

## The Development And Design Height-Adjustable Seat (Lift Seat)

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**Abstract:** *Ergonomically designed chairs are important for seated workers to increase their productivity and to reduce low back injuries due to use of ergonomically poor designs of chairs. Most of the existing chairs designed for the longtime seated workers are not considered full ergonomic aspects and a way of restricting the chair's mobility on the floor. The primary aim of this project was to design and develop an adjustable seat which is improved by adding adjustable seat height functions from 30 cm to lower. Computer Aided Design (CAD) such as Inventor 2019 and Solidworks are used to assist in designing the chair. Analysis is performed to determine the user's satisfactory, user friendly and multifunction. The users satisfactory is included these factors; design finishing, comfortable, maintenance, useful and stability. This innovation resulted a chair with the ability of the vertical movement from the floor until 30cm height and can accommodate a person up to 900 N.*

**Keywords:** ergonomic, adjustable, height, seat, scissor lift

### 1. Introduction

Ergonomic is the application of scientific information concerning humans' factor to the design of objects, systems and environment for users. Sitting needs 20% less energy than standing to do the same work, if the body is properly supported. Sjan-Mari van Niekerk and co-researchers, the usefulness of a chair intervention has long-term impact, particularly with respect to musculoskeletal symptoms, as well as the relapse of symptoms and the consequent cost of maintenance (Niekerk, S.M. et al 2012). Previous study shown that to examine possible mismatch between the individual bodies dimensions of person is very crucial (Nasr Al-Hinai et al., 2018). However, the new vision that aims at creating a world consisting of people, objects, and environments has been proposed that unite that would make the product (chair) as a natural element with its relations (Virve, P., 2017). An ergonomic chair with adjustable parts may solved musculoskeletal disorders and also reduced the symptoms in users (Samira et al. 2018, Hoeben C, & Louw Q., 2014). Efficiently, the design of ergonomically chair has been considered based on four basic parts of the chair; seat, back rest, hand rest and legs (Gopura, R.A.R.C. & Amarasena, K.G.A.H., 2008). A hybrid robotic chair/bed system has been developed by Meng Ning and co-researchers. The technology designed is proposed in helping bedridden as the system is more intelligent and convenient to the users (Ning et al., 2017). The relation between human feelings and emotions has been studied by the researcher in related with the engineering discipline in developing a product in order to satisfaction to users (Soewardi, H.& Dindadhika, K.A., 2018). In this study, Lift Seat was designed to facilitate movement of fluctuations in users without having to get up and sit down again. It is enhanced by adding the Scissor Lift concept on the platform of the seat that aims to move vertically the person who sat on it. In addition, ergonomically designed chairs increase the seating comfortability of the user's position.



### 1.1 Design Principles of Scissor Jack

Scissor jack is a simple mechanism used to drive loads in a short distance. The power screw design of a common scissor jack reduces the amount of force required by the user to drive the mechanism. Most scissor jacks are similar in design, consisting of four main members driven by a power screw.

A scissor jack is operated simply by turning a small crank that is inserted into one end of the scissor jack. This crank is usually Z shaped. The end lift into a ring hole mounted on the end of the screw, which is the object of force on the scissor jack. When this crank is turned, the screw turns and raised the jack. The screw acts like gear mechanism. The screw thread turns and moves the two arms, producing work. Just by turning this screw thread, the scissor jack can lift a vehicle that is several thousands of pounds.

The mechanism of scissor jack used a simple theory of gears to get its power. As the screw section is turned, two ends of the jack move close together. Because the gears of the screw are pushing up the arms, the amount of force being applied is multiplied takes an infinitesimal amount of force to turn the crank handle, yet that action causes the brace arms to slide across together. As this happened, the arms extend upward. The gravitational weight is not enough to prevent the jack from turning, since there is no direct force applied.

### 1.2 Design Principles of Scissor Lifts

The major specification of scissor lifts is the symmetrical. In order to work the distance from the loaded point to the cross, the point must be the same as the distance from the cross point to the ground. This ensures that weight is distributed equally through the scissor beams. The application of scissor lift has widely used because of the variety of the power source. For examples; scissor lift for lifting cars can be empowered electrically, hydraulically and mechanically. Meanwhile, the industrial scissors lift used diesel. Basically, a scissor lift can be categorized into two; single scissor lifts and multiple scissor lifts. The construction of the scissor action can be hydraulic, pneumatic or mechanical. Depending on the power system employed on the lift, it may require no power to enter descent mode, but rather a simple release of hydraulic or pneumatic pressure.

Hence, in this study, the project of scissor lift is adapted. A powerful lifting jack operated by screw in a horizontal position that lengthens or shortens the horizontal diagonal of a parallelogram consisting of the linkages of the jack. The chair is designed considering overall ergonomics to increase their comfort and to reduce movement of the person. In the design, a scissor lift (which can restrict the chair mobility on the floor) is also proposed. By using existing concepts, we add improvements near scissor lift. The repeat function is to move something easily while the grip functions is that grip of stuff so that stuff does not move on your own. Designing a more ergonomic design making it easier for users in terms of comfort and provide aspects of restocking and arrangement work, especially on the lower items in the mini market.

## 3. Methodology

To create a good project design is important in keeping up with current trends and considering marketing costs as well as consumer satisfaction should also be taken into consideration. On the other hand, user safety and comfort factors are the most important elements when implementing this project. This project involved three phases to achieve the objectives which are (i) the design process consists, (ii) fabrication process and (iii) analysis of lift seat to determine users' satisfactions.



### 3.1 Design Process

The design process consists of several phases as shown in Figure 3. The problem is identified based on the needs and requirements of users. Mechanical jack and scissor lift principles were studied to determine the concept design of height adjustable seat (lift seat). The design of lift seat was drawn using Computer-Aided Design inventor software version 2019. The design of frame structure was analyzed using Solidworks.

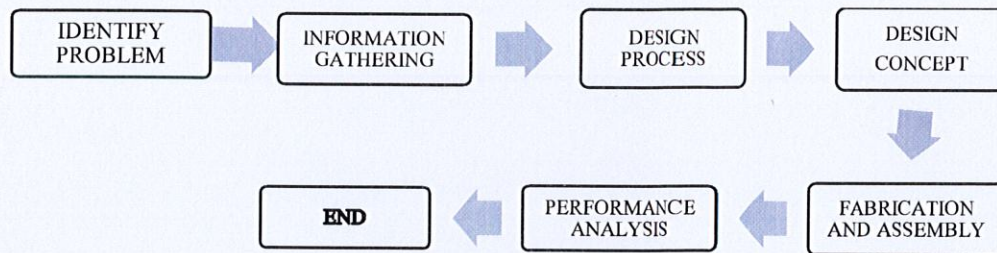


Figure 3: Design Process Flowchart

### 3.2 Design Concept

The purpose of the Lift Seat design is to reduce the burden and problems on the senior citizen and disable people. This is because, they have problem to getting up and down after a long time seat on the floor. Not only that, the Lift Seat also aim to reduce the problem the employees who are tried to put the stuff on shelves in a bow down position. With ergonomic design, it will facilitate the movement. This seat is designed for the person weight up to 90 kg in order to give more easily in doing up and down movement. In the middle of the rear body of the chair actuator is fixed in order to control the movement. The detail design of lift seat was shown in figure 4 below. Mild steel hollow (1" x 1" x 1.2 mm) is used as a beam of the structure.

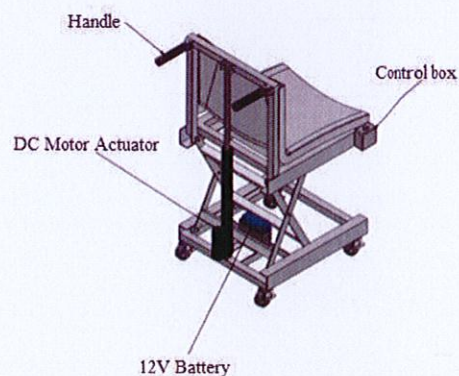


Figure 4: Design of Lift Seat by inventor 2019

#### 3.2.1 DC Motor Actuator

The main purpose of the actuator used in the Lift Seat is to make it the main driving force for the seat lift to move downward as a result of the movement caused by the actuator. This Actuator is mounted on the back of the Lift Seat and is attached to the bottom of the Lift Seat and above the seat structure so that it can be mounted up and down.



It uses the battery power to move it and connects it using a positive and negative wire attached to the toggle switch and then mounted to the right of the seat so that it can be controlled and adjusted in height according to the comfort of the user at the desired height. The maximum height of this actuator is 30cm and it can handle up to 900N which weighs approximately 91kg.

### 3.2.2 Control box

A toggle switch that applies in Lift Seat is used to move up and down the Lift Seat. The right switch is used to move up while the left switch is move down. A toggle switch used because it easy for users to use and toggle switch is common switch that always uses in daily. Moreover, a toggle switches also easy to find and buy.

A toggle switch or tumbler switch is a class of electrical switches that are manually actuated by a mechanical lever, handle or rocking mechanism by a moving a lever back and forth to open or close an electrical circuit. Toggle switches are available in many styles and sizes and are used in numerous applications. Many are designed to provide the simultaneous actuation of multiple sets of electrical contacts or the control of large amounts of electric current or main voltages.

A switch where a definitive click is heard, is called a "positive on-off switch". A very common use of this type of switch is to switch lights or other electrical equipment on or off. 1 ways toggle switch rated 20A@12V with metal plate ON/OFF decal.

### 3.2.3 Battery

Battery is commonly used to act as a power supply to an electrical component. So, the battery used on this Lift Seat is intended to provide the Actuator with enough power to move it from one level to another. These batteries are located at the bottom of the Lift Seat between the site and the scissor and are furthermore included with safety features such as adding an iron barrier to the battery so that it is not easily picked up and taken by irresponsible people.

The Actuator's wire is fitted with new wires designed and mounted once with a toggle switch to allow it to be controlled by the user if the wires are attached to the battery. The battery used on the Lift Switch is a 12 VCD type battery used on motorcycles and is readily available in any shop that sells spare parts in case of battery drain.

### 3.2.4 Handle

Paddle that used in this project called Lift Seat is a regular paddle used on a motorcycle to put the foot on while riding a motorcycle. The idea came, when the issue of how this Lift Seat can make it easier for users to push it without lift it. Therefore, a regular paddle used on motorcycle can be used for holders of Lift Seat. The paddle is easy to control where if want to use it, just open. When done, just close it.

## 4.0 Result and Discussion and Conclusion

The main function of the scissor jack is to be a tool that helps to attach a load on its surface so that it does not move and is stronger to move from one place to another using specific concepts such as hydraulic, pneumatic, actuator and etc. according to product suitability. These Scissor jacks are usually shaped like 'zig-zag' and are coated with each other and are then combined using a tool according to the material used such as screws, nuts and so on. Since this scissor jack has a pair that moves parallel to the surface of the plate or product such as it is placed on the shaft and on the front or back with the aim that it will move in a balanced manner and can handle the load in parallel. This end of the scissor jack is usually a bearing or tool that will help move the scissor jack so that there is less friction between the scissor jack and the path through



which the scissor jack goes. The illustrated designs by using solidwork and real design can be seen from figure 5 and figure 6 below.

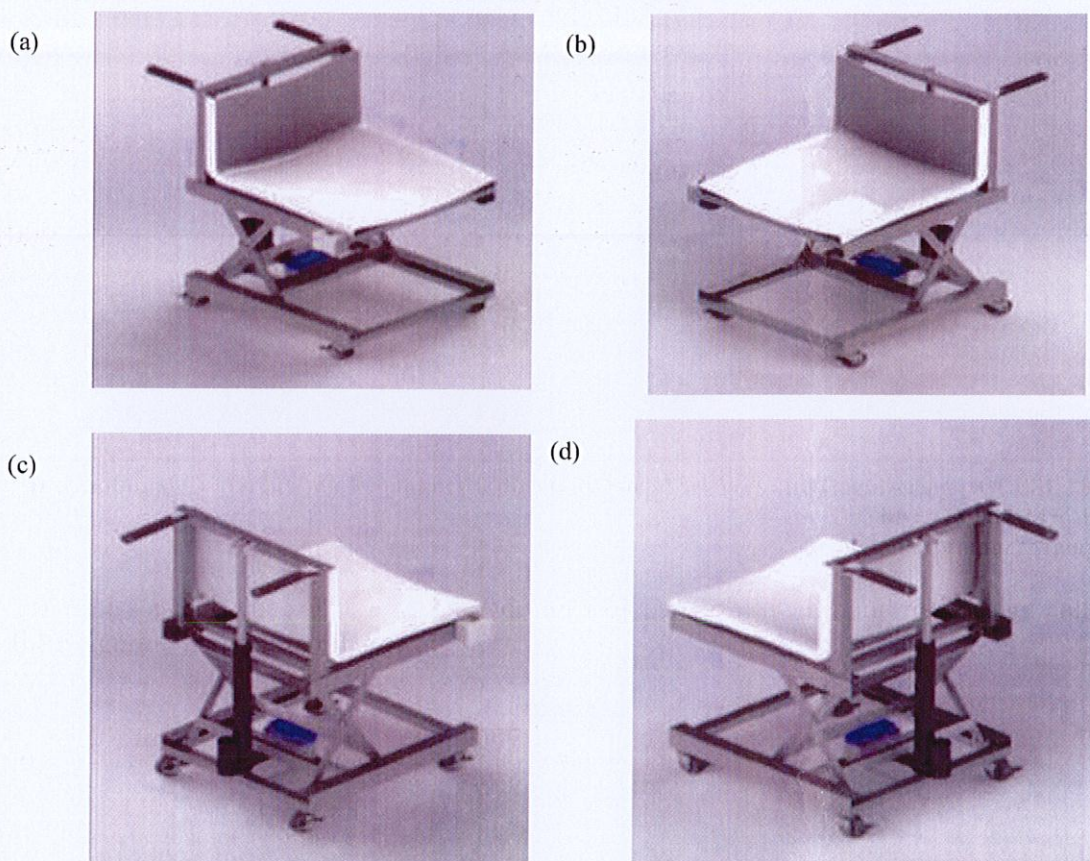
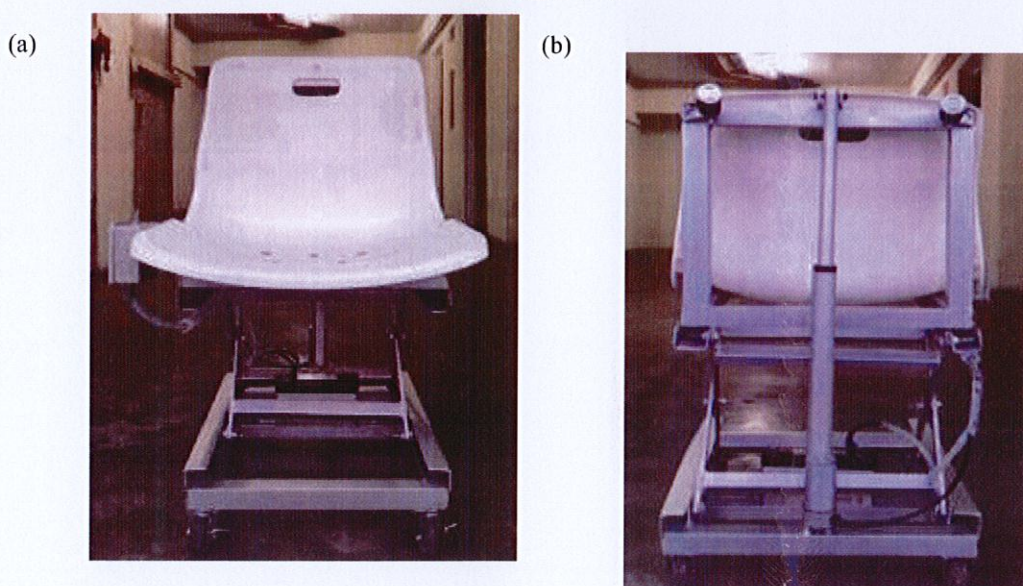
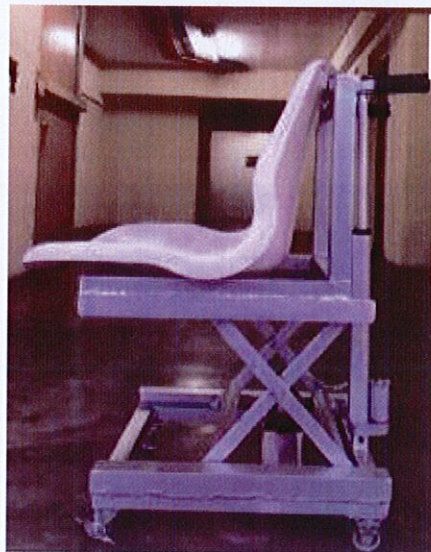


Figure 5: Design of Lift Seat by Solidworks; (a) front right view, (b) front left view, (c) back right view and (d) back left view.

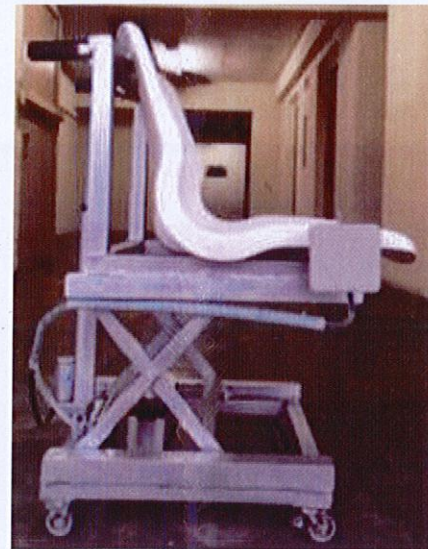




(c)



(d)



**Figure 6: Design of Lift Seat by Solidworks; (a) front view, (b) back view, (c) left view and (d) right view.**

Indirectly, the scissor jack moves smoothly and is easy to operate as it has a moving tool such as a wheel or bearing placed at the end of the scissor jack. Further, this Scissor jack must use strong and hard steel to prevent any accident or accident arising from the failure of the steel scissor jack intended to accommodate the load placed on the surface. Among other reasons to use scissor lifts as a tool to assist with movement is because they are easy to operate or maintain in the event of any damage or anything that needs to be maintained.

The purpose of this scissor applied to the Lift Seat is to serve as a tool to support the human load that is on the Lift Seat during the up and down process. This scissor is made from flat bar due to its thin structure which allows it to save space and hence a strong and hard type of steel which is very suitable as a tool for the actuator.

The presence of this scissor indirectly makes the Lift Seat more balanced as it is positioned left and right under the seat. This scissor on the Elevator Seat is only one pair and allows this scissor to only go to a height of 30cm equal to the maximum actuator height.

#### **4.1 Satisfactory user survey**

The survey composed of questions based on a thorough review of the literature and was based on three categories; users satisfactory, user friendly and multifunction. The users satisfactory is included these factors; design finishing, comfortable, maintenance, useful and stability. A summarized version of the questionnaire is provided in Table 1. About 40 respondents were answered this survey which involved person weight in range 20 to 90 kg.



Table 1: Questionnaire; users satisfactory, user friendly and multifunction

Questionnaire	
<i>Users satisfactory</i>	
1.	The design of this Lift Seat is ergonomic and neat.
2.	The seat used on the Lift Seat is comfortable.
3.	The elevator seat is easy to maintain and clean.
4.	This Elevator Seat facilitates the movement of users who have trouble getting up.
5.	This elevator seat is able to accommodate the load.
6.	Lift Seat is suitable to be placed in this area.
7.	Lift Seat height is sufficient and suitable for use by all ages.
8.	Elevator Seat has stable and sufficient stability
<i>User friendly and multifunction</i>	
9.	This Elevator Seat is easy to use and user friendly.
10.	This elevator seat can be used as a multi-purpose chair.

#### 4.1.1 Physical satisfactory, ecofriendly and multifunction.

Beginning with identifying problems and justifying the scope, the project identifies the problem of 'lift seats' until the machining process. Scope of the project is necessary to ensure that the key objectives of the project are met. To begin the process of product development, a model search is performed to find the right method for design, at the same time, customer needs are identified by conducting in-market research. From this stage, the product targets meet up to provide machine design needs based on customer needs. In the histogram figure below show that 40 respondents had been answered the questionnaire. Majority respondent strongly agreed that three main factors have been given major impact in the design which are maintenance, useful and stability of the product. Figure 7 also shown that the comfortable and finishing factor of the design does not give a big impact to the overall design.

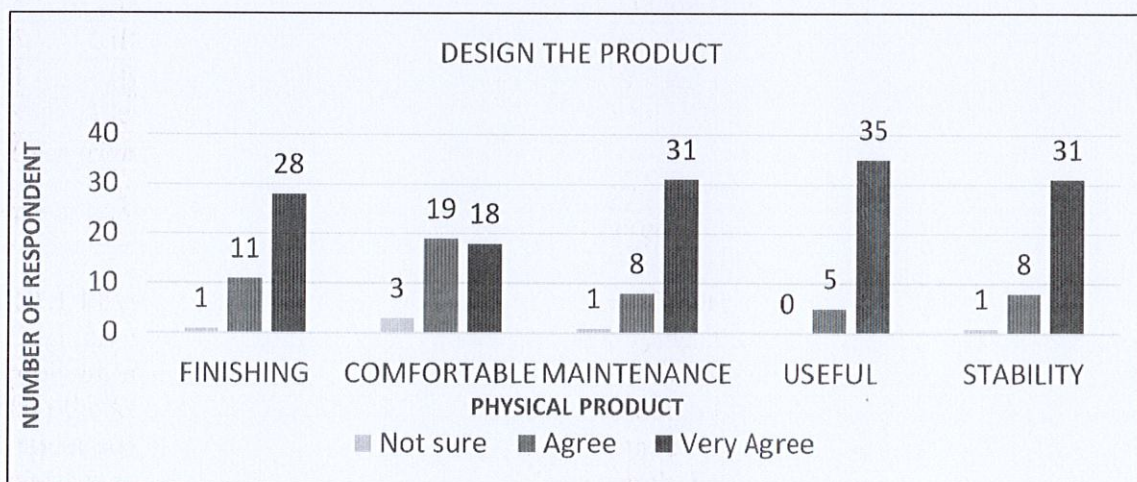


Figure 7: Result on the users satisfactory is included these factors; design finishing, comfortable, maintenance, useful and stability.

Lift seat chair includes a structure arrangement wherein a lower frame is provided rigid support for the up and down movement. The movement of the lift seat can be done in four ways which are forward and backwards and also vertically; up and down. Figure 8 overall shown that the



respondent had agreed that user-friendly factor give a value-added to the design. The use of Lift Seat can also be considered as a multifunction because of the effectiveness in various situations and condition.

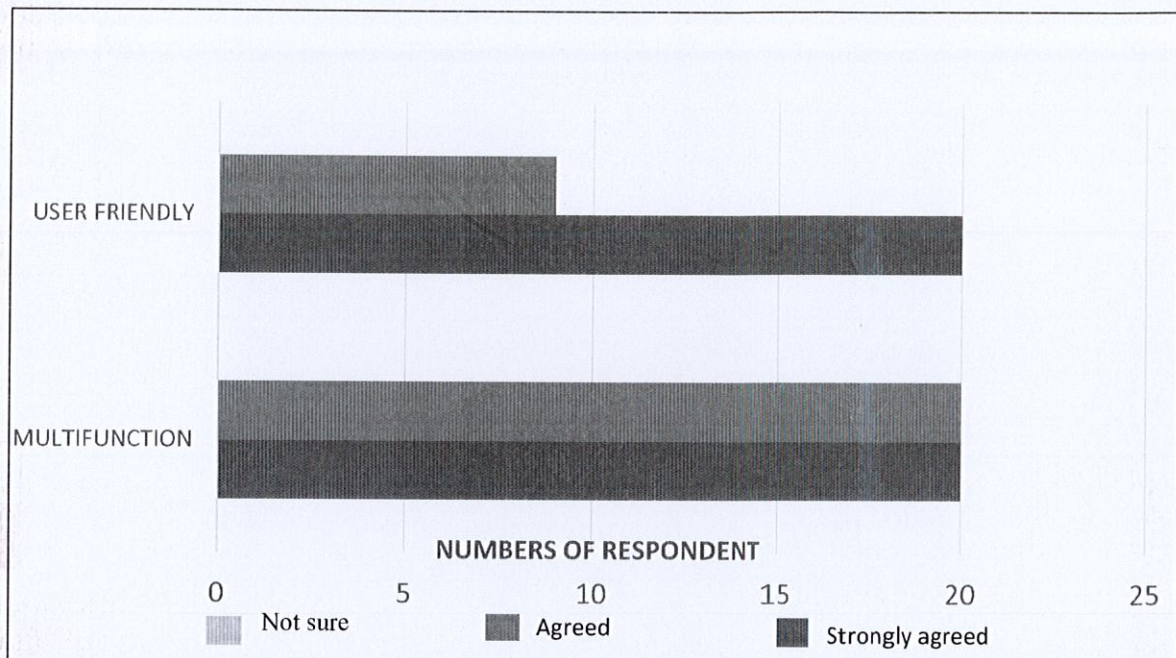


Figure 8: Result on the users satisfactory factors; user friendly and multifunction

## 5.0 Conclusion

This study is using the scissor jack concept to consider ergonomic demand, to undertake the capital issue in order to establish the design regulation to suitable for different body figure's in users' movements. The achievement of this project is using an ergonomic tool to achieve suitable for users especially who are disable, bedridden or bend over position needed. The respondents had the majority been agreed that this chair is very useful for the critical situation, stable and also low maintenance. The structure of adjustable item has been applied for the pattern.

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