

Prioritizing Wheel chair as per Indian context

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Abstract. The wheelchair is one of the most ordinarily utilized portability that helps to the general population with physical impairments. The wheelchair user interface is the slightest seen yet the most basic outline calculates. A comprehension of the client's capacity and the expected utilization of the wheelchair is required so that the client's potential is boosted. The chosen contemporary venture addressed the pragmatic issues confronted by the wheelchair clients and finding the wheel seat by which the customer was fulfilled. For the present examination, the investigation of the client prerequisites was done utilizing MAUT technique. Distinctive wheelchairs were surveyed on the premise of criteria for the wheelchair. The criteria chosen were performance, comfort, durability, and repair.

1. Introduction

Disability is the condition of being unable to do the certain things as done by the normal person. In a report granted by World Health Organization (WHO) in 2011, it was evaluated that 15.3% of the total population deals with the disabilities around the world. According to the report of census 2011 in India, there are 27 million people have disability out of which 5.4 million have the disability in movement in India. The objective of the paper is to collect and analyze the data and testing the satisfaction and rating the comfort of the wheelchair users based on the extensive fact findings and research on the existing models. The selected paper will address how the design of wheelchair enabling its users to lead a more active life and to participate in as many activities as possible without affecting their health and safety.

1.1 Wheelchair

The wheelchair is one of the commonly used assistive devices for enhancing personal mobility, which is a precondition for enjoying the human rights and living in dignity. Wheelchair assists the people with disabilities to become the productive members of their communities. Wheelchairs comes in a wide variety of formats to meet the specific needs of their users. They may include specialized seating adaptations, individualized controls, and may be specific to particular activities. There are wide variety of types of wheelchair, differing by propulsion method, mechanisms of control, and technology used. For the sake of convenience Wheel Chair was categorized under the following head-

- Physically handicapped wheelchair (PHWC): It is a wheelchair designed for people with physical disabilities such as muscular dystrophy and spinal cord injury.
- Patient wheel chair (PWC): It is a wheelchair which is helpful in moving the patients from bed to the different place.
- Ultra-Light Wheel Chair (ULWC): It is a type of a manual wheel chair which weighs less than the lightweight wheel chair and have a light and lasting frame.

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- Ergonomic Wheel Chair (EWC): It is a wheelchair which are designed by keeping the ergonomics in consideration.
- Transporter Wheel Chair (TWC): It is a type of lightweight wheelchair which have small wheels and are made of lighter materials.

2. Literature Review

Several scientists and researchers are working for advancement in Wheelchair technology and options are aimed at improving access to full participation in daily activities, as well as safety during wheelchairs. While travelling over the rugged surface, the wheelchair users feel the vibration through the caster wheels. These vibrations make the users feeling tiredness and which leads to discomfort. Many researchers worked upon the design of caster wheels which will have the function to absorb the vibration. S.G. Terashima and Y. Kikawa (2007) developed the comfortable and an inexpensive caster wheels for wheelchair with the vibration absorptive function. According to Clinicians, the vibrations are more harmful for the people with SCI (spinal cord injury). The vibrations caused a condition called spasticity. Spasticity is a condition which causes uncontrolled movements. Sigrid et al. (2008) compared the Spinergy wheelchair wheels and conventional steel-spoked wheelchair wheels. Before the study, it was claimed that Spinergy wheelchair wheels will absorb 25% road shock more than the conventional steel-spoked wheelchair wheels. Wheelchair ride comfort is an important factor in improving the comfort and if the problem is not recognized, it may cause pain and deformities in spinal cord or in the pelvis. Digovine et al. (2000) tested the ride comfort of the ultra-light and lightweight manual wheelchairs. Christian (2016) focused on the use of assistive technology for better designing of the wheelchairs.

3. Result and Discussion

The collected data against for wheel chair assessment are subjected to various statistical analyses such as factor analysis and Kaiser–Meyer–Olkin (KMO) test. Factor analysis on 120 useful responses has been conducted using principal component method followed by varimax rotation via SPSS17.0. After analysis it is found that only 10 items are coming under 4 dimensions of wheel chair assessment. Percentage of total variance explained was found to be 71 %, which is an acceptable value for the principal component varimax rotated factor loading procedure. The value of alpha for each dimension is shown in Table 1. The value of KMO, which is a measure of sampling adequacy, was found to be 0.53 indicating that the factor analysis test has proceeded correctly and the sample used is adequate as the minimum acceptable value of KMO is 0.5 .Therefore, it can be concluded that the matrix did not suffer from multicollinearity or singularity. The result of Bartlett test of sphericity shows that it is highly significant (significance = 0.000) which indicates that the factor analysis processes is correct and suitable for testing multidimensionality.

4. Factors chosen for analysis

Four major decisive factors were chosen for the analysis of the wheel chair which are-

- Performance: Performance of the wheelchair helps the user to move easily and be independent.
- Comfort: Comfort is an important feature of the wheelchair which helps the user to sit in the wheelchair for longer time duration.
- Durability: Durability of the wheelchair is another feature which let the user to use the wheelchair for the long- time purpose.
- Repair: For repairing the wheelchair, the spare parts must be easily available.

The analysis of the collected data was done by using MAUT METHOD.

4.1. Maut Method

F the set of q criterion f_i ($i = 1, 2, 3, \dots, q$)

Alternative f_j (a_i) are first transferred into marginal utility contribution denoted by U_j , in order to avoid scale problems. The marginal utility scores are then aggregated with a weighted sum or addition (called additive module)

Utility Function can be written as –

$$\forall \alpha_i \in A; U(\alpha_i) = U[f_1(\alpha_i), \dots, f_q(\alpha_i)]$$

$$= \sum_{j=1}^q U_j(f_j(a_i)) \cdot w_j$$

Where $U_j(f_j) \geq 0$ is usually a non-decreasing function and w_j represents the weight of criterion f_j

$$\sum_{j=1}^q w_j = 1$$

Marginal Utility functions are such that the best alternatives (Virtual or Real) on a specific criterion has a marginal utility score of an alternative is always 0 & 1.

Maximize the criterion

$$f_j'(a_i) = 1 + \left[\frac{f_j(a_i) - \min(f_j)}{\max(f_j) - \min(f_j)} \right]$$

Minimize the criterion

$$f_j'(a_i) = 1 + \left[\frac{\min(f_j) - f_j(a_i)}{\max(f_j) - \min(f_j)} \right]$$

Marginal Utility Score

$$U_i(a_i) = \frac{\exp(f_j(a_i)^2) - 1}{1.7}$$

Table 1. Factor Analysis for Wheel Chair

Dimensions	Items	Factor1	Factor2	Factor3	Factor4	Chrobanch's Alpha
Performance	4	0.537				0.560
	14	-0.679				0.662
	25	0.575				0.567
Comfort	2		0.685			0.661
	12		0.802			0.519
Durability	3			0.608		0.535
	9			0.625		0.507
	20			0.570		0.523
Repair	7				-0.550	0.512
	22				-0.664	0.519

Table 2. Naming of Constructs

Items	Items
4	Rate your satisfaction level regarding the maneuverability of the Chair
14	Rate your satisfaction level regarding the independence that you have gained with the help of your wheelchair?
25	Rate your satisfaction level regarding the performance of your chair Outside your house?
2	Rate your satisfaction level regarding the hand, back and foot support on your wheelchair?
12	Rate your satisfaction level regarding the overall comfort of your wheelchair?

3	Rate your satisfaction level regarding the durability of the chair?
9	Rate your satisfaction level regarding the overall performance of your wheel chair?
20	Rate your satisfaction level regarding the availability of spare parts for your wheelchair
7	Parts must be available for repair
22	Easy repair must be provided.

Table 3. Normalization Table of Maut Method

PWC	49 64 49	36 64	64 64 81	64 81
PWC	64 81 64	64 81	49 64 64	81 64
ULWC	49 64 64	64 49	64 81 36	49 49
EWC	81 64 49	81 49	64 49 64	64 49
TWC	64 81 81	49 64	36 64 49	81 49

Table 4. Iteration 3 Marginal Utility

PHWC	0.015376 0.000000 0.000000	0.000000 0.001296	0.004225 0.000625 0.007744	0.000676 0.003844
PWC	0.001521 0.001600 0.002401	0.006241 0.003969	0.001089 0.000625 0.003969	0.003136 0.001156
ULWC	0.000000 0.000000 0.002401	0.006241 0.000000	0.004225 0.003025 0.000000	0.000000 0.000000
EWC	0.004624 0.000000 0.000000	0.012769 0.000000	0.004225 0.000000 0.003969	0.000676 0.000000
TWC	0.001521 0.000000 0.006084	0.0016 0.001296	0.000000 0.000625 0.000961	0.003136 0.000000

Table 5. Ranking of Wheel Chair

PHWC	PWC	ULWC	EWC	TWC
0.45	0.41	0.60 (2nd)	0.72 (1st)	0.57 (3rd)

Finally we could draw conclusion from the analysis that Ergonomic Wheel Chair (EWC) with performance rating of 0.72 is most suitable from the perspective of the customer followed by Ultra-Light Wheel chair (ULWC) with a rating of 0.60.

5. Conclusion

Many types of wheelchairs are available in India used by different kind of people. It is very essential for them for their physical activity performing in office, in daily work. Maximum wheelchairs had a seat designed to provide comfort to the majority of disabled users. Neither of the wheel chairs are designed for ultimate comfort. From the present evaluation it is found that all wheel chair users' satisfaction depends on

four factors like comfort, performance, repair and maintenance. These chairs are then checked by prioritizing the best wheelchair among them. It is found that Ergonomic chair is the best among them as per users view. So more modification on the chairs and low cost will provide best service to all of them in future.

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