon-CO₂ mixtures are known as metal active gas (MAG) processes. MIG is an attractive alternative to MMA, offering high deposition rates and high productivity.



MIG/MAG is widely used in most industry sectors and accounts for more than 50% of all weld metal deposited. Compared to MMA, MIG/MAG has the advantage in terms of flexibility, deposition rates and suitability for mechanisation. However, it should be noted that while MIG/MAG is ideal for 'squirting' metal, a high degree of manipulative skill is demanded of the MIG welder.

The use of MIG welding will be applied to weld to the stainless-steel half-pipe with stainless steel rod at the pipe for slotting in the crutch. It is because the use of MIG welding system is easier than arc welding system.

2.4 SUMMARY

The Hands-Free Leg Crutch is a method used to help a person walk when they have a leg injury without occupying their hand. It can prevent users from getting shoulder pain by the use of this device. Compared to using a traditional crutch, the user can still move freely when using this product. Depending on the user's height, the height of the crutch can also be changed. This allows all relevant individuals to have it without having to talk about height issues.

The Hands-Free Leg Crutch is a device that is used to replace a widely used crutch. These devices are used to attach the crutch to the leg of the user and are strapped using a Velcro strap that can hold the leg of the user and can be easily handled. Different material forms are used to make the crutch lighter depending on their needs, such as aluminum. Through making the crutch lighter, the user can travel freely as the product's versatility increases. Metal as the base is the next material being used. Metal is used to provide good support for the customer. Users need stronger help in order for the consumer to manage the product perfectly, so that they can place more weight and confidence in this product. The leather and the cushion are put on top of the platform to make it easy for the consumer to use the product. The rubber on the bottom of the crutch is another material used to give users grip to prevent slipping on the slippery surface.

CHAPTER 3

METHODOLOGY

3.0 Introduction

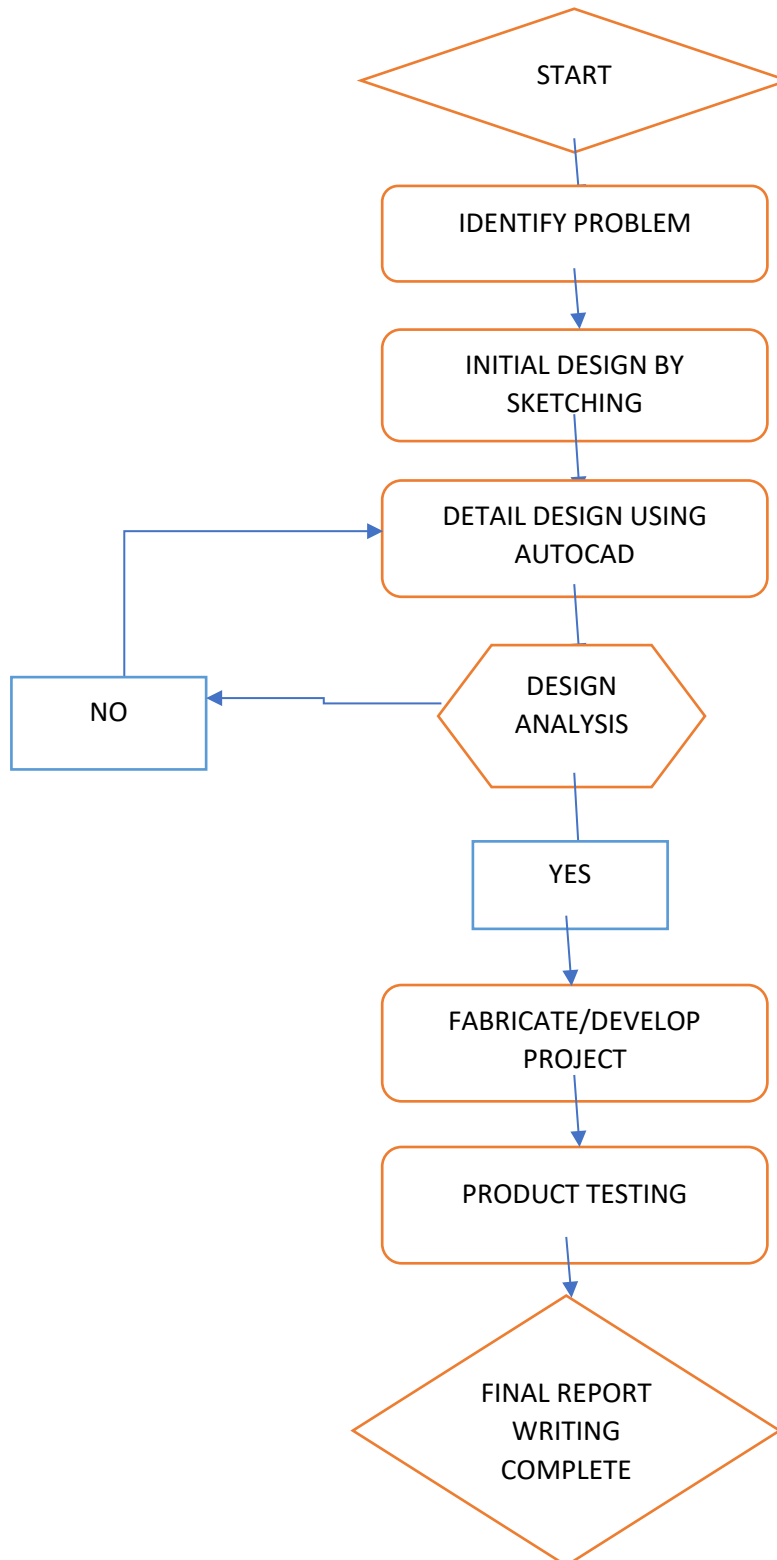
The hands-free leg crutch is based on a planned methodology. To discuss project design, meetings with group members are held. Using Autodesk Inventor Software 2019, the final project was planned. The debate on the design was ended, followed by a discussion on materials and costs. The cost of production, equipment, transportation and others are among the expenses considered. Aluminum and 'stainless steel' are the products agreed upon by all members. Aluminium is a common metal used for both industrial and non-industrial applications. In most cases, it can be difficult to choose the correct aluminium grade for your intended application. If your project does not have any physical or structural demands, and the aesthetics are not important, then almost any aluminium grade will do the job.

Next, welding, bolt and nut, and rivet is the type of attachment that will be used. After that, the project's development started with the purchasing of supplies. The purchased materials are then cut according to the planned length. To ensure that the tool works correctly, the finished material is then attached and tested. The height can also be changed on the legs for the hands-free leg crutch to suit all users, even if they are of different heights. This allows all relevant individuals to have it without having to talk about height issues. As the product produced works by placing the leg on the platform, cushions are placed on the platform to avoid the problem of leg pain, as is the case for a regular crutch on the market that causes users shoulder pain.

There were some errors on the first attempt, such as an imperfect connection that caused the stick to sway, and the material chosen was so thick that it felt difficult for the user to use. To allow people who use it to feel comfortable, the drawbacks of the project are further checked and enhanced. The leg crutch is then sent to make it work with finishes and leather as well as sewing straps.

3.1 FLOW CHART OF THE PROJECT

This project, the work procedure is done by step in a systematic plan. Figure shows the overview of the methodology and the description are present below:

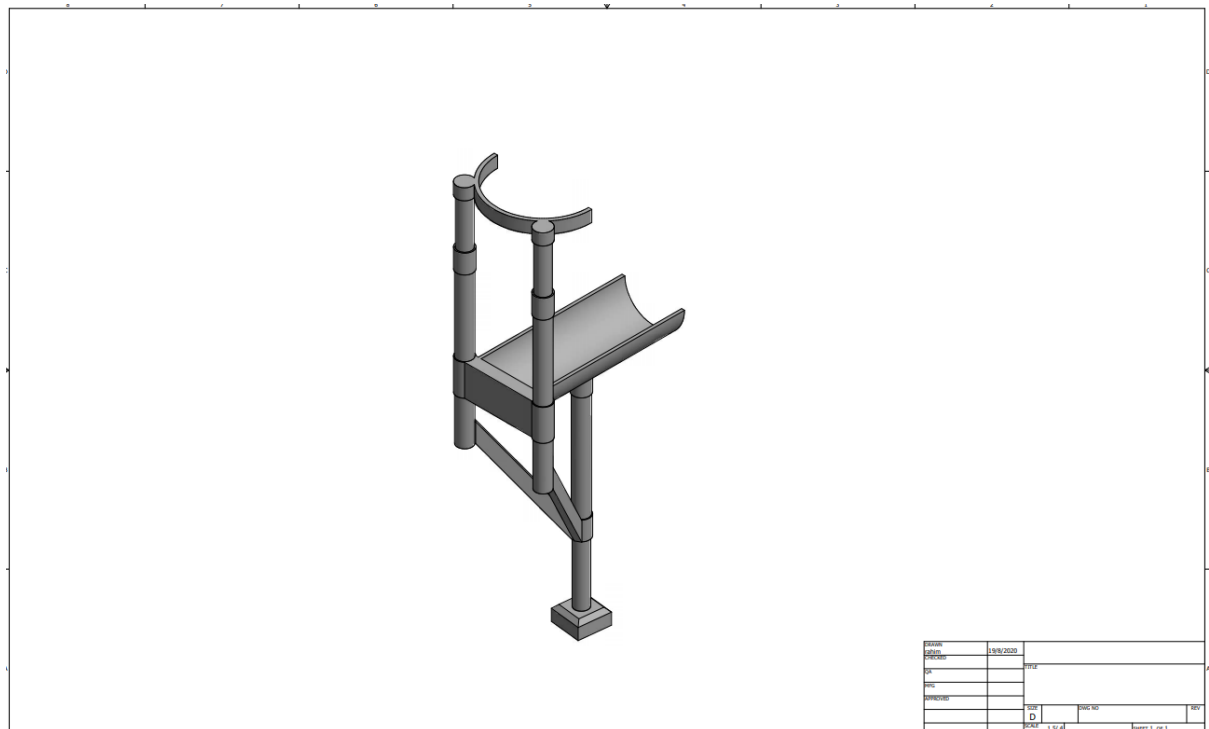


3.2 PROBLEM STATEMENT

The problem is mostly caused by a crutch designed to support the body of the user by using a hand when the user has a foot injury. This method is appropriate if the injury to the consumer is serious but somewhat inappropriate if the injury to the consumer is only minor. Next the crutch part used to hold the user on the hand part has a very hard and tapered surface. Not only does this cause the user to experience pain in the elbow, but it also causes the user's lower arm to feel sore. Furthermore, a crutch is a tool used to regulate its movement as a substitute for a foot while wounded using a hand. As a consequence of the hands that need to be used to operate the handle, this will cause the everyday routines of the user to be interrupted because of restricted movement.

3.3 DESIGN OF THE PRODUCT

The figure below shows the design of the product in a software that we used which is Autodesk Inventor.



3.4 FEATURES

- i. About the device;
 - a. With normal size but not too heavy.

- ii. About 'Hands-Free Leg Crutch' device;
 - a. Hands-free, enhanced mobility during daily activities
 - b. Ease for use due to customizable for a better fit
 - c. Affordable and inexpensive
 - d. Safely go up and down stairs

- iii. Device features;
 - a. Adjustable height for user
 - b. The use of PU leather and 1inch sponge for user's comfort
 - c. U-shaped aluminium plate for thigh grip

- iv. Other features;
 - a. Easy to assemble at home
 - b. Can be use while in public transport
 - c. Can go to work
 - d. Can go to school
 - e. Can attend social activities

3.5 DESIGN ANALYSIS

3.5.1 Requirement Analysis

For this phase we have done some research that is observation and questioners among student and other public people. Through this observation we had found how to solve people problem with their injury.

There are lists of questioners observation:

1. Gender

Male () Female ()

2. Age

13-17 () 18-22 () 23-27 () 28 & above ()

3. Did you ever break your leg?

Yes () No ()

4. Did you ever use a shoulder crutch to walk?

Yes () No ()

5. Do you think it is hard to use a shoulder crutch to walk?

Yes () No ()

6. Would you able to do things freely while using a shoulder crutch?

Yes () No ()

7. Do you think your armpit will get hurt when using a shoulder crutch for too long?

Yes () No ()

8. Do you think it is comfortable using a shoulder crutch to move around?

Yes () No ()

9. Do you find a leg crutch is a better option than the shoulder crutch?

Yes () No ()

10. If you need to choose between a leg crutch or a shoulder crutch, which one would you choose?

Leg Crutch () Shoulder Crutch ()

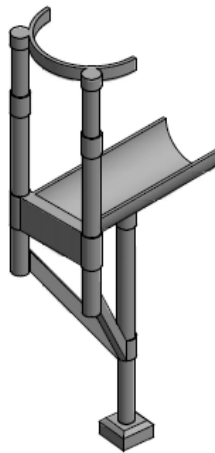
3.6 FABRICATE / DEVELOP PROJECT

3.6.1 CAD Drawing Design Analysis

Performing initial drawing design analysis to calculate the total number of materials needed to fabricate the project. The number of materials determines total measurements for project to ensure how much the price is needed to buy the materials needed.

3.6.2 Design function and System Concept

Design made by the use of Autodesk Inventor Professional 2019 to synthesize the design for project. Based on the device, it allows the user to walk freely without causing injury at their armpits. By the leg placement which is 90° at the platform, it will ensure the comfortability of the user to walk freely.



3.7 TESTING

- i. Testing the connectors
- ii. Testing the comfortability
- iii. Testing the leg strap
- iv. Load testing
- v. Walk tests
- vi. Device testing

3.8 ADVANTAGES AND DISADVANTAGES

3.8.1 Advantages

- User don't feel pain on their shoulder
- user can move freely
- user's daily routine is not disturbed

3.8.2 Disadvantages

- quite expensive due to the material and working process
- user might find out its difficult to use at first

3.9 STRUCTURE OF PRODUCT

In order to decide the design of the Hands-Free Leg Crutch, many factors are taken into account, such as the design, parts, size and finish that will be used. In order to attract attention and user comfort when using the crutch, it is important to choose the best design.

3.9.1 Design of The Hands-Free Leg Crutch

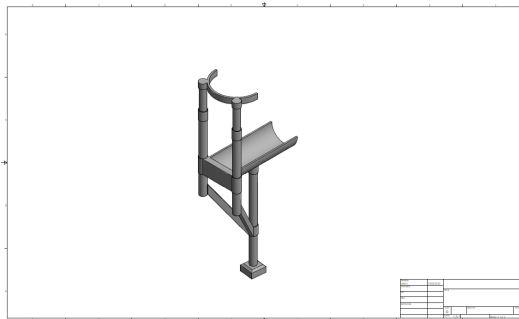


Figure a design of the crutch

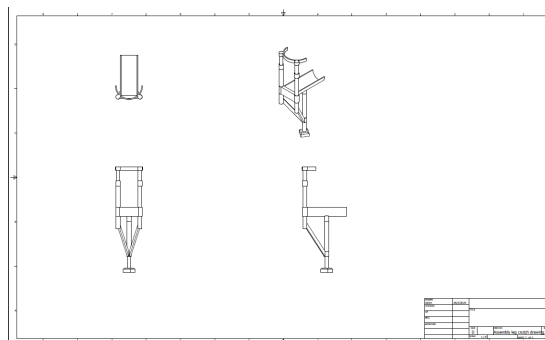


Figure b view of the crutch from different angle

3.9.2 Parts of The Hands-Free Leg Crutch

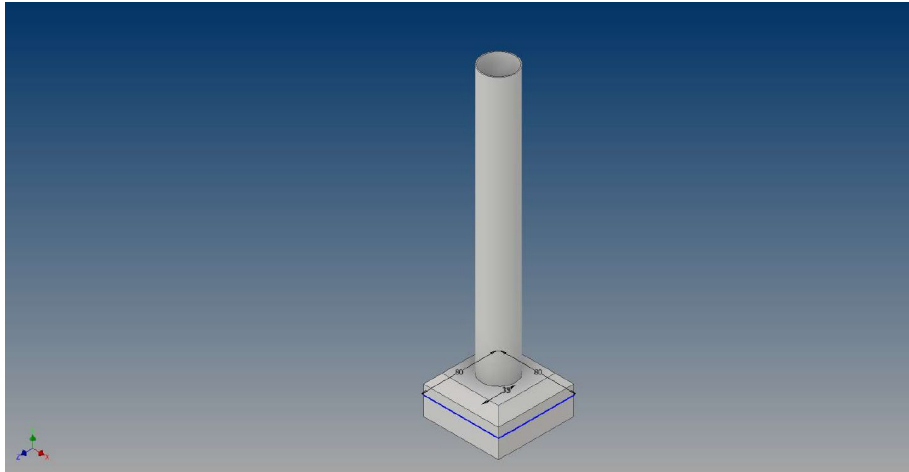


Figure c leg of the crutch

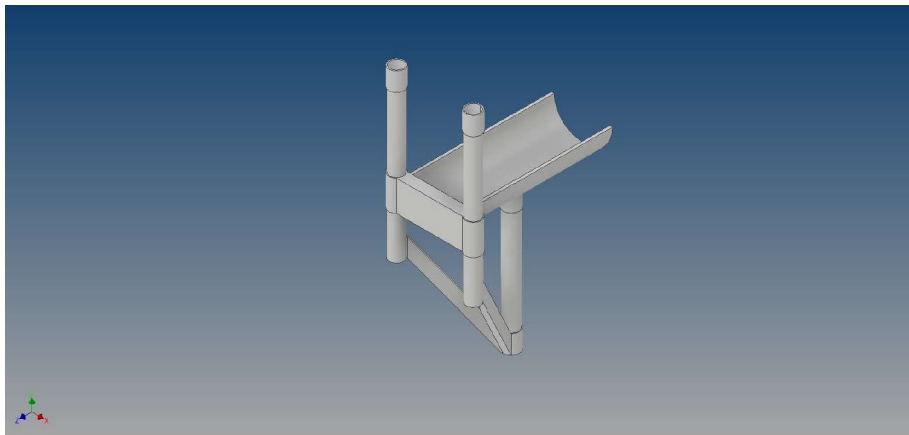


Figure d platform of the crutch



Figure e holder for leg crutch

3.9.3 Dimension Of The Hands-Free Leg Crutch

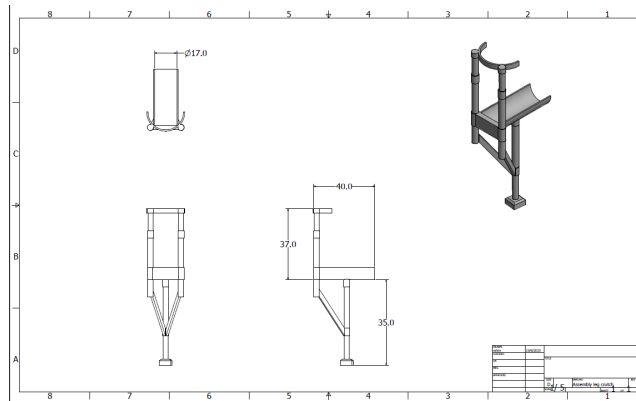


Figure f dimension of the crutch

3.9.4 Finishing Of The Hands-Free Leg Crutch

To achieve user comfort and safety, some material has been considered, such as cushion and leather finishing, it is agreed to be put in the platform to prevent user from feeling pain on their knee and the leather to make the Hands-Free Leg Crutch look more stylish. Next, Velcro is used as strapping to make it easier to use and avoid injury.

CHAPTER 4

RESULT AND DISCUSSION

4.0 INTRODUCTION

The aim and scope of this project is to ensure that users can move easily even with leg injury, prevent users from experiencing pain in the shoulder when traveling, and allow users able to move faster than using a traditional crutch.

This initiative is carried out by incorporating equipment to help people stand up in order to help others who suffer from leg injuries. In order to allow the user to comfortably move and manipulate it the instrument should be light. Everyone can also operate this tool regardless of height and weight, since this tool is capable of adjusting the height according to the user's suitability. Strapping may also be altered and does not limit the movement of blood

Before carrying out this project, many things will be taken into consideration, including the materials used. The material used is deliberately chosen to prevent the instrument from failing to work properly. To minimize the weight of the wand, aluminum was selected to

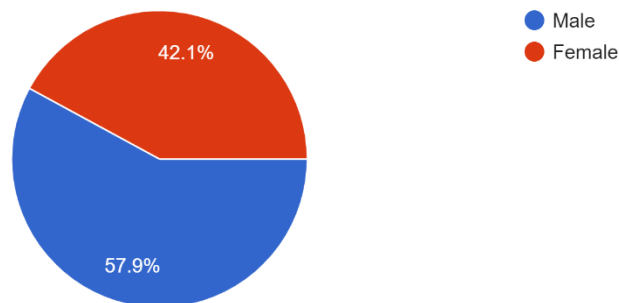
4.1 DESIGN ANALYSIS

To survey on the respondent's preference between leg crutch and shoulder crutch, a questionnaire was drafted and distributed to friends and their peers who are familiar and not familiar with injuries on their legs are chosen to answer this questionnaire.

A total of 76 people responded to answering the questionnaire.

Chart 1

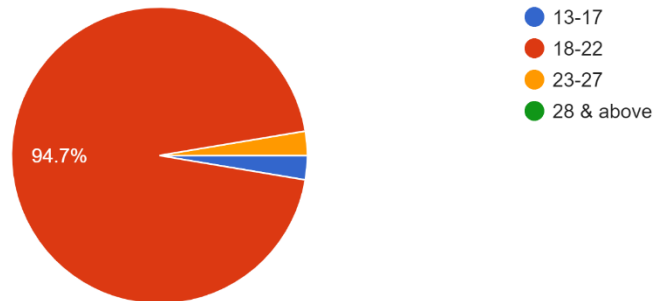
Gender
76 responses



From the chart 1, it is found interestingly enough that there is 44 male respondent (57.9%) and 32 female respondents (42.1%) from a total of 76 respondents. Again there is also no gender bias as into who can answer in the questionnaire as it is open to all family and friends.

Chart 2

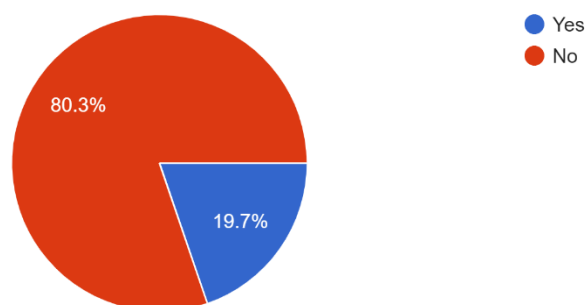
Age
76 responses



It can be seen that the respondents are between the ages of 13-27. This is due to the distribution of the questionnaire to our circle of friends and family are from the 13-27 range of age. From chart 2, we can see that a huge portion of the respondents is from the age group of 18-22 which is 72 (94.7%). While there are 2 respondents from the age group of 13-17 (2.6%) and 23-27 (2.6%).

Chart 3

Did you ever break your leg?
76 responses

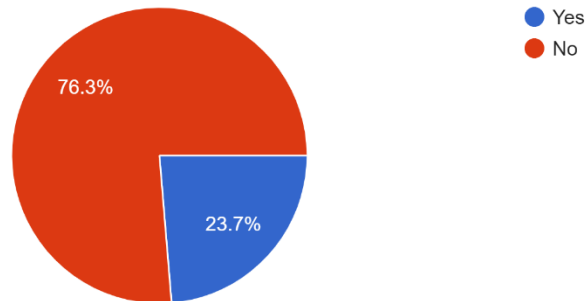


From the chart 3, it is shown that from the total of 76 respondents only 15 respondents (19.7%) have an experience of breaking their leg. While another 61 respondents (80.3%) have never experienced any injuries with their leg.

Chart 4

Did you ever use a shoulder crutch to walk?

76 responses

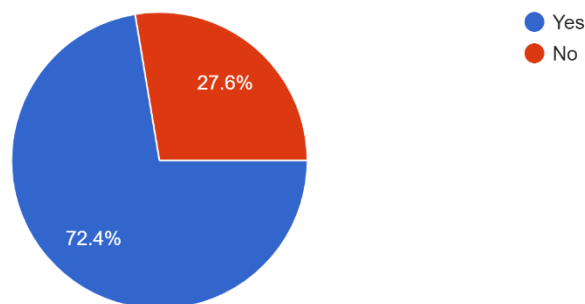


It is surprising enough that only 18 respondents (23.7%) ever use a shoulder crutch to walk. On the other hand, a total of 58 respondents (76.3%) never really use a shoulder crutch. From the distribution of the responses for this chart, it is shown that the majority of the respondent never injured their legs and never get to use a shoulder crutch to walk.

Chart 5

Do you think it is hard to walk using a shoulder crutch?

76 responses

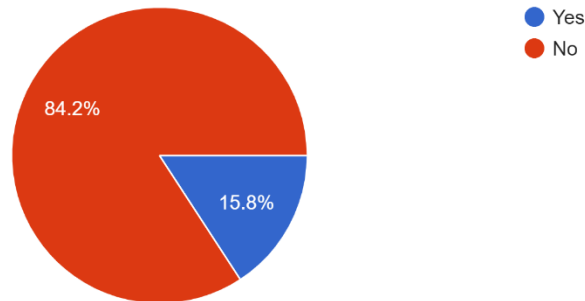


From chart 5, we can observe that majority of the respondents thinks that it is hard to walk using a shoulder crutch with 64 respondents (72.4%) dominating the chart by answering yes. Only 21 respondents (27.6%) answering no. For the respondents who answered no, the factor might be because they are used to walk using a shoulder crutch without any issues.

Chart 6

Would you able to do things freely while using a shoulder crutch?

76 responses

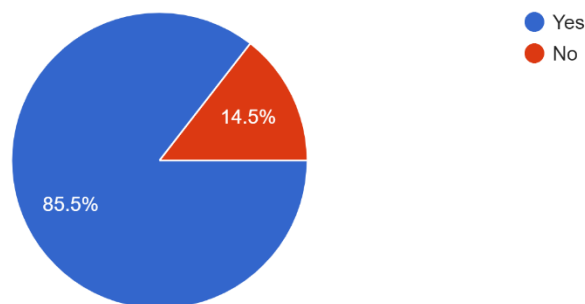


We can see from Chart 6 that using a shoulder crutch have a huge impact on whether you are able to do things freely while using it. Therefore, 64 respondents (84.2%) choose no while 12 respondents (15.8%) choose yes. It shows that the majority of the respondents thinks that they would not able to do things freely while using a shoulder crutch.

Chart 7

Do you think your armpit will get hurt when using a shoulder crutch for too long?

76 responses

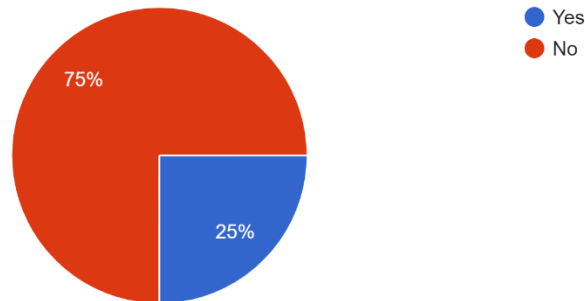


In Chart 7, the response on whether our armpit will get hurt when using a shoulder crutch is quantified. With 65 respondents (85.5%) agree that by using shoulder crutch for too long will hurt our armpit. This is due to excessive pressure to our armpit and shoulder when using a shoulder crutch because they need to support their weight by using the shoulder crutch which will hurt our armpit and shoulder. On the other hand, 11 respondents (14.5%) disagree that they will get hurt by using a shoulder crutch for too long.

Chart 8

Do you think it is comfortable using a shoulder crutch to move around?

76 responses

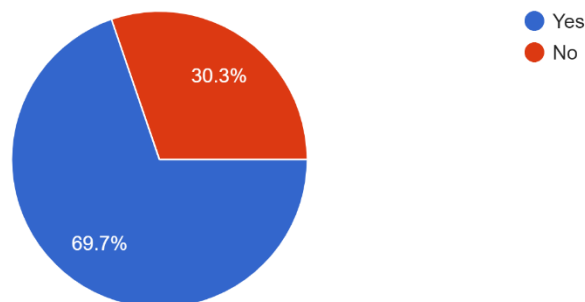


In Chart 8, 57 respondents (75%) think that it is not comfortable to move around when using a shoulder crutch. While another 19 respondents (25%) think that they can move around comfortably when using a shoulder crutch.

Chart 9

Do you find a leg crutch a better option than the shoulder crutch?

76 responses

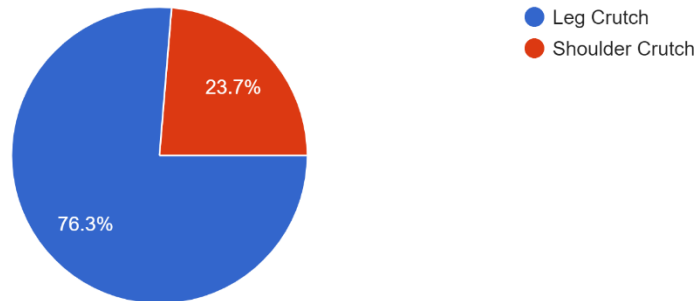


It can be seen from Chart 9 that 53 respondents (69.7%) find that a leg crutch is a better option than the shoulder crutch. This might be that several respondents have a bad experience when using a shoulder crutch. For example, some of the respondents hurt their shoulder and armpit when using a shoulder crutch due to excessive pressure. On the other hand, 23 respondents (30.3%) do not think that a leg crutch is a better option.

Chart 10

If you need to choose between a leg crutch and a shoulder crutch, which one would you choose?

76 responses



In Chart 10, we can see the respondent's preference towards 2 types of crutches. A majority of 58 respondents (76.3%) chose that they would use leg crutch. While another 18 respondents (23.7%) chose shoulder crutch. It is proven that most of the respondents prefer to use leg crutch than shoulder crutch. This is because when they use a leg crutch, their hands are free so they can do things freely without the limitation of their hands being occupied like when using a shoulder crutch.

4.2 DESIGN AND COMPONENTS

4.2.1 List of components

LEG CRUTCH

A crutch is a mobility aid which transfers weight from the legs to the upper body. It is also used by people who for reasons ranging from short-term accidents to permanent disabilities, cannot use their legs to support their weight.



STRAPS

An elongated flap or ribbon, typically of cloth or leather, is a strap, often also called a strop. Thin belts are used as part of clothes or luggage, or as a sleeping bag.



ALUMINIUM

Aluminium is a lightweight metal that is silvery-white. It's mellow and malleable. In a wide range of items, including cans, foils, kitchen utensils, window frames, beer kegs and pieces of aircraft, aluminium is used. This is due to its peculiar properties. It has low density, is non-toxic, has high thermal conductivity, has excellent resistance to corrosion, and can be cast, machined and molded easily. It's non-magnetic and non-sparking as well. It is the second most malleable metal and the sixth largest metal. It is the second most malleable metal and the sixth most ductile.

As aluminium itself is not especially solid, it is sometimes used as an alloy. The alloys are lightweight but solid with copper, manganese, magnesium and silicon. In the construction of aircraft and other modes of transport, they are very important.



CUSHION

A cushion is a soft bag filled with fur, hair, feathers, polyester staple fiber, non-woven cloth, or even paper broken into pieces of some ornamental material. It can be used to sit or kneel on a chair or couch, or to soften the stiffness or angularity of a chair or sofa.



SCREW



Similar types of fasteners, usually made of metal and characterized by a helical ridge, known as a male thread, are a screw and a bolt. By connecting the screw thread with a similar female thread in the matching section, screws and bolts are used to fasten materials.

BADMINTON'S GRIP

We used badminton's grip as a platform for the bottom part of the crutch to widen the surface area and results in more balance and stability



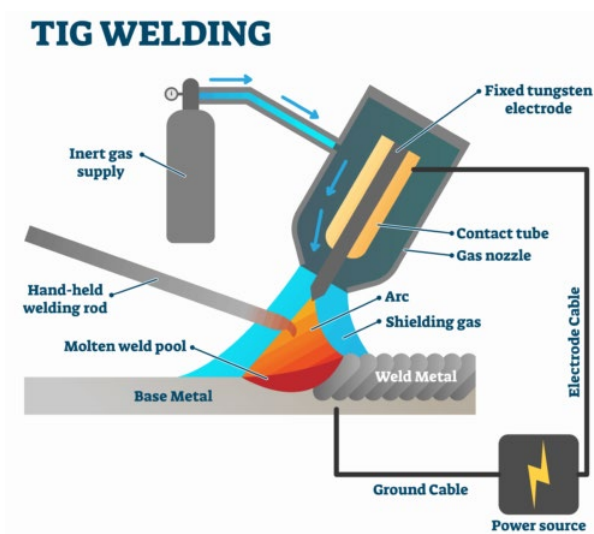
STAINLESS STEEL



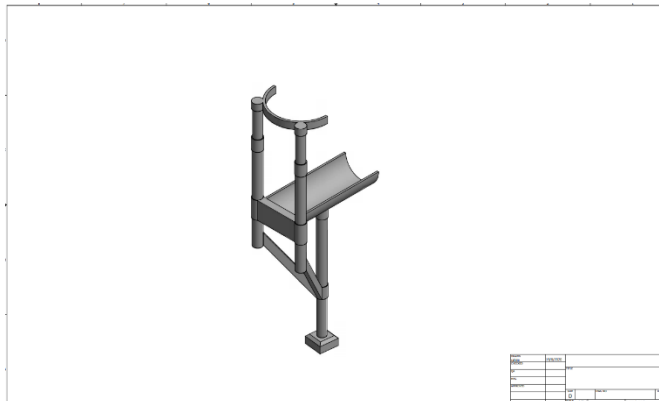
Stainless steel is a corrosion-resistant alloy of iron, chromium and, in some cases, nickel and other metals.

TIG WELDING

Tungsten inert gas (TIG) welding is the primary method used to weld aluminium. Because the aluminium workpiece requires a lot of heat to get up to temperature--but can hold that heat for a long time--a welding machine with current control is useful for keeping the aluminium workpiece from overheating, causing a burn through. TIG welding can be applied to both thin aluminium sheeting and thicker aluminium plate. Because TIG welding requires a separate filler rod, the welder must choose a welding rod with an alloy as close to that of the workpieces as possible.



4.2.2 DESIGN DESCRIPTION



CONCEPT DRAWING OF THE DESIGN



ACTUAL PRODUCT

DESIGN DESCRIPTION

- This product is designed using aluminum and 'stainless steel'
- Cushions are also placed on the platform to prevent pain in the legs
- Badminton's grips are used for the bottom part of the crutch to widen the surface area and results in more balance and stability

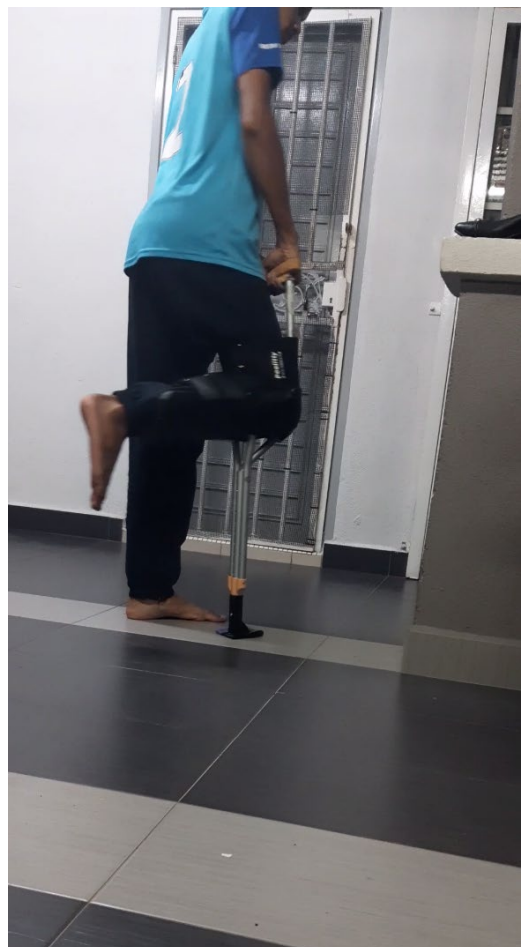
- Strappings are used to tighten and lock user's leg to the crutch so that it will stick to the leg.

- **4.3 RESULT**

- 4.3.1 HANDS-FREE LEG CRUTCH SET UP**

To ensure the strap is strapped properly and neat, to make sure the height adjustment foot is functionally and does not have any problem or broken. To make sure all the components at the device is connected correctly to each parts and connectors. So, after user's leg is placed at the platform, strap the calf with comfortable tension as well as thigh.

- 4.3.2 WALK TESTING ALONG 5m GARAGE**



4.3.3 WALK TESTING GOING UPSTAIRS



**4.3.4
TESTING
DOWNSTAIRS**



**WALK
GOING**



4.4 COSTING

For this costing is project on that going over budget. This will list of the estimates and it's control the spending. This will get actually costs. This help to cost project. The table below costing for this project.



to help the track without get a detailed used to ultimately to manage the shows the

COMPONENT	PRICE (RM)
1 pair of shoulder crutch	84.00

Posture Corrector X/O Leg Correction Belt Knee Valgus Straighten Tool with postage	35.00
Metal labour work	150.00
Leather labour work	150.00

Total expenses: RM 419.00

CHAPTER 5

CONCLUSION

5.0 INTRODUCTION

Group discussion is held when planning for the project job and activity. The work is fairly distributed to all members of the group, so that work can be done on time. According to the set timetable, this project was successfully completed at the end of the 5th semester. The desired goals were effectively accomplished by this initiative. Successfully accomplished project design.

A meeting was held with the project lecturer to address the project's new progress and discuss the issues faced during the completion of the project.

All the preparation was neatly prepared for semester 5. For each week, the division of tasks is scheduled such that the project is completed efficiently on time. In order to accomplish project goals more effectively, issues found are often addressed in order to be resolved. Project reliability while in use, improper connection to materials and unsuitable design are among the problems encountered. With the project lecturer, this topic is addressed in order to get the best solution. When the project is finished as planned, the project is evaluated to meet the goals of the project. various problems that were successfully encountered while completing this project and this project was successfully completed on time

5.1 PROBLEM BUILDING PROJECT

5.1.1 PROBLEM AND CHALLENGES

Among the major problems that have been detected during this project 2 are:

- Project cannot be weld using MIG welding method for metal and aluminium.
- The use of aluminium plate cannot be use for leg platform due to unaffordable price and also to ensure project weight.
- Lack of time during project fabrication due to pandemic situation that requires all shop to be closed before 10 p.m.
- The use of bolts and nuts are unable to be applied.
- Project would be too heavy if replace platform from aluminium to stainless steel pipe.
- Many sharp edges at project.

5.1.2 SOLVING PROBLEM

- To solve this problem, we decided to combine these materials by using connectors for the steel and aluminium.
- The stainless-steel pipe is used to replace the aluminium because it is cheaper than aluminium plate.
- Workshop owner decided to start early because didn't want the project finished too late.
- The project used awning type screw and standard screw to ensure the connection is permanent.
- The steel pipe was cut in square in the middle of it to reduce some weight.
- All edges were grinded until no sharp edges.

5.2 OTHERS PROBLEM

During the process of designing a project, many aspects which needs to be taken and emphasized so that resulting product is able to achieve the desired purpose and satisfaction of the user's taste. For example, in this final project 'Hands-Free Leg Crutch', many aspects of the project considered among them are,

- Reasonable price
- Useful products to users
- Quality
- Manufacturing costs
- The process involved

In addition, there are several factors that need to be considered and emphasized had no problem handling the tool.

The features are need to be specified is as follows:

- Non-complicated handling
- Easy to use and facilitate barrier transfer work

5.3 CONCLUSION

The process of designing the project was carefully made and it was quite difficult due to various of problem and obstacle such as transportation, money and etc. However, the problems are solved with the help of each member of the group. A good teamwork is needed so that the designated project can achieved the point where it is perfect. The project was based on a normal crutch where the way to use it is too restrictive because the users need to hold the crutch by hand so it will limit the movement and activities when using it. So, the 'Hands-Free Leg Crutch' was designed to use without the support of hands so that users can move freely without any limitations and reduce any pains like when using the normal crutch.

We did a twist on the design of the project with its strategies and application. All will use it and benefit from it. Maybe one day, even though advanced equipment is available on the market, our projects can be sold and become one additional device in the future.

5.4 RECOMMENDATION

Hands-Free Leg Crutch" can be formulated after completing this project." Any of our ideas and opinions were expressed and represented after seeing and understanding the outcome.

Any of the suggestions that follow are:

1. Before beginning project work, get opinions or recommendations from others who are more informed and experienced such as supervisor.
2. Do more research on the current issue related to the project that you want to create.
3. Understand the scope area that you want to do in more detail and in depth about the project.
4. Learn more details about the equipment that you want to use in the project

References

1. Common Sports Injuries: Incidence and Average Charges. (2016, June 14). Retrieved September 28, 2020, from <https://aspe.hhs.gov/report/common-sports-injuries-incidence-and-average-charges>
2. Heitz, D. (2018, November 10). Everything You Need to Know About Sports Injuries and Rehab. Healthline. <https://www.healthline.com/health/sports-injuries#statistics>

3. The Best Crutch Substitute: Introducing the iWALK 2.0. (2020, September 3). IWALK Free. <https://iwalk-free.com/product-introduction/>
4. Underarm Crutches vs. Hands-Free Crutch | iWalkFree. (2019, November 9). IWALK Free. <https://iwalk-free.com/crutches/>
5. Forearm Crutches vs. iWALK 2.0 [Hands Free Crutch]. (2019, November 9). IWALK Free. <https://iwalk-free.com/forearm-crutches/>
6. iWalk2.0 Product Specifications | iWalkFree. (2020, January 20). IWALK Free. <https://iwalk-free.com/specifications/>
7. Limited, S. B. S. (2020, October 19). 4 Types of Stainless Steel. BS Stainless Limited. <https://www.bsstainless.com/4-types-of-stainless-steel>
8. Wikipedia contributors. (2020, December 24). Stainless steel. Wikipedia. https://en.m.wikipedia.org/wiki/Stainless_steel
9. <https://www.sciencedirect.com/science/article/abs/pii/S0160791X1930288X>
10. <http://permalite.com.au/why-permalite/benefits-of-aluminium/>

GANTT CHART

WORKING PROGRESS GANTT CHART - LEG CRUTCH

N O	WORK PROCEDURES	PLANNING /	WEEKS															
		ACTUAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Material Selection and design	Planning	■	■														
		Actual		■														
2	Search for the crutch materials	Planning		■	■													
		Actual		■	■													
3	Structuring the Leg Crutch	Planning			■	■												
		Actual			■	■												
4	Experiment with the Leg Crutch	Planning				■												
		Actual				■												
5	Leg Crutch Improvement	Planning				■	■	■	■	■	■	■						
		Actual				■	■	■	■	■	■	■						
6	Compilation of Documentation	Planning				■	■	■	■	■	■	■	■					
		Actual				■	■	■	■	■	■	■	■					
7	Final Results of the Leg Crutch	Planning													■	■	■	
		Actual													■	■	■	
8	Presentation	Planning																■
		Actual																■

Legend

Planning	■
Actual	■