MULTIDISCIPLINARY APPLIED RESEARCH AND INNOVATION
e-ISSN: 2773-4773

MARI

Vol. 6 No. 3(2025) 18-24
https://publisher.uthm.edu.my/periodicals/index.php/mari

Car Seat Swivel for Enhanced Accessibility for Disabled Individuals

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DOI: https://doi.org/10.30880/mari.2025.06.03.003

Article Info

Received: 01 March 2025
Accepted: 01 May 2025
Available online: 30 June 2025

Keywords

Accessibility Technology, Swivel Mechanism, Assistive Mobility Devices, Disabled-friendly Automotive Design, Ergonomic Seating Solutions

Abstract

This project focuses on developing a car seat swivel mechanism tailored to improve mobility and comfort for individuals with leg disabilities. The innovation is centered on modifying Proton Saga car seats to allow rotational movement of up to 30 degrees, facilitating easier entry and exit. The design employs durable yet lightweight materials such as steel and aluminium, ensuring safety, stability, and ease of use. A manual swivel mechanism was chosen to minimize costs and simplify installation, making it an affordable and practical solution. The methodology involved analyzing existing seat slider technologies, user feedback, and ergonomic principles to create a user-centered design. Prototype testing revealed the swivel mechanism's ability to support various user weights while maintaining stability and comfort. Enhancements included built-in safety features, such as secure locking mechanisms, and a compact design to prevent interference with the car interior. This project contributes to the field of assistive mobility technologies by offering an affordable, practical, and customizable solution for enhancing vehicle accessibility. Its focus on a specific user group and integration into a widely used vehicle model demonstrates significant potential for improving the quality of life for individuals with disabilities.

1. Introduction

Transportation is essential for everyone, yet individuals with disabilities often face significant challenges when commuting. One of the primary issues is the difficulty of entering and exiting vehicles, particularly for those with leg disabilities. According to the U.S. Census Bureau (2002), disabilities affect more than 8% of individuals aged 5 to 20 years, 19.2% of those aged 21 to 64 years, and 41.9% of those aged 65 and older. Despite the provisions of the Americans with Disabilities Act of 1990 (ADA), many transportation systems fail to address these specific needs, leaving a gap in accessible mobility solutions [1].

The inability to easily enter and exit cars compromises the independence of individuals with disabilities and underscores the importance of innovative solutions. Current vehicle adaptations, such as powered swivel mechanisms, are often prohibitively expensive, overly complex, or require significant modifications to the vehicle, limiting their accessibility to the wider population [2], [3].

This project focuses on developing a manual car seat swivel mechanism that is cost-effective, easy to

install, and compatible with Proton Saga vehicles, Malaysia's national car. The Proton Saga is widely used due to its affordability and relevance to individuals across various income levels, making it an ideal candidate for this innovation.

The proposed solution modifies the base of the car seat, enabling a rotational movement of up to 30 degrees. The design emphasizes the use of lightweight and durable materials, ensuring safety and reliability while maintaining affordability. This innovation addresses a crucial need by providing a practical and user-friendly tool that enhances mobility and independence for individuals with leg disabilities, ultimately contributing to improved quality of life [1], [2], [4], [5].

1.1 Existing Solutions and Technological Foundations for Swivel

The product, known as the "Adjustable Car Seat Slider for Disabled," is different from existing market solutions in many significant ways. For starters, it is considerably less expensive, which is an important consideration for people searching for affordable ways to increase their mobility. Another aspect of our design that appeals to a larger audience is its simplicity of installation. The invention does not require energy and operates manually, allowing for more adaptation and reliability in a range of settings [5], [6], [7].

Swivel seats are a valuable accessibility element for those with disabilities, facilitating everyday mobility. They handle the difficulty of moving from wheelchairs to car seats by spinning towards the vehicle's entrance, making the whole process easier [2]. Traditional automobile seats sometimes restrict wheelchair users, limiting their independence. Swivel chairs, which can pivot, make this shift easier, reducing physical effort and increasing freedom. These seats are becoming more common in accessible vehicle adaptations, as they are adaptable to a wide range of cars [1], [5]. They include strong locking mechanisms, user-friendly controls, and adjustable settings that satisfy a variety of demands, improving quality of life and encouraging equality. The reference to National Mobility Equipment Dealers Association (NMEDA) publications emphasizes the industry's recognition of the critical importance of adaptive equipment since they think that when it comes to conquering mobility issues, driving is typically at the top of the list [6]. Thus, in vehicles with adjustable seats, individuals with disabilities also can drive their cars if the car seat can be swiveled facing outside of the car [3].

Many years ago, the first invention of the swivel car seat was created by Chrysler, which could swivel up to about 40 to 45°. It is considered a convenience to the buyer even though it was originally made as a mere innovation [2], [6]. A few companies took on the issue of developing car seat swivels that are simple to use and beneficial to those with disabilities while encouraging acceptance and happiness. They developed a variety of inventions, from simple designs to ones that include current technology. Each update prioritizes user comfort and adapts to individual preferences, ensuring that everyone has an enjoyable experience [1], [4], [5], [8].

A moveable vehicle seat swivel includes several necessary technical concepts. Linear motion using ball bearings or wheels decreases friction, resulting in smooth seat adjustments. Material science allows the selection of long-lasting, corrosion-resistant materials that are both lightweight and flexible [9]. Statics and physics guarantee that the locking mechanism maintains the seat steady while driving. Integration theories attempt to effortlessly fit the slider into current vehicle seats of various types. User testing with a wide group of volunteers helps [4], [5]. Enhance the design based on feedback, with a concentration on simplicity of use. Finally, cost-effective design solutions improve production efficiency while keeping the product useful and inexpensive [7].

2. Material and Methods

This design was developed using several techniques. Material selection was the most crucial component of this project. Several materials were removed from the list because they lacked the necessary features for the project from a variety of perspectives. In conclusion, some are most suited for this project. In addition, various strategies were proposed to help in the efficient and robust implementation of this project [9], [10], [11].

2.1 Materials and Construction

To improve project efficiency, the strength, weight, and quality of materials are carefully considered during material selection [12], [13].

- Mild Steel (Low Carbon Steel)

  This material is chosen for our swivel and slider mechanism because of its strength and durability allowing it to endure dynamic stresses during vehicle movement [12]. The parts made from this material are the sliding rail and its handle.

- 6061 Aluminum

  This material is also a part of our swivel and slider mechanism for being lightweight and sturdy improves the firm's capacity to handle weight distribution while ensuring safety and structural integrity [13]. The parts made from this material are the Lazy Susan Plate and its handle.

- Epoxy Paint

  Paint serves two key purposes on a vehicle seat: protection and aesthetics. It provides protection against external variables such as sunshine, moisture, and scratches, extending the seat's lifespan [13].

- High-Density Polyurethane Foam

  Foam is commonly made of high-density polyurethane foam, which is selected for its comfort, durability, and ability to hold form over time [12].

- Welding

  We use it to establish tight connections in certain parts of the swivel and slider components. We picked welding because it is a reliable method for building strong links [9].

- Threaded Fasteners

  Fasteners (steel bolts (Grade 8.8)) are used because they are easy to remove. We used threaded fasteners to increase the security of all linked components [10], [11].

2.2 Methodology

The research methodology provides a structured framework for achieving the project's objectives and addressing key research questions [14]. This chapter details the design process of an adjustable seat slider for individuals with leg disabilities, the focus of this final-year project. A methodology flowchart as in Fig.1 illustrates the development process.

Initial online research into existing seat slider technologies confirmed that individuals with leg disabilities experience difficulties entering and exiting vehicles. This project aims to mitigate these challenges through innovative design. Following group discussions, materials for the seat swivel were selected based on strength and cost-effectiveness. The primary objective is to optimize the seat swivel mechanism to effectively benefit users and address practical issues related to vehicle accessibility.

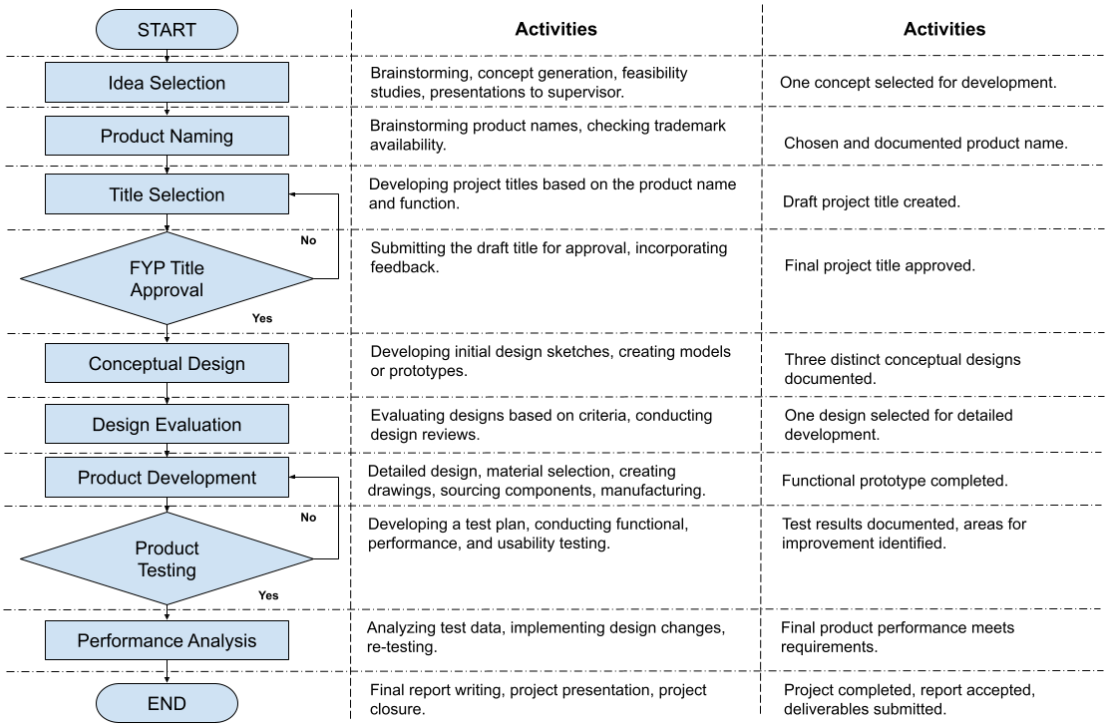


Fig. 1 *Methodology Flowchart*

2.3 Prototype Development

Several conceptual designs were developed during the initial project discussions. SolidWorks 2021 software was then used to create a detailed digital prototype, as illustrated in Fig. 2. This figure shows the detailed design before physical prototype development.

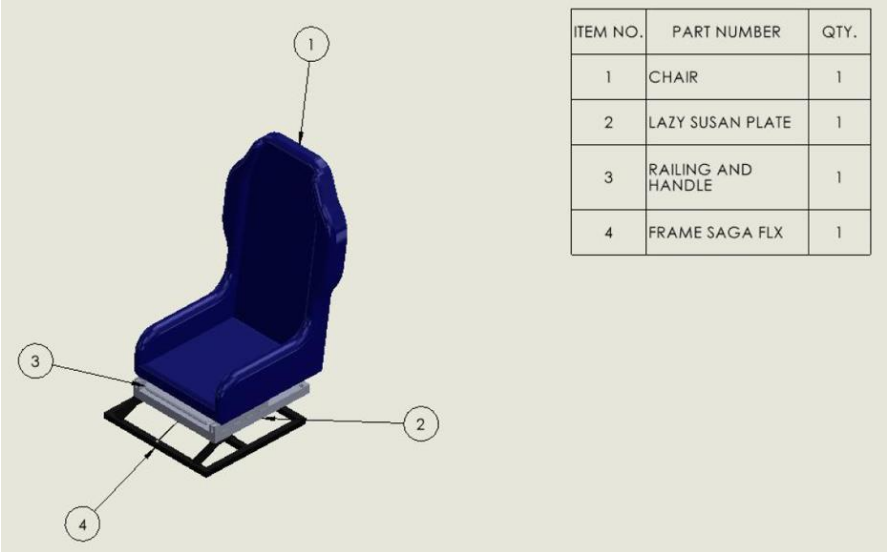


Fig. 2 *Final Prototype Design*

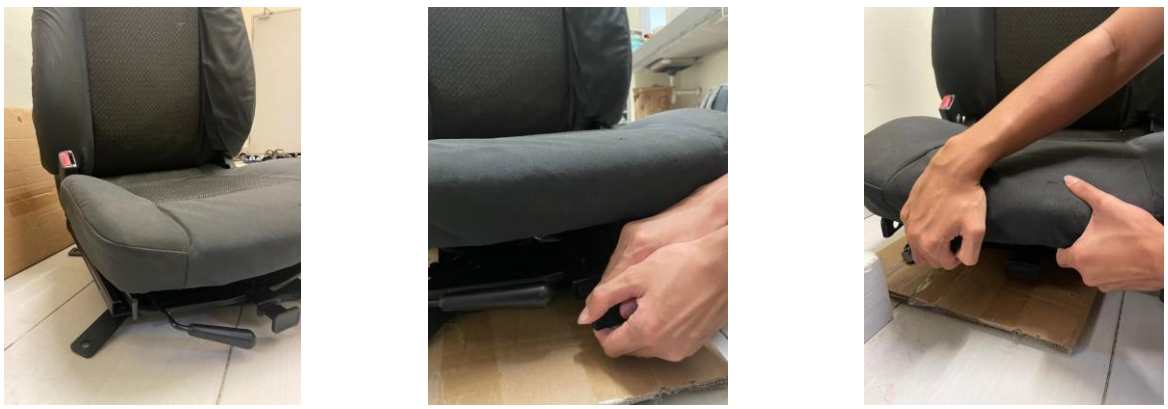
3. Results and Discussion

This section presents the findings from the testing and evaluation of the adjustable car seat swivel mechanism developed for Proton Saga vehicles. The results encompass the operational procedures, technical specifications, and innovation highlights of the prototype, followed by a detailed analysis of its functional performance and usability across different user profiles. Through iterative testing and feedback, the limitations and potential areas for improvement in achieving the targeted 30-degree rotation for enhanced accessibility are discussed.

3.1 Operating Instructions for the Adjustable Car Seat Swivel

The operation of the Adjustable Car Seat Swivel mechanism is shown in Fig. 3. Pulling the adjustment lever under the seat's front edge starts the operation, which enables the seat to move forward or backward down the track. To make sure there is adequate room for the seat to spin freely, this first step is crucial.

Next, the locking mechanism handle, which is situated on the side of the seat, must then be pulled by the user. By doing this, the lock is released, allowing the seat to freely rotate. The user can spin the seat in the specified direction after the lock is released. Because it enables users to position the seat for easier entry and exit from the car, this swivelling feature is very helpful for people with limited mobility.



(a) **(b)** **(c)**

Fig. 3 *Operating Instructions for the Adjustable Car Seat Swivel (a) Pull the lever to move the seat forward or backward (b) Pull the lock mechanism to turn the seat (c) The chair rotates in the following direction.*

3.2 Product Specifications and Innovation Highlights

This section details the product specifications of the adjustable car seat swivel mechanism, derived from measurements and testing of the fabricated prototype. The key innovation of this project is the development of an affordable and easily installed manual swivel mechanism specifically designed for Proton Saga car seats, enabling up to 30 degrees of rotation to improve vehicle entry and exit for individuals with leg disabilities.

Table 1 *Product Specification*

No.	Component	Component Size
1	Weight	12 kg
2	Height (Seat Height)	520 mm
3	Width (Seat Width)	460 mm
4	Length (Seat Length)	610 mm
5	Track Length	750 mm
6	Material	Stainless steel and Aluminum
7	Rotation Angle	Up to 45 degrees
8	Weight Capacity	130 kg

The specifications as presented in Table 1 formed the basis for evaluating the mechanism's performance and represent the culmination of the design and fabrication process.

3.3 Discussion

The fabricated prototype car seat swivel mechanism as shown in Fig. 4 underwent functional testing to assess its rotation capabilities. Testing revealed that the mechanism did not achieve the full 360-degree rotation as initially designed. Specifically, the seat backrest extended beyond the defined clearance area, physically limiting the swivel's range of motion. This interference prevented the mechanism from turning completely.

(a) **(b)** **(c)**

Fig. 4 *The part of the car (a) Consultant box was hit (b) Consultant box was hit (c) Guidelines that show the limit of the chair can turn*

Table 2 *Max rotation angle achieved based on respondent weight*

Respondent No.	Respondent Weight (kg)	Max Rotation Angle Achieved (degree)
1	44	17
2	57	18
3	76	20
4	81	20
5	103	24
6	121	25

Testing of the prototype car seat swivel mechanism was conducted to evaluate its rotation capabilities and identify any limitations. In the initial test run as shown in Table 2 above, it was observed that the car seat

backrest breached the consultant box area. This interference prevented the seat from achieving its full rotation potential. To address this issue, the seat position was adjusted forward for the subsequent tests.

Test two demonstrated an improvement in the maximum rotation angle compared to test one. However, the chair still did not reach the desired 30-degree rotation. The maximum rotation angle achieved varied depending on the respondent's weight, ranging from 17 degrees for a 44kg respondent to 25 degrees for a 121kg respondent. Even a small rotation, such as the targeted 30 degrees, can significantly improve access to the car seat for individuals with limited mobility by allowing them to angle their legs more easily during entry and exit.

For the final test run, the seat was moved as far as practically possible, guided by the image in Fig. 4(c). This adjustment aimed to maximize the rotation angle. While further improvement was observed, the highest rotation angle achieved was 25 degrees, observed for the 121kg respondent. The mechanism still did not achieve the 30-degree target consistently across all tested weights. Further investigation is needed to determine design modifications that can ensure the desired 30-degree rotation without interference across a wider range of occupant weights.

Table 3 *Ease of Use based on Respondent Age*

No.	Age	Physical Ability	Ease of Use Rating
1	19	Strong	Strongly Agree
2	27	Average	Agree
4	56	Limited Mobility	Neutral

Usability testing was conducted to evaluate the ease of use of the adjustable car seat swivel mechanism across a range of users with varying physical abilities and ages. Respondents were asked to interact with the mechanism and rate its ease of use using a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). The results, presented in Table 3, offer insights into the mechanism's accessibility and user-friendliness.

As shown in Table 3, the 19-year-old respondent, categorized as having 'Strong' physical ability, rated the ease of use as 'Strongly Agree.' This suggests that for users with full physical capabilities, the mechanism is highly intuitive and easy to operate. The 27-year-old respondent, with 'Average' physical ability, rated the ease of use as 'Agree,' indicating a positive user experience, although perhaps with slightly less ease than perceived by the 'Strong' respondent.

The most critical finding is the 'Neutral' rating from the 56-year-old respondent with 'Limited Mobility.' This suggests that while the mechanism may be usable, it does not provide the same level of ease for individuals with mobility limitations, the target demographic for this project. This 'Neutral' rating highlights a key area for improvement in the design. Further investigation is needed to understand the specific challenges faced by users with limited mobility. For example, the effort required to release locking mechanisms, the speed and smoothness of rotation, or the positioning of handles may present difficulties. Future design iterations should prioritize addressing these ergonomic factors to enhance usability for the target user group [15]. It's worth noting that while only three respondents participated in this initial usability test, the data reveals a clear trend: the mechanism's usability decreases as physical ability declines. A larger and more diverse sample size in future studies would provide a more comprehensive understanding of user experience and inform further design refinements.

The testing confirmed the adjustable car seat swivel mechanism's safety and weight capacity as in Table 2, supporting various user weights. However, the mechanism did not achieve the full 30-degree rotation consistently, with a maximum of 25 degrees observed. Usability testing (Table 3) showed that while users with strong physical abilities found the mechanism easy to use, individuals with limited mobility experienced challenges. Therefore, while safe and capable of supporting different weights, the design requires further refinement to achieve the target rotation and improve usability for the target demographic.

4. Conclusion

In conclusion, this project successfully developed a prototype adjustable car seat swivel mechanism designed to improve vehicle accessibility for individuals with limited mobility. The mechanism allows the car seat to not only slide forward and backward but also rotate, offering an enhancement over standard car seat designs. While testing revealed limitations in achieving the targeted 30-degree rotation consistently across all user weights (with a maximum rotation of 25 degrees observed) due to interference from the seat backrest, the mechanism demonstrated stable and safe operation throughout testing. Usability testing (Table 3) highlighted the need for design improvements to accommodate users with limited mobility better, as evidenced by the 'Neutral' ease-of-use rating. Despite these challenges, the project achieved its core objective of creating a functional prototype with the potential to assist individuals with disabilities in entering and exiting vehicles.

Future work will focus on refining the design to achieve the full 30-degree rotation and enhancing usability for the target demographic, specifically addressing the ergonomic factors that presented challenges during testing. This project contributes to assistive mobility technologies by providing a foundation for a practical and potentially impactful solution to improve vehicle accessibility.

Acknowledgement

The author would like to express sincere gratitude to everyone who contributed to this project and to whoever has given their support, including the Centre of Diploma Studies, Universiti Tun Hussein Onn Malaysia.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Waiz Uzair, Muhammad Amirul Haziqq, Nur Miza Afiqah, Noor Azizah Sidek;* ***data collection:*** *Waiz Uzair, Muhammad Amirul Haziqq, Nur Miza Afiqah;* ***analysis and interpretation of results:*** *Waiz Uzair, Muhammad Amirul Haziqq, Nur Miza Afiqah, Noor Azizah Sidek;* ***draft manuscript preparation:*** *Waiz Uzair, Muhammad Amirul Haziqq, Nur Miza Afiqah, Noor Azizah Side. All authors reviewed the results and approved the final version of the manuscript.*

References

[1] M. J. Field, and A. M. Jette, "*Transportation patterns and problems of people with disabilities*," in The Future of Disability in America, National Academies Press (US), 2007.
[2] M. Colley, P. Jansen, E. Rukzio, and J. Gugenheimer, "*Swivr-car-seat: Exploring vehicle motion effects on interaction quality in virtual reality automated driving using a motorized swivel seat*," Proc. ACM Interactive, Mobile, Wearable Ubiquitous Technol., vol. 5, no. 4, pp. 1–26, 2021.
[3] L. R. Smith, "*Turn-Taking in Face-to-Face Conversations: A Proposed Theory of Chair Swiveling*," 2018.
[4] K.N. Young-Hoon and C. Mackie, "*The importance of child car seats and current challenges with their use*," Paediatr. Child Health, vol. 17, no. 9, pp. 483–484, 2012.
[5] A. Weichenrieder and H.G. Haldenwanger, "*The best function for the seat of a passenger car*," SAE Trans., pp. 601–616, 1985.
[6] C. D. Allison, "*Vehicle modifications: Useful considerations for life care planners,*" in Life care planning and case management handbook, Routledge, 2018, pp. 799–811.
[7] M. N. Relf, "*Maintenance-free operating periods—the designer's challenge,*" Qual. Reliab. Eng. Int., vol. 15, no. 2, pp. 111–116, 1999.
[8] L. R. Smith, "*Turn-Taking in Face-to-Face Conversations: A Proposed Theory of Chair Swiveling*," 2018.
[9] M. I. Khan, "*Welding science and technology. New Age International*," 2007.
[10] J. A. Speck, "*Mechanical fastening, joining, and assembly*," CRC Press, 2018.
[11] A. Blake, "*What every engineer should know about threaded fasteners: materials and design*," CRC Press, 1986.
[12] M. F. Ashby and D. Cebon, "*Materials selection in mechanical design*," Le Journal de Physique IV., vol. 30, no. 12, p. 995, 2005.
[13] L. Holloway, "*Materials selection for optimal environmental impact in mechanical design*," Mater. Des., vol. 19, no. 4, pp. 133–143, 1998.
[14] U. Flick, "*Introducing research methodology: A beginner's guide to doing a research project,*" Sage, 2015.
[15] H. McGraw, "*The Ergonomics of Adult Car Seat Design and Comfort*," 2018.