INCLUSIVE DESIGN METHODS FOR THE DEVELOPMENT OF MOBILITY DESIGN SYSTEM FOR PEOPLE WITH DISABILITIES IN MALAYSIA

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

December 2023

FRSB 2023 2

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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There is a need to incorporating inclusive design methods for the development of mobility design system for people with disabilities (PWDs) in Malaysia, due to lacking on some specific areas in product development stages in cooperating with design philosophy and user study in local. In current, there are many improvements areas which can take place to improve on current wheelchair design especially among Malaysian users and its functionalities which includes its shape, seating position, appearances, safety, ergonomics and cost. Therefore, there is a potential study area to prove that present Mobility Design System (MDS) needs more attention to be systematically develop according to user needs. The aim of this study is to conceptualize Inclusive Design philosophy in product development for People with Disabilities (PWDs) in catering their daily activities. This research adopts the understanding of Inclusive Design theory with Design Development Research (DDR) to understand about user in its design research and product development stages (as in 3 different stages of development in this research). The study has been conducted into a mixed methods data collection phases which involved with interviews, observations and documentations. The data collection stages involved with pilot study activities, main field work including 10 interviews with PWDs, and 5 design expert panels for validations, together with design development process. The process of designs in this research is a process to verify the input collected from the participants during fieldwork. These design process includes the design specifications, and design guidelines to ease the development of a new product for a group of specific users. This research will contribute to the production of a novel framework for researcher, product designer as well as providing a a more understanding about PWDs for a manufacturer and product developer, also to create an opportunity for new product development knowledge. As a consequence of implementing the design process adopting inclusive design framework, the outcome of this research will also be contributing to improve the major issues experienced by PWD when using wheelchairs.

Keyword: Inclusive Design (ID), People with Disabilities (PWDs), Mobility Design System (MDS)

SDG: GOAL 3: Good Health and Well-being, GOAL 11: Sustainable Cities and Communities, GOAL 12: Responsible Consumption and Production.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KAEDAH REKA BENTUK INKLUSIF UNTUK PEMBANGUNAN SISTEM REKA BENTUK MOBILITI UNTUK ORANG KURANG UPAYA DI MALAYSIA

Oleh

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Disember 2023

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Terdapat keperluan untuk menggabungkan kaedah reka bentuk inklusif untuk pembangunan sistem rekaan mobiliti untuk orang-orng kekuraang upaya (PWDs) di Malaysia, kerana kekurangan beberapa bidang tertentu dalam peringkat pembangunan produk dalam korporat dengan falsafah rekaan dan kajian pengguna di tempat. Pada masa ini, terdapat banyak kawasan kemiskinan yang boleh berlaku untuk meningkatkan reka bentuk kerusi roda semasa terutamanya di kalangan pengguna Malaysia dan fungsi-fungsi yang termasuk bentuk, kedudukan tempat duduk, penampilan, keselamatan, ergonomi dan kos.Oleh itu, terdapat kawasan kajian yang berpotensi untuk membuktikan bahawa Sistem Reka Bentuk Mobiliti (MDS) kini memerlukan lebih banyak perhatian untuk dikembangkan secara sistematik mengikut keperluan pengguna.Tujuan kajian ini ialah untuk konseptualisasikan falsafah reka bentuk inklusif dalam pembangunan produk untuk orang-orang dengan kecacatan (PWDs) dalam menguruskan aktiviti harian mereka. Penyelidikan ini mengamalkan pemahaman teori reka bentuk inklusif dengan Penelitian Pembangunan Reka Bentuk (DDR) untuk memahami tentang pengguna dalam penyelidikan rancangan dan tahap pembangunan produk (as in 3 different stages of development in this research). Kajian ini telah dijalankan dalam fasa pengumpulan data kaedah campuran yang melibatkan wawancara, pemerhatian dan dokumentasi. Tahap pengumpulan data yang melibatkan aktiviti kajian percubaan, kerja lapangan utama termasuk 10 wawancara dengan PWDs, dan 5 panel pakar reka bentuk untuk pengesahan, bersama-sama dengan proses pembangunan rancangan. Proses reka bentuk dalam kajian ini ialah proses untuk mengesahkan input yang dikumpulkan daripada peserta semasa kerja lapangan. Proses reka bentuk ini merangkumi spesifikasi rekaan, dan panduan rekaan untuk memudahkan pembangunan produk baru untuk kumpulan pengguna tertentu. Penyelidikan ini akan menyumbang kepada pengeluaran rangka kerja baharu untuk penyelidik, pereka produk serta menyediakan pemahaman yang lebih tentang PWD untuk pengeluar dan

pengembang produk, juga untuk mewujudkan peluang untuk pengetahuan pembangunan produk baru. Sebagai akibat daripada pelaksanaan proses reka bentuk yang mengadoptasi rangka kerja rekaan inklusif, hasil penyelidikan ini juga akan menyumbang kepada meningkatkan isu-isu utama yang dialami oleh PWD apabila menggunakan kerusi roda.

Kata Kunci: Reka bentuk Inklusif, Orang Kurang Upaya (OKU), Sistem Reka bentuk Mobiliti

SDG: MATLAMAT 3: Kesihatan dan Kesejahteraan Baik, MATLAMAT 11: Petempatan dan Masyarakat Mampan, MATLAMAT 12: Penggunaan dan Pengeluaran Bertanggungjawab

ACKNOWLEDGEMENTS

Alhamdulillah, above all, thank you, Dear Allah s.w.t, for benefiting me much more than I deserve. I would like to offer my gratitude and appreciation to my major supervisor, Prof. Madya Rizal Rahman, for his ongoing patience, inspiration, and in-depth understanding of my Ph.D. study and my delighted research in this subject. Especially during Pandemic Covid 19 and endemic time, his breadth of experience, support, and encouragement have made my doctoral engagement a reality. Aside from my primary supervisor, I'd like to thank the rest of my research committee for their helpful suggestions and direction Dr. Noranita Mansor, Dr. Wan Arnidawati Wan Abdullah as well as Prof Madya Dr.Syed Shafiq (UTM) and my friend Dr. Imran bin Abdullah (Unisza), for their insightful comments and help in broadening my study from other perspectives.

I would also want to thank the Faculty of Design and Architecture at Universiti Putra Malaysia, as well as other faculty members and administrative staff, for guiding me to success.

Finally, I would like to express my heartfelt gratitude to my beloved mother, Hjh Husna binti Hj. Hussien, for her Doa and blessing, my beloved wife, Zurina Shahnaz, for always being with me in good or bad times and her Doa for my success in life, and all my children Nur Farah Nazirah, Ahmad Farhan Aqil, Nur Farzana Izzati, and Ahmad Faris Aqil for their patience and understanding Your support will always be the power to carry ahead. Same goes to all my siblings, my late father, Hj. Ariff bin Osman, and my late brothers, Dr. Muhammad Fuad bin Ariff and Ahmad Fathee bin Ariff.

This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows”

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LIST OF ABBREVIATIONS

PWDs	Person with Disabilities
IDA	Inclusive Design approach
SPSS	Statistical Package for Social Sciences
SWD	Social Welfare Department
UD	Universal Design
IDP	Inclusive Design Principle
IDE	Inclusive Design Element
MDS	Mobility Deign system
ADDIE	Analyze, Design and Develop, Evaluate (Validate)
DDR	Design Develop Research
UNDP	United Nations Development Program
WDU	World Disability Union
WHO	World Health Organization
QL	Qualitative Method
QN	Quantitative Method
MWFCD	Ministry of Women, Family and Community Development
UPM	University Putra Malaysia
JKMM	Jonatan Kebajikan Masyarakat Malaysia
DSWM	Department of Social Welfare Malaysia
DSM	Department of Standards Malaysia
ADA	American with Disabilities Act
SPSS	Statistical Package for Social Sciences
SWD	Social Welfare Department
UD	Universal Design
MDS	Motility Deign system

ADDIE	Analyse, Design and Develop, investigate and Evaluate (Validate)
DDR	Design Develop Research
UNDP	United Nations Development Program

CHAPTER 1

INTRODUCTION

1.1 Introduction

It is essential to incorporate inclusive design principles while creating a mobility design system for individuals with disabilities (PWDs) in Malaysia. This is because certain elements of product development necessitate the incorporation of design philosophy and user studies at the local level. Currently, there are several areas where improvements may be made to optimize the design of wheelchairs, specifically to meet the requirements of users in Malaysia. The criteria encompass the wheelchair's structure, seating arrangement, visual appeal, safety attributes, ergonomic design, and cost. Hence, there exists a promising research domain that aims to bolster the current Mobility Design System (MDS) by incorporating a more organized approach that aligns with user requirements.

1.2 Background of Study

According to the World Health Organization (2010), a wheelchair is the most often used assistive technology to improve personal mobility, which is essential for enjoying human rights and preserving a decent life. Wheelchairs enable those with impairments to fully engage in their communities. Approximately 650 million persons, which is nearly 10% of the global population, were found to have impairments. S. Sheldon stated that research suggests that a portion of this 10% population is in need of a wheelchair. According to estimates from 2003, around 20 million individuals who needed a wheelchair for their mobility did not possess one. There is evidence suggesting that only a small portion of individuals who require wheelchairs are able to obtain them, and of those who do, only a limited number have access to a suitable wheelchair.

In Malaysia, Individuals with Disabilities (PWDs) use the Wheelchair as a Mobility Design System (MDS). Nonetheless, as a result of widespread production, it lacks authenticity to fulfill the distinctive needs of each consumer. The current MDS (Mobility and Disability Solutions) created for people with disabilities is deemed too expensive, bulky, and unpleasant, with insufficient developments in terms of safety, functionality, aesthetics, and ergonomics. This emphasizes the importance of paying more attention and relevance to the specific qualities of the user while designing and developing MDS (Mobile Device Software). Extensive testing is required to assure its reliability and evaluate its functionality, usability, and user satisfaction. Inclusive design is the practice of making products, services, and settings accessible and usable to a wide spectrum of people, including those with disabilities or other distinguishing traits.

The goal of this project is to develop and build a Multidimensional Design System (MDS) utilizing an inclusive design approach. The design approach will be based on the Scott.E. Page (1987) model, which emphasizes individuality, an inclusive process and tools, and a broader positive impact. In addition, MDS will have the Sommer's (1983) element of inclusive design, which designed for individuals with impairments. Given that this research is focused on a specific project, the Design and Develop Research (DDR) approach is used, with the ADDIE paradigm. The research design adopted was Analyze, Design & Develop, and Evaluation.

1.3 Problem Statement

This study analyzed wheelchair users' daily struggles. People with impairments (PWDs), especially wheelchair users, usually facing several challenges. Associate Professor Sr. Ts. Dr. Noorsidi Aizuddin Bin Mat Noor (2015) found 28 million Malaysians, including disabled people. He found that Malaysians value learning disabilities over physical disabilities.

As per mentioned by researcher earlier, the PWDs did not satisfy with current wheelchair design due to it did not meeting the user needs in the area of; i. wheelchair's structure, ii. Aesthetic and ergonomic includes seating arrangement, visual appeal, iii. safety attributes, and cost which will be elaborate as below"

i.) Wheelchair's Structure

To date, most commonly of the manual wheelchair are using aluminum alloys for manual wheelchairs (6000 series and 7000 series). These alloys are preferred because of their strength-to-weight ratio, reliability in withstand the weignt of PWDs (13.6 kg) and manufacturability. Heat treatment can be carried out before use to improve performance to meet demand. The weight of a manual wheelchair varies depending on the type and frame composition. The normal manual wheelchair weighs 13.6 kg. Manual wheelchairs weigh between 13 and 20 kilograms, with lightweight models weighing 6.3 kilograms and large units weighing more than 18kg. Electric wheelchairs can weigh 22–45 kg or more. While the weight of electric wheelchairs can range from 22-45 kg or more.

In order to comply with ISO requirements for wheelchairs and scooters, the researcher must possess a comprehensive understanding of the technical details of the product. This knowledge is necessary to successfully navigate the industrialization and testing procedures outlined below:

i. ISO 7176-1: 2014 are comply to wheelchair static stability tests.

ii. ISO 7176-8: 2014 specifies wheelchair and scooter static, impact, and fatigue strength. It defines test methods for meeting requirements. It also mandates test result disclosure.

iii. ISO 7176-19: 2008 includes the power and control system standards, as well as the test processes for electric wheelchairs and scooters. It specifies safety and performance under normal conditions, as well as abuse and failure.3. so that the product can be shipped to other nations

By establishing the standard, PWDs have the choice of selection for the types of wheelchairs choose. Wheelchair difficulties must be resolved. According to Marieke GM Kloosterman (2010), wheelchairs allow impaired people to walk independently. Bad arm function, pain, insufficient arm force, restricted cardiovascular capacity, inappropriate body posture, and a harsh environment can all impede self-propelled hand-rim wheelchair mobility. A powered wheelchair, mobility scooter, or assistance may help overcome these constraints in challenging conditions.

Hence, this study demonstrates that people with disabilities (PWDs) have multiple obstacles due to the current design of wheelchairs. Multiple wheelchair design strategies and methodologies are currently accessible. However, most ideas generated by these design methods failed to consider the desires and requirements of the users. The design method's terms are detailed as follows:

ii.) Aesthetic and Ergonomic

Aesthetic and ergonomic includes seating arrangement, visual appeal. It is considered that both are related and important in wheelchair design. The ergonomic aspect of wheelchair design includes the seating arrangement, which should be designed to provide maximum comfort and support to the user. The seat should be contoured to fit the user's body shape and provide adequate support to the back, hips, and legs. The seat height should also be adjusted to ensure that the user's feet are flat on the ground and the knees are at a 90-degree angle.

On the other hand, the aesthetic aspect of wheelchair design focuses on the visual appeal of the wheelchair. The design should be visually appealing and should not look like a medical device. The wheelchair should be designed to look like a piece of furniture or a fashion accessory.

1.3.1 The Impact of Difference Design Approach

The design of wheelchairs is a complex process that involves finding a delicate balance between ensuring safety and managing costs. According to research conducted by the University of Pittsburgh, a wheelchair is able to fulfill a range of movement and postural requirements, which are frequently contradictory in nature. A wheelchair user uses a single wheelchair to engage in various activities across diverse indoor and outdoor environments.

When designing a wheelchair, it is crucial to take into account the user's weight, height, and maneuverability in order to ensure safety. The wheelchair must provide adequate support and stability to the user while being able to withstand challenging environmental conditions.

Expense is an additional factor to take into account when constructing a wheelchair. Standard wheelchairs are more cost-effective than custom-made ones, allowing customers to make their selection depending on financial constraints and intended use. Wheelchair users require additional accessories such as cushions, armrests, footrests, and safety belts to ensure both safety and comfort.

Therefore, it is imperative for the researcher to carefully evaluate and address the problems that develop in order to provide people with disabilities (PWDs) with a suitable Mobile Device System (MDS) to assist them in their everyday activities.

Other problem occurred on wheelchair.

i. **Form follows function** - This concept is a fundamental architectural philosophy that states that the design and shape of an architecture should be primarily determined by its intended function and purpose. It emphasizes the importance of connecting a structure's form with its functional requirements, ensuring that the design not only serves the needs of its users, but also represents the basic purpose.

ii. **Various Design Approach.** In the context of Systematic Design Approach, the conceptual design of modular and adaptable products, where "product" refers to any instrument, artefact, structure, electrical, power or service. (S. Ceccaccip, Luca Giraldi, M. Mengoni,2017).

iii. As for **Styling Design**, it focuses only on the outside aesthetic appearance of a product (form, color, graphic line and texture) to provides buyers with a great deal of value. (1mmarketing, 2015)

iv. Moreover, **Customized Design** is a procedure that alters the appearance or functionality of a product dedicated and relevant to the person. (Mugge, Schoormans, & Schifferstein ,2009,p.468).

v. **Research Through Design**. which is an approach to scientific inquiry that takes advantage of the unique insights gained through design practice to provide a better understanding of complex and future-oriented issues in the design field.

vi. As for **Universal Design (UD),** it is accessible to everyone, but it focuses more on how the environment is organized and what is included within the buildings. Therefore, none of these solutions are based on the user's requirements and are accessible to the majority of individuals with disabilities.

1.3.2 Designing Applicable to User's Needs

Most wheelchair designs prioritize problem-solving over local user demands. This essential issue must be addressed to improve wheelchair users' lives. Early design requires determining user demands, according to Blasco (2014). Many approaches for determining needs are documented. When users have specific requirements due to information scarcity or prototype testing, it gets more challenging. Blanco, Marco, Berbegal, and Casas (2014). Requesting inclusive design needs identification. Recently accepted "Behaviour & Information Technology" essay is 1-36.

According to Robertson, B. (2023), wheelchairs and accessories are medical equipment for mobility-impaired people. These devices are safe and practical. Stability, electrical components, body posture and repositioning, transportation, and postural support device performance affect skin tissue care and daily activities. Companies must follow ISO 14971's risk management process to ensure wheelchair testing is adequate. Product applications, user needs, and usage situations should be considered. PWDs and universal design (UD) adapt the environment to user demands. The designs ignored user demands because there was no customer involvement.

This research seeks to create a disabled Mobility Design System (MDS). To address user needs, the system will handle inclusive design issues, concepts, elements, and places. Benefits are for wheelchair-bound PWDs with various problems. Developing the MDS for wheelchair-bound people is necessary. There are many reasons to include inclusive design in all products, especially for disabled individuals. Different motives have arisen:

i.) The Designs are Merely Concerned with Style and Ornament (Styling Based) Rather Than Meeting the Requirement of the User

Jeff Patreane (2013) defines "styling" as "style" and "aesthetics." The technique stresses color, shape, and graphic typography to improve product look. Shahriman Zainal Abidin (2015) describes a stylist as a designer who improves new items' appearance using a broad design idea. While aesthetics helps us appreciate a concept, viewpoint, temperament, comprehension, sentiment, or merit in art. In contrast, the three-dimensional Inclusive Design Principle asserts the problem stemmed from the design not meeting user needs. Design components by Sommers (1983) and Scott. E. Page (1987).

Considering the importance of aesthetics in generating respect for an idea, perspective, attitude, understanding, emotion, or value. This statement challenges the three-dimensional framework of the Inclusive Design Principle, which asserts that the problem occurred due to the design's failure to meet the user's wants and preferences. The design feature suggested by Sommers (1983) and Scott. E. Page (1987).

ii.) Did Not Involve User to Get Their Opinion and Suggestion in Design

Market-driven designs dominate Malaysian product design. Users should understand how routers, modems, WiFi terminals, etc. work. Product-driven enterprises manufacture and market, according to SME Asia (2020). It thinks a great product will attract top customers and make money. Many companies sell "user-designed goods." Ken Cook (2002) claims they use user feedback to improve products. This view of Proactive Inclusive Design involves widespread engagement.

Therefore, in this study, to ensure the end outcome is not only suitable for the user but also accessible to all, industrial design experts, design engineers, and disability experts were engaged. This was done in the context of this study, using the inclusive design approach.

iii.) High Cost Instead of Low Cost (Affordable)

Cost is important for MDS design, especially for moderate PWDs who cannot afford high-end wheelchairs. The Malaysian Department of Social Welfare Malaysia (Jabatan Kebajikan Masyarakat Malaysia, or JKMM) funds disabled people to buy and receive MDSs for free in certain circumstances. This study will evaluate how MDS may reduce motorized and smart applications to lower project expenses. The system's feasibility, efficiency, utility, user-friendliness, and cost-effectiveness will be assessed. Mobility Design System encourages impaired people to live in healthy, joyful, and environmentally friendly communities. Chris Pangilinan (2018), Jean Todt (2018). Malaysia has manual, powered, and "smart" wheelchairs. Bretannica.com describes manual wheelchairs as "any sitting surface with wheels linked to it to aid in the mobility of the user." C. DiGiovine (2014). As a result, in this study, the researcher will utilize survey interview tools from the qualitative approach to acquire information on the real requirements from PWDs, and will employ the Inclusive design idea to develop an inexpensive wheelchair that is accessible to the majority of wheelchair users.

iv.) Corporate or Institution Oriented Instead of Human Oriented

Most firms are now corporate. Few compartmental decision-making methods are human-centered. Not skill, but Board of Directors approval dictates most decisions. Meeting goals and implementing strategies is corporate orientation. Though "humaneness Bott (2021) defines "the extent of an organization or society encourages and rewards a person of being fair, altruistic, friendly, generous, caring, and kind to others" a "the degree of an organization or society encourages and rewards individuals for being fair" (House et al. Thus, Goldman (1978) asserts human orientation is neither business- or institution-driven. This study's human orientation should be individual, not institutional.

v.) Instead of Redefining Client to Include Users, Redefine Client to Exclude Users

Goldman (1987) describes to this as being only the user (PWDs), rather than the owner. Since the end-user was the only one with a stake in the research, the designers need to focused on the consumer to resolve their concerns and deliver solutions within user budget. (PWDs).

vi.) Using Grassroots Design Approach Rather Than Top-Down Design Approach

According to Michelle Maiese (2013), the purpose of developing a grassroot process is to improve a local community's sense of ownership in an intervention process, empower local communities, and build a culture that promotes long-term peace which recognizes efforts to empower individuals and communities in restoring their cultural identities and autonomy. While Linh Tran, (2016), mentioned that Top-down project planning might leave the team feeling left out and unable to voice their opinions. Top-down initiatives need clear communication. Unclear specifications and expectations may lead to miscommunications and project failure. They didn't design the project; thus, they don't know the intricacies. Project managers must communicate higher management's intentions.

As a result, in this study, the "bottom-up technique" is also known as the "grassroots design process," and both titles correspond to the same notion. The researcher in charge of carrying out this study must request that an analysis of the user's requirements be carried out using the Need Analysis employing ADDIE in Design Develop Research (DDR). This request should be made once the researcher has understood Scott. E. Page's (1987) and Sommer's (1983) Inclusive Design Element (IDE) of the Inclusive Design Approach (IDA).

vii.) Being Authoritarian Instead of Democratic

Democratic in Inclusive Design refers to the ability to listen carefully and in depth to the user's opinion, views, and consensus on the difficulty they face when using a standard wheelchair to maneuver and go about their daily activities, rather than the secondary opinion of others on their problem. The Cambridge Dictionary defines authorization as demanding that others obey and refusing to grant freedom as they see fit; it entails designing without empathy for people with disabilities who struggle to use wheelchairs to carry out their daily tasks Therefore, in phase one, researcher will be using design thinking process which includes "empathy," to really understand in depth the PWDs difficulties faced using wheelchair within their daily activities.

viii.) Accepting the Way People Think about Design Instead of Trying to Change Them

Graeme Tuttle, (2021) says that “design thinking” puts the client’s needs first. It is a hands-on, iterative study of how people connect with compassion. “Human-centered” design focuses on how well it works for people, not how the designers or investors want it to work. Designers have to watch how people use a product or service and make changes based on what they see. Saying that, in the design thinking process, the user’s needs should come before the designer’s ideas about how the design should work.

Utilizing un-suitable Technology to design the wheelchair. Therefore, in this study, Goldman, (1978) suggest that the output of the design should use appropriate technology to produce the design suit to the affordability of the moderate PWDs rather than using the high technology solutions for high income affordable PWDs. Thus, in this research, the researcher will minimize the used of high technology but with a high impact and efficiency.

x.) Development Process Controlled by Corporate Interest Rather Than Alternate Development Process Models

According to Boston Consulting Group (2018), it is critical to have a corporate growth drive to address the expectations of clients when digitization and market developments occur. Changes in the labour market have an impact on others. According to Warren Buffett, the goal of corporate development is to determine a company’s future. “It’s all about gaining a competitive advantage, not just for today and tomorrow, but for the next 10 or 20 years,” he explains. Alternative models of development or redevelopment, according to Wai-fong Ting (2012), also strive to assist in the rebuilding of these communities, and the alternative paradigm is built on a bottom-up, or grass-roots-first, communication approach.

According to Aamir Shahzad (2014), communication development is distinguished by conceptual flexibility and the range of communication approaches utilized to solve the issue. According to Goldman (1987), the phrase “Use of Alternative Models of Development Process” consequently refers to a development process that is not directed by the corporation. The researchers will place a strong focus on aesthetics, comfort, and safety in this investigation.

xi.) Homogeneity (Single Need User) Rather Than Heterogeneity (Multiple Need User)

Goldman (1978) suggests that another name for heterogeneity is “multiple needs user.” According to Maximilian Siebert (2018), the term “heterogeneity” refers to the fact that not all of the data has the same characteristics. When a number of separate research are pooled together for the purpose of analysis or a meta-analysis, it is inevitable that differences will be discovered. The reverse of

heterogeneity is homogeneity, which describes a situation in which all of the research demonstrates the same result.

This study's design shouldn't be limited to people with permanent disabilities; rather, it should take into consideration people with disabilities that prevent them from having legs. That way, people who don't have legs but still needs to move around and take care of their daily responsibilities can use the wheelchair. It was highly advocated by Goldman, A. B., and Schneider (1978) that product designers make use of inclusive design techniques while they are in the process of producing goods. These techniques will only be successful if it can be shown that they are effective in the products and designs that are generated (Clarkson and Keates, 2003). By means of carrying this out in practice.

1.4 Research Method, Research Question and Research Objective

In this study, the research method, research question, and research purpose and all-important parts of the study's success using and perform the research to ensure that the study is completed methodically. The research topic is the question that tries to answer, and it serves to steer the research process by providing a clear focus for the study. The research objective is the goal that the study seeks to achieve, and it helps to ensure that the study is carried out with a clear purpose in mind. All three of these variables contribute to the research study's structure and meaning, as well as the reliability and validity of the findings. As a result, in this study, the researcher will develop the aim, research question, and research objective during the first part of the investigation. The researcher will list the research technique, research topic, and purpose as shown below:

1.4.1 Research Question

The research questions of this research study are:

i. What is the characteristic of PWDs on wheelchairs and their daily activities?

ii. What Are difficulties factors face by PWDs on moving around on wheelchair in their daily life activities?

iii. How to solve problem for PWDs to overcome their difficulties on moving around on wheelchair in their daily life activities?

1.4.2 Research Objective

i. To identify definition and characteristic of PWDs using wheelchair.

ii. To analyze difficulties factors, face by PWDs on moving around on wheelchair in their daily life activities.

iii. To propose a concept design, development and to validate a wheelchair with MDS for PWDs to overcome their difficulties on moving around on wheelchair in their daily life.

1.5 Research Scope and Limitation

This study experiment did not concentrate on leverage from ground zero since there are so few wheelchair users who must crawl and climb to use the wheelchair. As a consequence, just the user and their range will be customized, and the design will not accommodate other individuals with disabilities who use a wheelchair. This goes against the philosophy and idea of inclusive design that the researcher would be adopting.

The design is based on large number of wheelchair availability at the mall, polyclinic and hospital. (Need Analysis study). Thus, the design scope needs to be detachable for ease of transport and indoor smooth surfaces flooring used.

Due to Covid 19 situation, interview session, Expert designer interviews, PWDs respondent interview and expert validation will be taken place via online communication. As a result, some areas of detail will be unclear, such as detail view on the PWD's activities on the usage of wheelchair. The information can only be gathered through online conversation.

As a result, research study is restricted to explain only the difficulties encountered by PWDs in translating the processed need analysis data to concept design using inclusive design process and presenting to subject matter expert based on 3D Caid model, as well as the situation encountered and the output of dimension drawing for them to validate the design result.

1.6 Significance of Study

This study revealed that challenged wheelchair users are unsatisfied with the manufacturing process. The challenge emerged when the design did not meet the user's needs and requirements, and according to the Inclusive Design Principle, the three-dimensional model by Scott. E. Page, (1987) and the design element by Sommers, the design did not comply with the user's needs and requirements (1983). (affordable) It is costly to create MDS for PWDs.

Most PWDs cannot afford the existing MDS due to its high cost, design for commercial use that is not based on the user's needs and requirements, inaccessibility to most people with disabilities, and unsuitability for Malaysian PWDs users due to the fact that most local wheelchair resellers import and assemble wheelchair parts locally.

The other reason being is unresponsive design that mostly are problem-solving. They did not solve the issue, and did not use human factors and ergonomics, or bring empathy to the design process.

Most solutions are mass-production-oriented. The design are merely Concern with Styling based rather than meeting the requirement of the user therefore it will led to poor design performance, did not tackle the problem, mass manufacturing for volume production and not accessible to all PWDs. Therefore, the PWDs are force to use the wheelchair even thought it is not suitable for some of them.

Therefore, it is a need to design and develop MDS using Inclusive Design Approach (IDA) which the process will dissolve most of the major issues and difficulties faced by the PWDs using wheelchairs. By having concept design being validated by the subject matter expert, would allow the concept design outcome becoming more solid and viable through the design specification and design guidelines. The outcome of the research will be benefit to some category as below:

i.) User

Able to maneuver with affordable mobility design system with inclusive design concept to get equal access in education within the campus area by themselves, able to access the public utility independently with minor assistant. With this the individuals will feel more independent in managing their daily life.

ii.) Industrial Designer

The knowledge gained from PWDS using wheelchair characteristic inclusive design framework and design specification (guidelines) of designing the PWDs with wheelchair mobility design system will be the reference and guidance for other designers to continue their studies in this area.

iii.) For Public Awareness

The implementation of inclusive design concepts inside the community-towards PWDs-based products would raise public awareness, such as mobility design systems for PWDs using wheelchairs, a distinct group of individuals who also have the right to improve their everyday lives.

By raising public knowledge of community services, there will be more inclusive design-based products that can cater to persons other than PWDs

iv.) For Manufacturer

Manufacturing will gain opportunities as a benchmark to create a new range of inclusive design-based products for people with disabilities (PWDs), generating a new opportunity for another group of people, whether old or PWDs with various types of impairments. Benefits of the research

In this research, based on the fact listed above, the researcher, here is some contribution that can be gain from this research.

i. An improvised MDS version based on design and develop research (DDR) using Inclusive Design. Currently MDS was designed using systematic and engineering approach (Zol Design,2016) other design using customized design (A.F,2018). Basically, other design used problem solving design approach (Engineering approach).

ii. This potential Inclusive Design research-based product (MDS) can be commercialized after undergoing standard procedure process.

iii. The introduction of more research-based product will benefit the producer and the user in terms of quality authentic customer based product.

iv. This Inclusive Design research-based product (MDS) contribute literature review for another researcher, Industrial designer and producer.

v. Innovative concept such as" add on features concept", "hybrid concept", "insightful concept" and "solution base not problem base "which was used in this research will benefit another researcher and industrial designer.

vi. The instrument design for need analysis and expert evaluation form which were develop can be benefited for another researcher.

vii. Rich authentic reliable feedback from the user and expert evaluation can be the basis for future researcher and industrial designer.

1.7 Summary of Chapter 1

This chapter addressed the subject of the existing Mobility Design System (MDS) utilized by People with Disabilities (PWDs), including the statement of problem, study purpose and question, scope and limitation, and research contribution. The current MDS design is based on problem solving (Engineering Design and Systematic Design Approach). There have been attempts to incorporate humanistic elements such as empathy (Design Thinking Approach) and environmental elements (Universal Design Approach), but they are still not

based on the user's needs. Inclusive Design Approach (IDA) design to meet the demands of the user (PWDs). IDA are based on three domains (Scott .E. Page, 1987), seven principles of inclusive design, and an inclusive design element (Sommer, 1983).

This two-phase DDR study employed the ADDIE model. In phase one, Need Analysis was undertaken utilizing an interview procedure to establish the characteristics and classification of PWDs, as well as their difficulties in using MDS. The data was analyzed with NVIVO to acquire the theme and sub-theme of their challenges, as well as suggestions for improving the MDS's features. In phase two, the data acquired will be used to design and create the actual MDS. Experts will evaluate the concept drawing in terms of utility, ergonomics, comfort, and safety. The advantages of the research were also explored.

The final phase, validation, involves using 3D CAID models to duplicate the scenario on the completed theme based on the cad drawing with dimensions. The data will be verified by a subject matter expert. The validation technique will yield final inclusive design guidelines based on the researcher's approach and framework.

1.8 Thesis Organization

The thesis is organized into six chapters that lead to the objectives of this research. The description of each chapter is as follows:

Chapter 1 An introduction to the study's background. As a result, the thesis' problem statement is elaborated, followed by the research significance and objectives. The research scope is set to ensure that the research is carried out with clarity.

Chapter 2 To provide a complete literature review of previous and recent research works on diverse research methodologies, orientations, and technology trends. The chapter concludes with a critical summary of the reviewed documents about the issue.

Chapter 3 This research study's research method are described in detail using Design Develop Research (DDR). The overview methodology used is illustrated in a flow chart for design research methods. Settings, parameters, and conditions are described, illustrated, and tabulated, whenever relevant, for the first and second phases of method and instrument use, survey questionnaire process, survey interview handling process, qualitative analysis tools used in both phases, outcome of data formulating guidelines and produce conceptual inclusive design on mobility design system for PWDs using wheelchair, and validation tests conducted by the subject matter expert, result and validation tests conducted by the subject matter expert, result and summary.

Chapter 4- To describe the data collection outcome and analysis process for both the first phase of need analysis data collection and the second phase of expert evaluation survey questionnaire utilising a Likert scale, both qualitative approaches were used. The results of the analysis will be given in order to test the hypothesis while also answering the research question.

Chapter 5 discusses the process of generating inclusive design concept through the design guidelines and design specification derives from the output of data analysis. Results of the inclusive design concept will then be validated by subject matter expert. the subject matter expert will then be interview by the researcher. Again, the data will be analyzed using nvivo.to be transcribe to coding and formulating outcome. As for the survey questionnaire, it will also be issued to the subject matter expert in the form of Likert scale and analyses it in the form of chart and graph.

Based on both data gathered, after testing the hypothesis and answering research question, the research will the summarized and refine.

Chapter 6 concludes and recommendation the work of this thesis and presents potential opportunities for future research work on wheelchair accessories in view of learned knowledge

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