

Designing a Personal Pneumatic Car Jack Tool for Women

Hansel Pius Manuel

Department of Product Design, Faculty of Design,
Universitas Pelita Harapan, Indonesia
01025190004@student.uph.edu

Michael Christoffel Limahelu

Department of Product Design, Faculty of Design,
Universitas Pelita Harapan, Indonesia
michael.limahelu@lecturer.uph.edu

ABSTRACT

In today's increasingly advanced era, where many women are required to drive their own vehicles, it is common to see women driving alone, particularly in four-wheeled vehicles, on the roads. Any vehicle, including four-wheelers, is at risk of experiencing a flat tire while on the road. This issue can affect female drivers just as it does any other driver, as all vehicles and drivers face similar risks. Specifically, women may not know how to change a tire or may be unfamiliar with the process. Most of them are not well-acquainted with using the toolkit provided by the manufacturer.

The research utilizes a Research Through Design (RTD) approach, which involves iterative cycles of design, prototyping, and testing. This method allows for continuous refinement and evaluation of design concepts. Data collection was conducted through literature reviews and focus group discussions. We gathered several sources and invited participants to engage in tire-changing experiments under supervision. After the tire-changing activity, we discussed their experiences with them, focusing on what they found most difficult and what they found easiest. From the data collected, the most challenging tasks identified were aligning the tire with the bolt holes and jacking up the vehicle, as these two processes were the most time-consuming and physically demanding for them.

Keywords: Product design, Flat Tire, Research Through Design

INTRODUCTION

Private vehicles are one of the most commonly used modes of transportation. In big cities like Jakarta, private vehicles are abundant because they are the most practical means of transportation in any situation and greatly aid in moving from one city to another. According to data from the Central Statistics Agency (BPS) of DKI Jakarta (2023), there are approximately 3,365,467 registered vehicles. As cited by BPS DKI Jakarta, 50% of the registered vehicles in DKI Jakarta are privately owned and driven by their owners. Among the many female drivers, they often experience emergencies such as flat tires. such as flat tires. Most female

drivers cannot or do not understand how to change a spare tire. As reported by Kompas.com (Janlika Putri Indah Sari), many women panic when faced with a flat tire because they cannot change it themselves and do not know how to replace it with a spare tire.

From the observational data gathered by the authors' team, it was found that 80% to 90% of the women observed do not understand how to use the car's toolkit, and they encounter difficulties when using it. The car's toolkit, especially for changing tires, remains very challenging, particularly for a female driver when driving alone.

Often, we find vehicles parked or stopped on the side of the road due to flat tires. The only solution is to replace the tire with a spare tire and use the car's toolkit. However, in this millennial generation, particularly among women, there is a lack of knowledge about how to change a spare tire in a car, especially in this modern and convenient era. The use of the toolkit, especially for changing tires, must be practical and easy to understand for users.

LITERATURE REVIEW

DFA (Design for Assembly) vDesign for Assembly (DFA) streamlines product design to simplify and expedite assembly, minimizing part count and assembly time while cutting costs. DFA is essential for engineers to optimize assembly processes and is typically implemented early in the design phase to make necessary adjustments for efficient assembly.



Image 1 Jack. (Source: Personal Data, 2024)

Image 1 is the car's built-in jack. Every car comes with a built-in jack provided by the manufacturer. This jack uses a screw system to lift the car. To use this jack, first it needs to be placed at the car's jacking point, then it needs to be raised by turning the provided handle.

The process of changing a tire in an emergency situation takes some time. Step by step in this tire replacement process, the first thing to do is to pull over to a safe roadside and avoid panicking. Once the car is safely parked, take out the safety triangle and place it at least 4 meters away from the car, both in the front and the back. Then, start by removing the spare tire from the car; usually, it's located either underneath the car or in the trunk. After that, take the jack and place it on the car's jacking point.

Before jacking up, loosen the lug nuts first to make it easier to remove the tire when lifted. Then, jack up the car by turning the lever to the right until the car is lifted. Once lifted, loosen and remove the lug nuts, followed by removing the tire. Next, replace it with the spare tire, ensuring it's centered so that the wheel holes and bolt holes align. After the lug nuts are in place, tighten them with the lug nut wrench, ensuring they are securely tightened. Then, lower the jack by turning it to the left, and after that, tighten the lug nuts again until fully tight. Be careful when tightening the lug nuts; they should be tightened in a zig-zag pattern to avoid damaging the bolt threads. And that's it; you're done.

Type of Car Commonly used by Women

In this modern era, it's undeniable that there are many female drivers. Cars are the most preferred vehicle for women, especially in urban areas. There are various types of cars available nowadays, ranging from SUVs, MPVs, hatchbacks, and more. Female drivers often drive four-wheeled vehicles, particularly hatchbacks or city cars. According to a survey conducted by Kompas.com (Aprida Mega Nanda) among executives at PT Astra, there's a significant interest in hatchback cars among female consumers. It's not surprising that hatchback cars attract many female consumers because their sedan-like shape and compact size are suitable for female drivers. Based on data from Kompas.com (Serafina Ophelia), interviews with female drivers revealed that the reason for choosing hatchback cars is their compact body and ease of maneuverability on narrow roads.

METHODOLOGY

Research through Design (RtD) is a methodology wherein designers generate and utilize design artifacts to facilitate knowledge creation and comprehension. It entails conducting research through the act of designing and prototyping, enabling the collection of insights and feedback from users. RtD proves especially beneficial in domains where conventional research methods fall short or where the design serves as the principal avenue for grasping the problem or issue under investigation.

Step-by-step of the research-through-design process. The first is a literature review, learning about DFA and existing jacking tools for theoretical considerations. secondly, collecting data, observing, and interviewing to obtain primary data. Third, after obtaining primary data, data analysis is carried out to determine what the design criteria are. After that, the design process and prototype creation are carried out. Once finished, the prototype is tested on users for user review. and finally, conclusions and evaluations regarding this product.

RESULT & DISCUSSION

Primary Data Results

Primary data collection was conducted with 14 women who frequently drive alone in their private vehicles, particularly cars. In this observation, the first thing we did was test and measure the time using a stopwatch when they performed the process of changing a car tire, starting from loosening the jack bolt and removing the tire until the tire could be reinstalled perfectly. We measured how long each process took, from the time taken to jack up the car to loosening the bolts to installing the tire, and so on. We also divided them into two age groups: 20–30 years old and 30–40 years old. From this data, we found that one of the longest time-consuming processes was the jacking process, taking 2–3 minutes.



Image 2 Observation and Interview. (Source: Personal Data, 2024)

For the second observation, after completing the tire-changing process, we conducted interviews with the same 14 individuals to inquire about the challenges they faced during the tire replacement process. From these interviews, we learned that they found the jacking process to be quite difficult. They mentioned that the jack felt heavy, especially when the car had already started to lift, and they were

unaware that the jack should be placed at the car's jacking point. They also didn't know where the jacking point was located.

Data analysis

From the results of interviews and observations, the main issue in the process of lifting a car jack is that when the car has already started to lift, the jack feels heavy because the weight of the car has shifted during lifting. Meanwhile, users also find it difficult to determine the jacking point location. From the interviews conducted, they also mentioned the need for an assisting tool to lift the car easily without having to use the jacking point and without having to manually turn it. This is particularly important for female drivers, as turning the jack is a very tiring process due to its weight.

Design Process and Prototyping

Design for Assembly (DFA) streamlines product design to simplify and expedite assembly, minimizing part count and assembly time while cutting costs. After conducting primary and secondary data searches, design criteria for this product can be determined. This product should be as simple as possible and easy to use for female drivers. The designed product must meet criteria such as not needing to be placed on the jacking point and not requiring manual turning of the jack. This jack has limitations based on the type of car it can lift. This jack can only lift lightweight vehicles like hatchbacks or city cars. Based on these design criteria, we proceeded to create designs that adhered to them. Through various design processes, a pneumatic system design was selected.

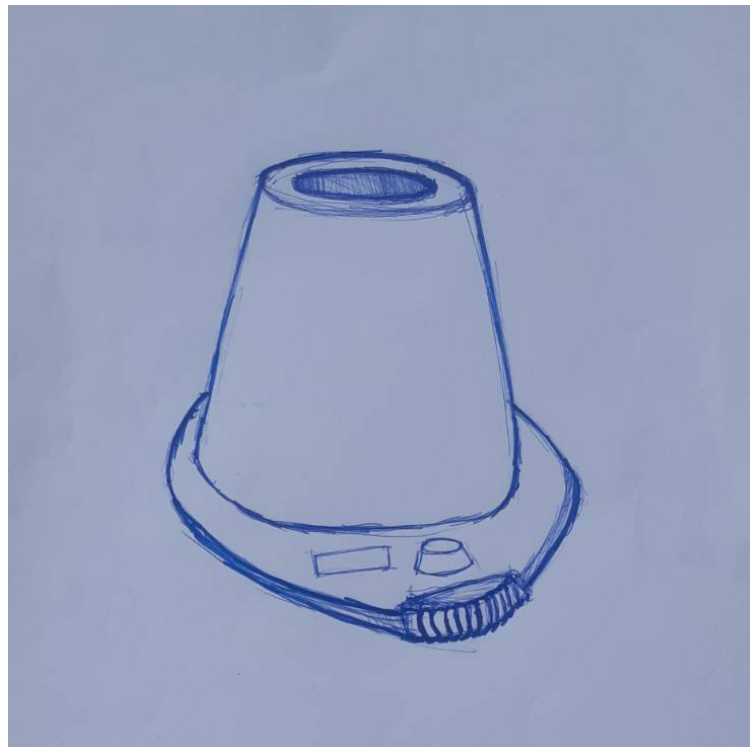


Image 3 sketch Pneumatic Jack. (Source: Personal Data, 2024)

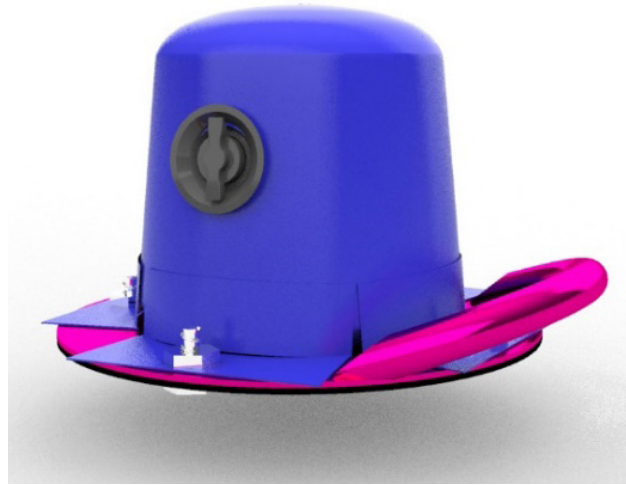


Image 4 3D Pneumatic Jack. (Source: Personal Data, 2024)

From this 3D model, a prototype will be made. This prototype will utilize PVC material for the rubber boat. PVC was chosen because it is lightweight, flexible, and strong enough to support the load.



Image 5 Final Jack Prototype. (Source: Personal Data, 2024)

The design of this pneumatic jack tapers upwards so that when it supports the weight of the car, it remains stable. This jack, made of PVC material, is capable of supporting the weight of the car up to 1,200 kg (1.2 tons). By using PVC material, users no longer need to operate it manually, and it does not require a jacking point. Its operation simply involves inflating the pneumatic balloon using the provided mini air compressor.

Through the design of this pneumatic jack tool, the product was created to simplify the process of lifting a car. This product can assist in emergency situations on the road. Targeting female drivers, this pneumatic jack can ease the process of lifting a car as it no longer requires a jacking point and its operation is no longer manual.



Image 6 User Testing (Source: Personal Data, 2024)

After completing all stages of the design and prototype process, we conducted user testing with 5 female drivers. The female drivers in this case are typically aged between 20 and 30 years old and are often students. They frequently travel to campus on their own and drive their own cars. Using this pneumatic jack, they attempted to lift the car easily. They only needed to place the pneumatic jack under the car and inflate its pneumatic balloon using the provided compressor.

After conducting user testing, we conducted interviews and asked several questions about the product. We asked some important questions, such as whether this tool is easier to use, and they all responded that it is easier to use compared to traditional jacks because it no longer requires a jacking point and manual turning. Female drivers felt assisted by this tool and found it easy to use.

CONCLUSION

This study aims to alleviate the inconvenience during the process of changing a flat tire on the road. Emergency situations such as tire blowouts are highly troublesome when they occur. Anyone, regardless of gender, faces the risk of experiencing a tire blowout while driving. Particularly for female drivers, they encounter difficulties when faced with this situation because they may not know how to change a tire and may not understand how to use the tools provided in the car. This can be quite challenging and inconvenient for female drivers.

The recommended design solution is to utilize this pneumatic jack, which enables drivers, especially female drivers, to lift the car. With this pneumatic jack, there is no need to search for a jacking point or manually rotate the jack. The product has undergone testing and has proven to assist drivers, especially female drivers, in easily lifting the car.

Although this product has several advantages, such as not requiring a jacking point and eliminating the need for manual rotation, the pneumatic jack still has some limitations. One limitation is the use of a heavy iron base for the bottom part of the pneumatic balloon, which can be burdensome for female drivers. For future development, this will be replaced with a lighter material such as aluminum alloy, which is both lightweight and strong enough to support the load.

REFERENCES

- Ferdian, A. (2022, December 4). *Cara Mudah Ganti Ban Mobil Buat Wanita*. KOMPAS.com. <https://otomotif.kompas.com/read/2022/12/04/180100015/cara-mudah-ganti-ban-mobil-buat-wanita>
- Ferdian, A. (2021, March 14). *Kenapa Wanita Cenderung Lebih Suka hatchback?*. KOMPAS.com. <https://otomotif.kompas.com/read/2021/03/14/092100315/kenapa-wanita-cenderung-lebih-suka-hatchback->
- Kurniawan, A. (2022, January 5). *Mengapa Pengemudi Wanita Lebih Suka Mobil hatchback?*. KOMPAS.com. <https://otomotif.kompas.com/read/2022/01/05/100200715/mengapa-pengemudi-wanita-lebih-suka-mobil-hatchback->