ECOSIA | International Conference
Institut Teknologi dan Bisnis Asia Malang
Indonesia, 10 December 2025

# The Effectiveness Using New Design Wheelchair-Bed for Dialysis Patients in Pahang Malaysia

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## Abstract

**Introduction/Main Objectives**:This study evaluates the effectiveness of a prototype wheelchair-bed developed for dialysis patients in Pahang, Malaysia.

**Background Problems:** Dialysis patients often experience discomfort during long treatment sessions at dialysis centers, indicating a need for improved supportive equipment that enhances comfort and functionality.

**Novelty:** The novelty lies in the prototype itself—a wheelchair-bed that uniquely combines mobility with reclining and bed functions, specifically designed to address the needs of dialysis patients.

**Research Methods:** The study involved a real prototype demonstration at a dialysis center. A structured survey was administered to a simulated sample of 213 respondents, including doctors, nurses, dialysis patients, and other healthcare personnel.

**Finding/Results:** The prototype received high overall satisfaction, with average ratings between 4.1 and 4.8 on a 5-point scale in criteria such as comfort, adjustability, ease of operation, and perceived benefits.Open-ended feedback highlighted strengths in comfort, adjustability, and caregiver convenience.Suggested improvements included reducing the device's weight and enhancing its ventilation system.

**Conclusion:** The findings confirm the prototype's initial effectiveness and provide valuable, actionable insights for the design team to further refine and enhance the wheelchair-bed before broader implementation.

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**Keywords:** Wheelchair-bed, patient comfort, green innovation, ergonomic healthcare equipment

## Introduction

In Malaysia, usually a Hemodialysis patient will facing undergo treatment session about four to five hours at dialysis center. Some dialysis centers had comfortable and spacious place for the patients. But some of the dialysis center, only provide wheel chair or single sofa for the patients. In additions, this prolonged immobility while treatment dialysis can cause discomfort, back pain, pressure related injuries and increase decency on caregivers. The assistive mobility such as wheel chair are widely used and it cannot be reclining as a bed which is can convenient to patient. Other than that, in Malaysia the demand of dialysis center is steadily rising, and in Pahang only already have 62 outlet dialysis centers.

There was previous research such as (Brienza et al., 2010) and (Duchesne et al., 2023), said that, it is crucial important of ergonomic seating and adjustable support system for mitigating pressure ulcer, improving circulation and enhancing overall comfort. Besides that, (Moorthi et al., 2020) and (Rushton, 2017), highlighted that how mobility constraints among dialysis patients significantly impact the quality of life and caregiver workload. Regardless of all these finding, there were limited literature addresses of multifunctional device that combine mobility, bed-like adjustability and ergonomic support specifically for dialysis patients.

In early stage of designing the prototype, (Sang et al., 2019) mentions that the wheelchair-stretcher hybrid systems have shown promising usability and often suffer from mechanical complexity, excessive weight or limited adaptability. Besides that, (Cui et al., 2023) mentions that newest systems including intelligent posture adjustment wheelchairs demonstrate technological advancements yet remain cost-prohibitive for many regional healthcare centers.

This study addresses a key gap by evaluating the prototype wheelchair-bed concept to provide reclining capability, improve the pressure distribution, the adjustable components and ease of operation for caregivers. Besides, the scientific significance of this work is focus on dialysis specific needs, the consideration of local Malaysian clinical context and integration of both patients and caregiver perspective.

**Figure 1. Challenge in Dialysis Care**

Source : Authors Data, 2025

The objective of this study is to determine the effectiveness of using prototype wheelchair-bed for dialysis patients in Pahang Malaysia. Another purpose of this study is to get area of improvement for the prototype based on practitioner and patient feedback.

This study evaluates the effectiveness of prototype wheelchair-bed developed for dialysis patients in Pahang Malaysia. The prototype combines mobility with reclining and bed functions to improve patient comfort during long dialysis sessions at dialysis centers in Pahang. After the prototype demonstration, a survey researched was conducted and administered a simulated sample of 213 respondents. The respondents included doctors, nurses, dialysis patients, and other healthcare personnel.

**Design Development of Wheelchair-Bed Prototype**

The design development of wheelchair-bed prototype was developed by researchers and it starts from concept selection. After doing concept screening and concept scoring, the final concept was selected and as shown in Figure 2. After concept had been made, 3D drawing design had been generate by using CAD software Autodesk Inventor 2021. This step is important so that the overview design in 3D can be realistic. The 3D modeling design of the prototype as shown in Figure 3. Lastly the prototype fabrication and final prototype as shown in Figure 4. This design development prototype takes around a year to be completed.

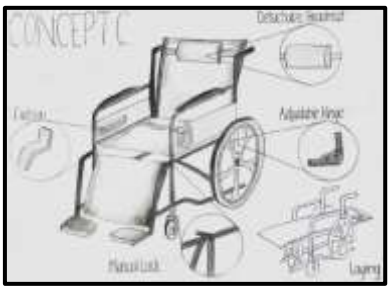

**Figure 2 Final Concept**

Source : Authors Data, 2025

**Figure 3 3D Modelling Design**

Source : Authors Data, 2025

**Figure 4 Finished Wheelchair-Bed Prototype**

Source : Authors Data, 2025

## Research Methods

A survey questionnaire had been implemented by the researcher to get data and information directly from respondents. This step survey is important and suitable in getting the data directly from the potential user of the prototype. It is more practical, effective and also saves some time

in gaining the data and information for the prototype said (Syirazi et al., 2022). This questionnaire has two parts which are Part A, B and C. Part A is related for demographics and background of the respondents. Part B is related to the effect of using the wheelchair-bed prototype. While part C is related for opinion and suggestion improvement for that prototype.

Responses to the statements in Part B are in the form of a Likert scale by accessing the comfort, cushion quality, backrest seat operation, headrest effectiveness, weight distribution, adjustability, footrest support, ease of operational, and overall usefulness. The use of Likert scale in this survey is suitable to get information such as opinion, attitude or belief of a person or a community group towards an event. Table 1 shows that the five Likert scale response option are Strongly Disagree (SD), Disagree (D), Not Sure (NS), Agree (A), and Strongly Agree (SA).

**Table 1 The Five Likert Scale**

| **Likert Scale** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| **Feedback Option** | SD | D | NS | A | SA |

Source : Authors Data, 2025

The instrument used in this study is a questionnaire survey. There were two types of information to be gathered which are quantitative data and qualitative responses. The quantitative data were analyses using descriptive statistics include finding the average score (mean), seeing how spread out the scores were (standard deviation), and making charts to show how often different scores appeared (distribution charting). While the qualitative response was analyzed through thematic classification.

The analytical process involved several key steps. First, numerical scores were aggregated to obtain an overall view of participant evaluations. Next, patterns in the mean ratings were identified to determine consistent trends across respondents. Open-ended feedback was then thematically coded to extract recurring ideas and concerns expressed by the respondents. Finally, all results were cross-referenced with established ergonomic requirements for dialysis patients and supported by findings from previous literature to ensure validity and relevance. Even though this study happened in a controlled setting, the steps that the researchers followed are the same ones used in real-world situations. This process helps the researchers clearly understand how well the prototype works and if it is effective.

## Results

The results from the questionnaire survey analysis were distributed to 213 respondents whose background from doctors, nurses, dialysis patients, and other healthcare personnel at 29 dialysis centers in Pahang Malaysia shown in the Figure 5. Respondents were proportionally distributed, with patients forming the largest group (35%). Clinical staff (doctors + nurses) comprised 40%, ensuring the evaluation considers both professional and user perspectives.

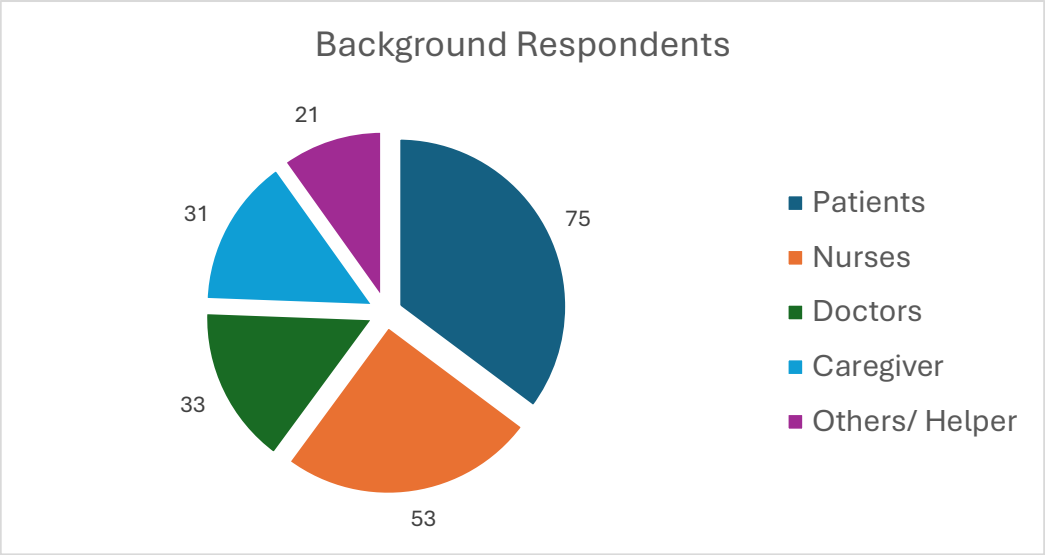


**Figure 5 Total Respondents and Their Background.**

Source : Authors Data, 2025

Across all nine items, ratings are consistently high, with means ranging from **4.14 to 4.78**, indicating a strong positive response shown in the Table 2. The results are presented directly and systematically, followed by interpretive discussion.

**Table 2 Feedback of Respondents**

| Questions | Mean |
|---|---|
| Overall Comfort of The Wheelchair-Bed. | 4.76 |
| Cushion Satisfaction of The Wheelchair-Bed. | 4.32 |
| Backrest Satisfaction of The Wheelchair-Bed. | 4.28 |
| Weight Distribution of The Wheelchair-Bed. | 4.22 |
| Headrest Comfort of The Wheelchair-Bed. | 4.14 |
| Reclining Adjustability of The Wheelchair-Bed. | 4.78 |
| Footrest Satisfaction of The Wheelchair-Bed. | 4.43 |
| Ease of the Wheelchair-bed operation. | 4.43 |
| Overall usefulness of the Wheelchair-bed. | 4.65 |

Source : Authors Data, 2025

## Discussion

The overall findings strongly confirm that the wheelchair-bed prototype successfully addresses the core needs of dialysis patients particularly in terms of comfort, adjustability, and ease of repositioning during long treatment sessions. The respondents consistently provided high ratings across all measured dimensions, demonstrating strong support for the design principles used in developing the device. There was previous research such as (Brienza et al., 2010) and (Tavares et al., 2019) said that, these results are in line with previous research highlighting the importance of ergonomic seating, pressure distribution, and adaptable support systems for individuals with limited mobility.

The caregiver responses further reinforce established evidence that ergonomic assistive technologies can significantly reduce physical workload and stress among healthcare providers, as noted in earlier studies (Rushton, 2017) and (Choi et al., 2024). The notably high operational ease score (mean = 4.43) suggests that the prototype is intuitive to use and making

it well-suited for dialysis centres where efficiency and reliability are essential. The positive reception of the reclining mechanism closely reflects advancements reported in posture-adjusting wheelchair systems (Cui et al., 2023), though unlike more technologically advanced models, this prototype prioritizes affordability and mechanical simplicity to support wider implementation.

The results also indicate several key implications such as the consistently high satisfaction ratings demonstrate that the prototype is ready for more extensive clinical testing and alignment with World Health Organisation (WHO) wheelchair provision standards WHO 2023. There were identified improvement needed such as reducing overall weight and enhancing cushion ventilation to represent feasible areas for engineering enhancement. Scientifically, this study contributes new dialysis-specific evaluation data, a topic rarely explored in existing literature, provides evidence supporting the practicality of integrated wheelchair–bed hybrid designs, and establishes a foundational dataset for future controlled field trials and further device optimization.

## Conclusion

This study provides strong and convincing preliminary evidence that the wheelchair-bed prototype is not only effective and safe but also highly beneficial for both dialysis patients and their caregivers. The consistently high scores in comfort, adjustability, and overall usability indicate that the device has significant potential for real-world application in dialysis canters, where patient stability and caregiver efficiency are critical. These positive outcomes suggest that the prototype successfully meets the practical needs observed in typical dialysis environments, offering improved posture support, enhanced mobility, and reduced physical strain during patient handling. At the same time, the findings highlight important opportunities for refinement—particularly optimizing the overall weight of the device to improve maneuverability and enhancing cushion ventilation to ensure better thermal comfort in Malaysia's warm and humid climate. As part of the development, future research should include multi-site clinical trials to validate effectiveness across diverse settings, long-term durability assessments to examine mechanical performance over extended use, and thorough compliance evaluations with ISO 7176 wheelchair standards to support regulatory approval and widespread adoption. Together, these next steps will help strengthen the device's reliability, safety profile, and suitability for integration into standard dialysis care.

## Acknowledgement

The authors thank the clinical practitioners, caregivers, and patients who provided early insights informing the prototype development especially from 29 Dialysis Centers in Pahang Malaysia. Appreciation is also extended to institutional partners supporting this prototype development such as Politeknik Melaka and Politeknik Muadzam Shah Pahang Malaysia.

## References

Brienza, D., Geyer, M. J., Kelsey, S., & Collings, J. D. (2010). A randomized clinical trial on preventing pressure ulcers: Effect of wheelchair cushions. *Archives of Physical Medicine and Rehabilitation*.

Choi, U. Y., Lee, J. S., & Park, H. Y. (2024). Reducing the burdens of paid caregivers of older adults: A scoping review of assistive technology evidence. *Geriatric Nursing*, 55, 12–20.

Cui, J., Wang, L., Tan, X., & Chen, Y. (2023). Intelligent wheelchair posture adjustment and action intention recognition. *Sensors*, 23(8), 4004.

Duchesne, G. A., Waller, J. L., Baer, S. L., Young, L., & Bollag, W. B. (2023). Pressure ulcer diagnosis is associated with increased mortality in patients with end-stage renal disease. *Life*, 13(1), 77.

ISO. (2022). *ISO 7176 series: Wheelchair standards*. International Organization for Standardization.

Lee, H. S., & Wong, T. S. (2021). Ergonomic considerations in wheelchair design for long-term clinical use. *Journal of Healthcare Engineering*, 2021, 1–10.

Lim, C. Y., & Rahman, N. A. (2022). Assistive device adoption among Malaysian dialysis patients. *Malaysian Journal of Public Health Medicine*, 22(3), 98–105.

Moorthi, R. N., Avula, V., & Kline, P. (2020). Mobility impairment in patients new to dialysis. *Kidney Medicine*, 2(3), 345–353.

Ng, S. F., Halim, N. A., & Goh, B. C. (2021). Human factors considerations in assistive seating for chronic illness. *Journal of Rehabilitation Research*, 58(2), 112–124.

Rushton, P. W. (2017). Understanding the burden experienced by caregivers of older adults who use a wheelchair. *Rehabilitation Research and Practice*, 2017, 1–9.

Sang, L., Zhang, H., & Xu, J. (2019). A novel wheelchair–stretcher assistive robot. *Applied Sciences*, 9(15), 3004.

Syirazi, M., Helmi, M., Azman, M. R. (2022). Malaysian Journal of Innovation in Engineering and Applied Social Science (MYJIEAS), Volume 2, Issue 1.

Tavares, C., Araújo, F., & Vaz, M. (2019). Wheelchair pressure ulcer prevention using FBG-based pressure sensing technology. *Sensors*, 19(10), 2311.

WHO. (2023). *WHO guidelines on wheelchair provision*. World Health Organization.

Yusof, N., & Abdullah, M. R. (2020). Assistive mobility challenges in Malaysian healthcare facilities. *Biomedical Engineering Online*, 19(1), 54.

Zhang, P., Liu, X., & Chi, Y. (2022). Pressure distribution analysis for reducing discomfort in long-duration seating. *Bioengineering*, 9(7), 314.