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Hydraulic Foot Jack with Lifter Stand

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Abstract: *A foot jack is required to lift a vehicle during maintenance under the vehicle and tyre changing works. In Vehicle Maintenance Skills subject, special needs students (deaf) need to do repair work under the car and motorcycle which involved safety. However, the design of lift platform area for existing jack is small and the user needs to place it carefully while raising the vehicle. The risk of accidents and damage could occur if the vehicle is not properly placed. Moreover, existing jack could only be used on four-wheeled vehicles. Therefore, the objectives of this innovation are to design a hydraulic foot jack with a wider lift platform to improve safety aspects and to design a dual-used hydraulic foot jacks for lifting a car and motorcycle. The scopes are to lift the vehicle below 2 tons and the empty spaces under the vehicle must be at least 16.5 cm height. The design, fabrication, installation and testing processes of product was done at welding workshop involving process of cutting, welding, milling and drilling. The hydraulic foot jack is capable of lifting at a height of up to 31 cm from the floor. Overall, the Hydraulic Foot Jack with Lifter Stand is a user-friendly maintenance device which is easy to operate, saves time and even reduces manpower consumption.*

Keywords: hydraulic foot jack, lift platform, maintenance

1. Introduction

Jack is a device that apply mechanical or hydraulic force to lift heavy loads. It is very important in the process of repairing the vehicle primarily involving the work at the bottom of the vehicle and the tyre changing work. The only part that contact between jack and load is called saddle. Saddle is placed under the vehicle to enable lifting. The location of lifting saddle is usually at the chassis rail where it is one of the vehicles strongest area (Parker, 2017).

However, existing floor jacks use a small saddle platform to lift a vehicle which the risk of accidents could occur especially when operated by special needs students (deaf). Difficulties to place the jack at an appropriate point is the main issues. Lecturer needs to frequently monitoring the students when doing a practical work to avoid the misplaced of saddle. This is among the problems faced by the existing floor jack user due to the nature of work.

At the same time, current products focus only on single used and this will require different types of jack for other usage. For example the existing floor jack is capable of lifting the four wheel vehicle only while for those with wide surface contact vehicle such as motorcycle require larger saddle area. This is because the only jack point for motorcycle is under the

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engine block. Therefore, some modifications at the saddle area is needed while maintaining the structural integrity of the whole jacks.

The main objectives of this project are to meet the needs of consumer floor jack users which is to design a prototype of hydraulic foot jack with a wider surface. As for teaching and learning process for Vehicle Maintenance Skills subject, students will perform practical task on both car and motorcycle. Thus, a dual-capability jack would be helpful in terms of cost saving. The impact of Hydraulic Foot Jack with Lifter Stand on special needs students (deaf) will then be analysed.

2. Literature Review

Generally, there are two main types of jacks which are mechanical and hydraulic. A mechanical jack is operated by turning a lead screw by applying a small force (Amedorme and Fiagbe, 2016). Hydraulic jacks use the principle of Pascal. The pressure inside hydraulic jack is distributed evenly in all directions. It is operated by using liquid preferably oil as it could lubricate the parts of jack as well (Sainath et al., 2014). Hydraulic jacks are used widely across the globe because of sturdy construction, reliable, hassle free operation, unparalleled performance and less maintenance (Wondwossen et al., 2017). Over the years, the design of hydraulic floor jacks has been changed to suit the height of latest vehicle (Fox, 2020). One of the main advantages of hydraulic jack is it could lift heavy objects although the jack itself is lightweight and portable (Ranglani et al., 2014). Hydraulic jacks tend to be stronger than mechanical jacks and can lift heavier loads with small effort (Al-Mohaia, 2019). There are various types of design and purpose for existing jack. Among those are as shown in Table 1.

Table 1: Types of hydraulic jack

Types of Jack	Feature
 **Floor Jack**	Use less power to lift a load. Widely used in workshops because it works better and faster compare to hand operated jacks such as scissor jack.
 **Bottle Jack**	Consist of two cylinders joined together in a bottle shape, having a cylindrical body and a neck, from which the hydraulic ram emerges. Use detachable hand lever to operate the pump which is easy to use.
 **Long Ram Jack**	Use long size of ram. A lever handle is easy to use. It is mainly used for performing various types of repairing work.

Figure 1 shows a common saddle design and location for hydraulic floor jack. Diameter of the saddle is ranging between 8 cm to 10 cm. Tabs at the edge of saddle will prevent an object from slipping off. However, slippage and damaged by the lifting saddle may occur at the bottom of the vehicle if not position at the correct place (Al-Mohaia, 2019). The floor jack could potentially cause serious injury to the user if it falls (Tijerina, 2020). A rotatable saddle is mounted to the lifting arm which act as an elevator and pivotally mounted on the frame's plates.

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Figure 1: Saddle position and design for hydraulic floor jack (AC Hydraulic A/S, 2019)

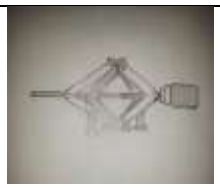
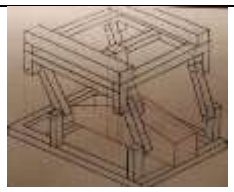
3. Methodology

The design, fabrication, installation and testing processes of product are done at welding workshop involving process of cutting, welding, milling and drilling.

Concept Design

The design of the concept that has been developed will be considered through several criteria as shown in Table 2. The concept design that gets the highest points value and meets the desired criteria will be selected as a final design. Design 2 has the most advantages compared to the other two designs. Thus, it is selected as a final design.

Table 2: Selection process for concept design

	 **Design 1**	 **Design 2**	 **Design 3**
Advantages	1) Lightweight	1) Very stable 2) Strong 3) Prevent slip when lift	1) Lightweight
Disadvantages	1) Less stable 2) Less strong 3) Locking mechanism is hard to design	1) Heavy	1) Less stable 2) Less strong 3) Locking mechanism is hard to design
Total of Advantages	**1**	**3**	**1**

Fabrication and installation

Figure 2: Fabrication and installation process

As shown in Figure 2, fabrication process starts with cutting a steel square tube and flat bar according to design measurements. It is accurately cut to ensure the stability of jack frame. Upper and lower parts of the frame are joined by using arc welding. Moving arms have been drilled and joined together by screw, washer and nut. During installation of hydraulic jack,

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some adjustments to the frame have been made to properly align the hydraulic jack position. Anti-slip base has been placed on top of the frame for better grip and protection against dented when contact with vehicle. The dimension of hydraulic jack is 45.72cm x 30.48cm x 16.50cm (before jack) the maximum height can reach to 31cm.

Testing and feedback

Hydraulic Foot Jack with Lifter Stand has been tested on car and motorcycle to assess the capability and the safety of the jack. To measure the impact of Hydraulic Foot Jack with Lifter Stand, data is collected by observation and feedback form students during practical works. It is divided into two sessions which are before and after the usage of innovation. 20 special needs students have been experiencing the usage of a normal jack and Hydraulic Foot Jack with Lifter Stand for a 3 hours session respectively.

4. Discussion

Figure 3 shows current method to lift a car by using hydraulic jack and jack stand. Students will placed the saddle along chassis rail or other strong structure below the car. Some adjustments for saddle location is needed before the jack handle could be pumped. After appropriate height is achieved, jack stand is placed below the chassis. It involves 3-4 steps and took about 50 – 60 seconds for special needs students (deaf) to lift the car.

Figure 3: Lifting method of existing jack

Table 3 shows a test results on a car. It is a simple method and has better safety features than the usual method. Hydraulic Foot Jack with Lifter Stand is fully operated by using manpower which the user just need to step on the jack foot pedal to lift the vehicle at a desired height. The wide saddle platform could just simply put under the chassis of the car to lift it. There's no need to worry about misplacement of saddle. It involves just 1 step and took about 30 seconds for special needs students (deaf) to lift the car.

Table 3: Test results on car

TEST ON CAR LIFTING	
Time taken to raise load (car)	30 seconds (Raised) 3 seconds (Lowered)
Required manpower	1 person

Table 4 shows a test results on motorcycle. The same Hydraulic Foot Jack with Lifter Stand has been used and it took about 25 seconds for special needs students (deaf) to lift the motorcycle. The wide platform is properly placed and support the below parts of the engine thus able to lift the motorcycle safely.

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Table 4: Test results on motorcycle

TEST ON MOTORCYCLE LIFTING	
Time taken to raise load (motorcycle)	25 seconds (Raised) 3 seconds (Lowered)
Required manpower	1 person

The innovation data have been collected before and after the practical work sessions. There are 2 batches of different classes that use the jack for practical works. In total, 20 special needs students have been participated in this survey and the result are shows on Table 5.

Table 5: Survey results of the effectiveness of jack as a teaching aid

ITEM	% AGREE (BEFORE INNOVATION)	% AGREE (AFTER INNOVATION)
I'm confident to use a jack to lift and support the vehicle	25	85
I feel safe to put jack under the vehicle	20	90
I need the help of a lecturer / friends to use a jack	90	25
I like to do a work that use jack	20	65
I feel comfortable (ergonomic factor) when doing a vehicle lifting work	10	45
Practical works at workshop is very difficult	100	20
I am focused and eager to do practical works at the workshop	20	95
I need more time to lift a vehicle by using jack	95	20
Practical works could be completed on time	15	75
Overall, jack at workshop is user friendly device	15	90

This survey consists of 10 simple questions which is divided into two categories. The first one is to get a data of effectiveness when using the jack and the second one is to get a data of supervision reduction from the lecturer. As an overview, it is clearly shows that students feels practical works at workshop is very difficult before the innovation which is 100% of the students agree. It could be said that proper equipment as one of the contribution factor based on this survey because after students used Hydraulic Foot Jack with Lifter Stand, only 20% agree that practical works is difficult. Students also could use the same device for car and motorcycle compare to existing method which require a different device.

Figure 4 shows the effectiveness before and after the usage of Hydraulic Foot Jack with Lifter Stand. This finding shows that the innovation could have a positive impact on teaching and learning sessions. Students feel more confidence and safer to use jack for practical work. This is because Hydraulic Foot Jack with Lifter Stand will give more support to the vehicle and easier to use compared to existing floor jacks. This equipment greatly facilitates students' practical work. Indirectly, students will be more motivated, focused on eager to do practical works.

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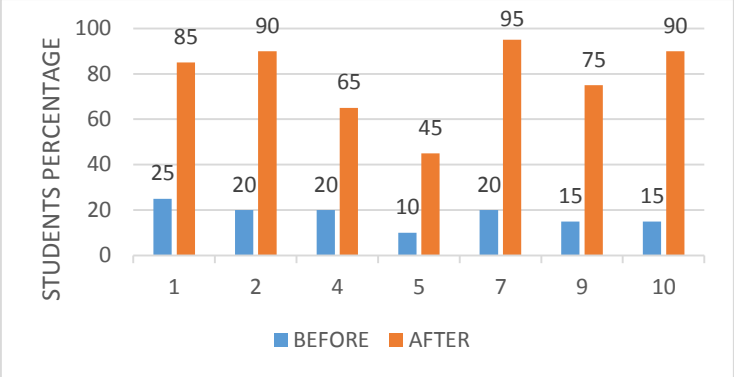

Figure 4: Percentage of effectiveness before and after innovation

Overall, the Hydraulic Foot Jack with Lifter Stand is a user-friendly equipment where it is easy to operate, saves time and even reduces manpower consumption. It is clearly shows at Figure 5 where it has a significant reduction of supervision by lecturer during the class. Students could perform the whole processes from placing the jack at proper location, lifting the vehicle, doing maintenance work under the vehicle and lowering the vehicle on their own after Hydraulic Foot Jack with Lifter Stand is used. The perception that practical works at workshop is difficult can also be reduced. With the help of good equipment, it can indirectly change students' perceptions.

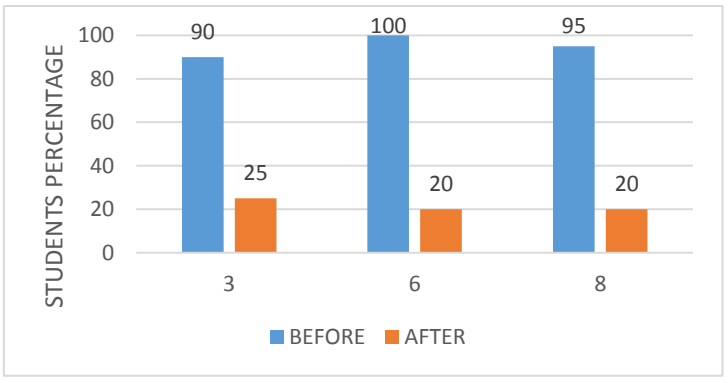

Figure 5: Percentage of supervision reduction from the lecturer before and after innovation

5. Conclusion

As a conclusion, with this innovation, students will be able to do a maintenance work with better safety because of wider saddle platform and reduce mistake during lifting and lowering the vehicle. Lecturer could also focus on other things instead of monitoring the students all the time during practical works. It is a useful device that can aid teaching and learning process. In terms of cost, a total of RM150 has been spend to build Hydraulic Foot Jack with Lifter Stand which is lower if compare with buying two different types of jacks. As for the institution, it is a cost saving ranging around at least RM850 to RM950 because one device could be used on both four wheeled vehicle and motorcycle.

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