



A USER-CENTERED APPROACH: EVALUATION OF A UNIVERSAL PORTABLE GRAB BAR

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Abstract

A considerable portion of the world's population is made up of people with disabilities, which leads to difficulties in carrying out activities of daily living. In addition to these difficulties, there is also the risk of accidents due to falls in the case of people with physical disabilities. One example is the transfer of wheelchair users and the elderly, especially in the context of the bathroom, in the toilet. For this reason, this study aimed to evaluate a universal portable grab bar through a user-centered approach, using two volunteer users as a sample: the first, a 61-year-old woman with mobility problems due to falls, and the second, a 60-year-old man with motor disabilities and a motorized wheelchair user. A real-world observation of the use of the product was carried out with the participants, including video recordings, timing and information collected through a questionnaire. Regarding the evaluation, it was observed that the portable grab bar presented functionality problems, identified in the failure of the fixation, and its functionality was only possible through the insertion of two adapted plastic locks. Among the usability problems, the following stand out: the instruction manual is in English, the lack of identification of the materials on which the bar can be used, and the lack of information regarding the average fixation time of the product. The study's major contribution was to evaluate an Assistive Technology product for people with disabilities.

Keywords: People with Disabilities; Usability; Assistive Technology.

1. INTRODUCTION

A considerable portion of the world's population has some disability, and Brazil is no different. According to the 2010 Demographic Census, approximately 46 million Brazilians, about 23.9% of the population, declared to have some degree of difficulty in at least one of the skills investigated (seeing, hearing, walking or climbing steps), or to have mental/intellectual disabilities. (BRASIL, 2012; IBGE, 2019).

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In the elderly population, with the decline in physical, cognitive and emotional capacity, a series of difficulties are observed, including motor coordination, often due to arthritis that requires care and changes (BATISTA; WIBELINGER, 2011; SALES, 2002), which interfere in daily activities.

People with Disabilities (PwD) need special care, and it is important to consider this group in the various aspects of health. (ARAUJO; FERNANDES, 2020; PASSINATO, 2021). Therefore, it is essential to take actions to mitigate this risk, such as care with the hygiene of devices for the execution of Activities of Daily Living (ADL), whether of low or high complexity.

Activities of Daily Living are basic self-care tasks, which include feeding, going to the bathroom, choosing clothes, grooming and taking care of personal hygiene, dressing, bathing, walking, and transferring (SBGG, 2021). When one is a PwD, some activities become risky in terms of safety from injuries and fractures, especially those performed in wet environments, which can result in accidents (DUCA; SILVA; HALLAL, 2009; CASTRO *et al.*, 2016).

Neto et al (2018) verified the main risk factors at home related to falls, one of the most recurrent being slippery or unprotected bathrooms. The need to design well-planned products for fall protection in slippery environments is understood, since it becomes necessary to meet the needs of these people. It is known that People with Disabilities (PwD), specifically physical disabilities, have a high risk of falling (SAVERINO; MORIARTY; PLYFORD, 2014).

Chen et al. (2011) conducted a study with 95 participants in which 87% of wheelchair users reported at least one accidental touch, that is, hitting objects or falls in the last three years. Xiang et al. (2006) in their studies found that there are 100,000 wheelchair accidents every year in the USA in a hospital environment, and 65 to 80% of the accidents are due to falls of users.

According to Brechtelsbauer and Louie (1999), elderly wheelchair users tend to suffer more accidents related to the transfer, whether it is carried out to the wheelchair or out of the wheelchair, with an increase in the mortality rate, decreased mobility and consequent impairment of quality of life.

In her study, Tsai (2020) reported that 61.8% of wheelchair accidents that cause fractures happen when transferred out of the wheelchair. The author identified that this drop occurs in the domestic environment (44%) and 71% are female. The environment built in conditions of accessibility makes the physically disabled obtain greater autonomy in their wandering, consequently in their activities.



In Brazil, NBR 9050:2020 establishes criteria and parameters for built environments, regarding accessibility conditions. Among the elements that enable accessibility are the grab bars, which are necessary to ensure the use of toilets, bathrooms and changing rooms, safely and autonomously by People with Disabilities (NBR 9050, 2020).

The grab bars in toilets, showers and changing rooms are fixed to the wall and floor, as the standard establishes, however, this is not the case when it comes to private and domestic environments. There are few domestic places where there is the installation of fixed bars, which makes it difficult for people with disabilities to occupy these spaces. With the proposal to enable accessibility in places where there is none, the universal portable grab bar emerges. Because it is portable, the user can take it when traveling, when visiting someone or even when renting a property for a period of time and it is not possible to modify it permanently. In the context of the COVID⁶-19 pandemic, there was a 20% increase in sales of products such as: grab bars, alarms for bathrooms, impact plates, among others (OVALE, 2020).

An important aspect of any assistive device is the user user experience, which can be provided with the proper implementation of usability principles. Shields (2004) argues that approximately 70% of the elderly wheelchair users studied need assistance in basic self-care activities, especially in relation to bathing, toileting and clothing.

Based on studies by different authors such as: Xiang (2006), Chen (2011), Brechtelsbauer and Louie (1999) and Tsai (2020), with a view to falls of PwDs. This research aims to evaluate the use of a universal portable grab bar. The evaluation of the product was carried out by two people with disabilities, through a predefined task, and a subsequent questionnaire of the 10 Principles of Usability proposed by Jordan (1998).

2. METHOD

An applied study was carried out with a qualitative approach, in relation to its objectives, it is classified as exploratory and descriptive. From the point of view of technical procedures, a data survey was carried out with users (SILVA; MENEZES, 2005; GIL, 2008).

The methodology was divided into two phases, the first of a **Theoretical nature**, where a research of the main themes for theoretical support was carried out and the second practical phase with an **Applied Research** (Figure 1).

⁶ COVID-19 is a disease caused by the coronavirus, called SARS-CoV-2, which has high transmissibility and a clinical spectrum ranging from asymptomatic infections to severe conditions (BRASIL, 2021).



Figure 1. Divided methodology of the Study. Source: Prepared by the authors (2021).

The Reference Blocks: **Product, User and Context** (MERINO, 2016) were used to organize the information collected, since they enable the definition of techniques and tools to be used during the development of the study.

2.1. Product Use Procedure

The **product** for the evaluation was chosen because it is commercial and allows it to be fixed on different surfaces, without suffering deformations with its use. In relation to the **Context**, it was defined that the tasks would be carried out in bathrooms, one residential and the other public, both located in the city of Caxias do Sul (RS).

Initially, the ICF and TCUIV were read and signed, according to the instructions of the Resolution of the National Health Council (CNS) No. 466 (BRASIL, 2013). Then, photographic records of the context were made and with the help of the *Kinovea* software, the anthropometric measurements of the users were investigated.

Next, the activity script was described (Figure 2) and users were asked to perform the first two tasks only once, and the last four tasks five consecutive times with an interval of 5 seconds:



Figure 2. Activity Roadmap.

Source: Prepared by the authors (2021).

After the completion of the tasks, questionnaires related to the usability of the Product were applied, containing 10 questions (one question for each principle) related to the 10



principles of Usability (Jordan, 1998), with answer options on a Likert Scale, according to the degree of agreement or disagreement on the question, selecting a point on a scale with five gradations, being: totally satisfied, partially satisfied, neutral, partially dissatisfied, totally dissatisfied (Figure 3).

MODELO DO QUESTIONÁRIO		
Princípios	Questões	Resposta (Escala Likert)
CONVENIÊNCIA	O produto apresenta conveniência, pois, quando fixado, não se movimenta nem vibra.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
DOMINABILIDADE	O produto é controlável para funções e operações previstas no projeto.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
USABILIDADE	O produto oferece ao usuário a possibilidade de usar o produto.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
INFORMAÇÃO / INSTRUÇÃO	O produto oferece informações necessárias durante o uso.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
PREVENÇÃO DE ERROS	O produto previne erros que possam causar danos ao usuário ou ao produto.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
CONTROLE DE USUÁRIO	O usuário tem controle sobre o produto e suas funções.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
CLAREZA E SIMPL	O produto apresenta informações visuais de fácil compreensão e uso.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
PRODUTIVIDADE / EFICIÊNCIA E INFORMAÇÃO	O produto oferece informações claras e precisas sobre o produto e suas funções.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
TRANSPARÊNCIA / ADEQUAÇÃO DE TECNOLOGIA	O produto é transparente em relação à tecnologia utilizada.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>
ERGONOMIA	A forma do produto contribui para o conforto de uso.	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>

ESCALA:

5 - Totalmente Satisfeito (Verde)

4 - Parcialmente Satisfeito (Verde Claro)

3 - Neutro (Amarelo)

2 - Parcialmente Dissatisfeito (Vermelho Claro)

1 - Totalmente Dissatisfeito (Vermelho Escuro)

Figure 3. Questionnaires regarding the usability of the Product.

Source: Prepared by the authors (2021), adapted from Jordan (1998).

The data were organized in a 2019 Excel spreadsheet and the average time in the use of the portable bar by the two users was identified. The activity was timed with the help of an Anytime digital handheld stopwatch, in order to mark the interval between the tasks and evaluate the execution time of getting up five times from the toilet and checking the durability time of the product's fixation on the different surfaces of the bathrooms, the 8mm thick tempered glass and the ceramics. Finally, Design Requirements were proposed, divided into the reference blocks of Product User and Context, taking as reference the analysis of the results of the users' evaluation.

3. MATERIALS AND EQUIPMENT

In this study, several materials and equipment were used, Figure 4 presents a temporal diagram of the activities.

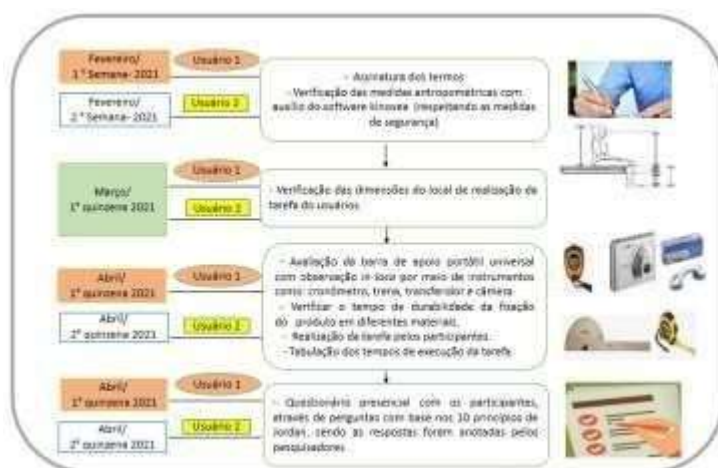


Figure 4. Temporal Diagram of Activities. Source: Prepared by the authors (2021).

4. PHASE 1 – THEORETICAL (THEORETICAL SUPPORT)

In the first stage, we sought to understand the current scenario of Persons with Disabilities (PwD), Assistive Technology, Usability.

4.1. Persons with Disabilities (PwD)

The term Person with Disabilities (PwD) was advocated in June 1994 by the Salamanca Declaration and Line of Action, during the World Conference on Special Educational Needs: Access and Quality (UNESCO, 1994). In the *International classification of functioning** (ICF), *disability and health*, disability was defined as a limitation in a functional domain that arises from the interaction between a person's particular ability and environmental and personal factors (WHO, 2001).

On December 2, 2004, through Decree 5,296, the federal government categorized the types of disability into five, as follows: (i) physical disability: complete or partial alteration of one or more segments of the human body, resulting in impairment of physical function; (ii) hearing impairment: bilateral, partial or total loss of forty-one decibels (dB) or more, measured by audiogram at the frequencies of 500Hz, 1,000Hz, 2,000Hz and 3,000Hz; (iii) visual impairment: blindness, low vision, cases in which the sum of the visual field measurement in both eyes is equal to or less than 60° or the simultaneous occurrence of any of the above conditions; (iv) mental disability: intellectual functioning significantly below average, with manifestation before the age of eighteen and limitations associated with two or more areas of adaptive skills; (v) multiple disability - association of two or more disabilities. In addition, the decree considers People with Reduced Mobility to be all those who do not fit into the previous



types, and who have, for any reason, difficulty in moving, permanent or temporary, generating an effective reduction in mobility, flexibility, motor coordination and perception (BRASIL, 2004).

According to the survey carried out by the Brazilian Institute of Geography and Statistics (IBGE), in the 2010 demographic census, approximately 46 million people living in Brazil declared to have some disability (23.9%), being classified as: visual, auditory, motor and mental or intellectual. In this scenario, of the 23.9%, it was detected that approximately 7% have motor disabilities, in different degrees of difficulty, and of these 2.33% were severely affected. In the South of the country (Santa Catarina, Paraná and Rio Grande do Sul), it is estimated that 22.51% of the population has some disability and that of these, 7.11% are related to motor disability (BRASIL, 2012; IBGE, 2019).

The World Health Organization (WHO) in June 2011 launched the World Report on Disability, which recognizes disability as the result of the interaction between people with disabilities and behavioral and environmental barriers that prevent their full and effective participation in society in an equal way. In addition, the report proposes recommendations for policies and programmes at national and international levels, through measures to improve the quality of accessibility and equal opportunities, promote participation and inclusion, and increase respect for the autonomy and dignity of PWDs (WHO, 2011).

In the Brazilian scenario, the Brazilian Law for the Inclusion of Persons with Disabilities / Statute of Persons with Disabilities (Law No. 13,146/2015) came into force on July 6, 2015, with the objective of ensuring and promoting, under equal conditions, the exercise of fundamental rights and freedoms by PwD, aiming at their social inclusion, and considered PwD all those who have **long-term impediments**, whether of a **physical**, mental, intellectual or sensory nature, which, in interaction with one or more barriers, may obstruct their full and effective participation in society on an equal basis with other people. The second chapter of the law presents that every PwD has the right to equal opportunities with other people and that they will not suffer any kind of discrimination, and that it is the duty of the State, societies and the family to ensure, as a priority, the realization of the rights related to life, paternity or maternity, health, rehabilitation, to scientific and technological advances (BRASIL, 2015).

4.2. Assistive Technology (AT)

The WHO (2001) understands Assistive Technology (AT) as any product, instrument, equipment or technology adapted or specially designed to improve the functioning of a PwD



(WHO, 2001). The legislation (Law 108-364-OCT. 25, 2004) of the United States of America (USA) defines TA as any item, piece of equipment, or system of commercially purchased off-the-shelf, modified, or customized product that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities.

The Technical Aids Committee (CAT) was established by Decree No. 5,296/2004 within the scope of the Special Secretariat for Human Rights of the Presidency of the Republic, with the perspective of simultaneously improving, providing transparency and legitimacy to the development of Assistive Technology in Brazil (BRASIL, 2004). AT is understood as an area of knowledge, with an interdisciplinary characteristic, which encompasses products, resources, methodologies, strategies, practices and services that aim to promote the functionality, related to activity and participation, of people with disabilities, disabilities or reduced mobility, aiming at their autonomy, independence, quality of life and social inclusion (CAT, 2009, p.9).

Bersch (2009) defined AT as the application of knowledge at the service of solving functional problems for people with disabilities, and which proposes to break the external barriers that prevent the performance and participation of people with some type of limitation. For Prestes (2011), AT is used to define an enormous diversity of resources and services for PwDs and these users need specialized services from different areas to facilitate their inclusion in the most varied social activities. According to Law No. 13,146/2015, AT was defined as any and all products, equipment, devices, resources, methodologies, strategies, practices and services that aim to promote functionality, related to the activity and participation of people with disabilities or reduced mobility, with a view to their autonomy, independence, quality of life and social inclusion (BRASIL, 2015). The *European Parliamentary Research Service* (EPRS) reports that ATs are designed to improve the functional capabilities of PwDs, some relatively low-tech, such as reading glasses, crutches, and hearing aids, and others more advanced, using cutting-edge science and technology (NIERLING, 2018).

Regarding the types of AT, the ISO 9.999:2011 Standard establishes terminologies and a classification of assistive products for people with disabilities, divided into three decreasing levels: class, subclass, and detail.

The Ministry of Finance, Science, Technology and Innovation and the National Secretariat of Human Rights of the Presidency of the Republic, in the publication of Interministerial Ordinance No. 362, of October 24, 2012, in the first annex, referring to the categories of AT that do not require a recommendation from a health professional, divided them into 12 Macro Areas, together with a description, and the Code, resource (goods and services)



and description of the resource, being: (i) **aids for daily living and practical life**; (ii) Augmentative and Alternative Communication (AAC); (iii) computer accessibility features; (iv) Environmental control systems; (v) architectural projects for accessibility; (vi) orthoses and prostheses; (vii) postural adequacy; (viii) mobility aids; (ix) aids for the qualification of visual ability and resources that expand information to people with low vision or blind; (x) aids for the expansion of hearing ability and for autonomy in communication for people with hearing loss, deafness and deaf-blindness; (xi) adaptations to vehicles; and, (xii) sports and leisure (BRASIL, 2012).

In relation to the first category in the area of aid for daily living and practical life, holders for household utensils, clothes designed to facilitate putting on and taking off, buttons, velcro, transfer resources and support bars stand out (BERSCH, 2017). The bar is considered a product that aims to provide safety to people, especially in bathrooms in general, being made of aluminum with epoxy paint and that must support more than 150kg, with a secure fixation (NBR9050:2020).

4.3. Usability

According to ISO 9241-11 (1998), usability is defined as the ability of a product to be used by specific users to achieve specific objectives effectively, efficiently, and satisfactorily in a specific context of use.

It is known that design seeks to understand people's needs, with the objective of designing and adapting products to their needs, providing more comfort during use (MORAES, MONT'ALVÃO, 2010). Iida (2005) describes that the comfort of a product must be extremely analyzed during the development of a project so that it best meets the needs of the user, without and with some type of limitation.

According to Jordan (1998), the analysis of how complex a real task is when it is performed happens with the number of steps needed to complete it: the fewer steps, the more simplified the task. Task analysis can be used to develop predictions about: ease of performing a given task; difficulty in performing a certain task; and, degree of effort required to reach the end of the task.

In this sense, Jordan (1998) proposed **10 usability principles**, which designers/engineers can take as references in product development to obtain more satisfactory results, these principles are shown in Figure 5.

USABILIDADE - JORDAN (2008)					
	PRINCÍPIO	JUSTIFICATIVA		PRINCÍPIO	JUSTIFICATIVA
01	CONSISTÊNCIA	Significa que tarefas similares devem ser executadas de maneira similar.	06	CONTROLE DO USUÁRIO	Os usuários devem ter o máximo de controle pessoal sobre as interações que têm com o produto.
02	COMPATIBILIDADE	A maneira como o produto computacional funciona deve corresponder à expectativa do usuário criada a partir das experiências vividas.	07	CLAREZA VISUAL	A informação deve ser apresentada de maneira que possa ser lida de forma rápida e fácil, sem causar confusão.
03	CAPACIDADE	O usuário possui determinadas capacidades para cada função que devem ser respeitadas. É importante que ao usar um produto, não tenha suas capacidades superadas ou ignoradas.	08	REDAÇÃO DA FUNÇÃO, MADEIRA E INFORMAÇÃO	Produtos com grande variedade de funções devem estar organizados para evitar que algumas funções se percam ou se tornem confusas. A informação deve ser acessível e de fácil compreensão.
04	RETRO-ALIMENTAÇÃO (FEEDBACK)	É importante que as interfaces dos produtos retornem aos usuários informações sobre o resultado de qualquer ação por eles tomada.	09	TRANSPARÊNCIA ADOQUISTA DE TECNOLOGIA	A associação de tecnologia deve ser usada para criar áreas que possam potencialmente trazer benefícios aos usuários e não apenas consequências e problemas de forma a manter a atualidade do produto.
05	PREVENÇÃO DE ERROS	Os produtos devem ser projetados de forma que a possibilidade de ocorrência de erros seja minimizada e que o usuário possa corrigir os eventuais erros de forma rápida e fácil.	10	EFETIVIDADE	A solução final do produto deve indicar claramente a sua função e o modo de interação.

Figure 5. Ten principles of usability.

Source: Prepared by the authors, adapted from Jordan (1998).

This bibliographic research enables an understanding of the concept of people with disabilities. From the analysis of the user's limitations, it is possible to identify which specific Assistive Technology product will contribute to its better usability. The possibility of evaluating the product, with a view to usability, allows for improvements and corrections, so the principles of Jordan (1998) corroborate this.

5. PHASE 2 – PRACTICE (APPLIED RESEARCH)

For the evaluation of the **product** (Figure 6), the portable support bar of the 2MED brand was used, as it is widely used and has a low purchase price, approximately R\$ 60.00. The bar in question is predominantly materialized in PVC (Polyvinyl Chloride) material, has two suction cups (A), being responsible for fixing the portable bar, has a mass of 284 g, and a dimension of 290 mm x 80 mm, two stainless steel springs (B) and rubber pins (C). It also has two locks for the operation of the suction cups and its structure is built in parts: upper (E) and lower (F).



Figure 6. Portable Support Bar.

Source: Adapted from YSL Moments (2021).



Two **Users** who are PwDs were considered, User I was a 61-year-old female with osteoporosis problems and difficulty in locomotion due to falls, and User II was a 60-year-old male User II who had a motor disability and was a user of a motorized wheelchair (Figure 7). In relation to the second user, it is known that he became disabled at the age of two due to infantile paralysis, which caused limitation of the development of the lower limbs, resulting in the non-articulation of the limbs, always keeping them straight.



Figure 7. Users and their anthropometric measurements.

Source: Prepared by the authors (2021).

Using the *Kinovea* software, it was possible to extract anthropometric measurements, as shown in Table 1, (without the need for physical contact, as the collection period coincided with the COVID-19 Pandemic), with the reference measurements highlighted in yellow in the previous figure. The height declared by user I was 156 cm, while user II could not inform how tall he was.

Table 1. Anthropometric measurements of users.

Item	User I	User II	Pcs.
Height	154,37	143,78	Cm
Hand Size	16	15,50	Cm
Arm Size	25,68	34,42	Cm
Forearm Size	25,72	22,17	Cm



Leg Size	78,40	64,69	Cm
Dough	60,00	46,00	Kg

Source: Prepared by the authors (2021).

The width dimensions dimensioned with a 70 and 156 cm tape measure were taken as a reference in the use of *the Kinovea* software at the evaluation sites. A dimensional discrepancy was observed between the two locations, while user I performed in a space with a size of the toilet bowl of 70 x 139 cm, user II used it in a space with dimensions of 156 x 160 cm, it is highlighted that the bathroom floor shown in Figure 8a is built in white porcelain tile and has a lower rate of moisture absorption, allowing a less slippery floor.



Figure 8. Home bathroom of User 1 (8a) and public bathroom used by User 2 (8b).

Source: Prepared by the authors (2021).

In relation to the second bathroom (Figure 8b), it was identified that its slate floor is slippery when wet, together with the absence of fixed support bars, which can cause inconvenience to users. It was found that the dimensional of the toilet bowl location is in accordance with NBR 9050, allowing diagonal, perpendicular and lateral transfer. The washbasin was inserted on the lower right side of figure 5b, it is located at a height of 85 cm and a length of 35 cm, exceeding the height of 80 cm recommended by the NBR9050 standard.

Based on this information, in addition to the data obtained through the Theoretical Support (Phase 1), and considering the instructions suggested by Merino (2016), in which he says that a DCU project should start from the Reference Blocks (PUC), these were defined as follows:



- Product - Universal Portable Grab Bar;
- User - People with Physical Disabilities;
- Context - Bathrooms, specifically in the use of the toilet.

From the definition of the Reference Blocks, an on-site test was carried out with users, with the purpose of collecting the largest possible and relevant data for the development of the project, considering the real needs of the User, in accordance with the reality of the product, the context in which it will be inserted, and consistent with the findings of the literature.

6. EXECUTION OF TASKS

After reading the consent forms (ICF and TCUIV) and the description of the tasks to be performed, User I began the activity by checking the instruction manual contained in the box print, where the necessary amount of information for the use of the main functions of the product was observed. Next, it cleaned the product and the surface on which it was fixed, then positioned the product on the surface, and then fixed it by positioning the locks in the diagonal position, a position of greater comfort and safety.

The Product was positioned on the right side of User I at a height of 75 cm and 45° of inclination, and fixed to the surface of the shower glass for a period of 40 minutes. An attempt was made to fix it on the left side, but the portable bar did not fix to the MDF of the bathroom sink cabinet. In addition, due to the distance between the toilet bowl and the front wall, it was not possible to fix the bar on the wall, since the User had a short reach.

After carrying out the surveys, the User used both hands, unfastened the suction cups of the product, removing the locks. At first, the User did not realize that in order to unfasten effectively, the spare end of the suction cup must be pulled, because depending on the surface there is a higher level of fixation (Figure 9).



Figure 9. User Evaluation I. Source: Prepared by the authors (2021).



User II started by checking the instruction manual printed on the product box, where it was observed that there was less adequate and necessary information for the correct use of the product. Subsequently, it cleaned the product and the surface on which it was attached.

He used his dominant hand (right) and tried to position the bar on the right side of the toilet, but was unsuccessful, because the bar did not fix on the bathroom partition, made of granite stone. In a new attempt, it was possible to fix the bar on the bathroom ceramic for approximately 16 minutes, during which time the reach of his arm in relation to the bar fixed in front of him was observed, he used his right hand for five consecutive times, with a spinal movement of approximately 60° , verifying the effective fixation of the bar. Based on the user's experience, a maximum reach distance of 60 cm was dimensioned, at which the portable bar could be fixed in front of it, as illustrated in Figure 10.



Figure 10. User Assessment II. Source: Prepared by the authors (2021).

User 2 identified that he did not have sufficient balance and reliability, due to the absence of part of the lower limbs at the time of transition from the wheelchair to the toilet, making the use of this product unfeasible, so it was not possible to perform the lifting test sitting on the toilet. It was found that the unfastening of the product occurred easily, after the removal of the external locks allocated by the authors.

7. TASK EVALUATION

To evaluate the Usability of the portable bar, the Structured Questionnaire technique was used, based on the Jordan (1998) questionnaire. To answer the questions, the User chose an option from the Likert Scale, according to the degree of agreement or disagreement on the question, choosing a point on a scale with five gradations, as follows: totally satisfied, partially satisfied, neutral, partially dissatisfied and totally dissatisfied. Then with the justification for each of the ten principles of the questionnaire. Figure 11 shows the answers chosen by the users, as well as a brief description of the reported justification.

Id.	PRINCÍPIO	USUÁRIO 01		USUÁRIO 02	
		Resposta	Justificativa	Resposta	Justificativa
01	CONSISTÊNCIA	Concordo Parcialmente	A utilização do Produto é similar ao uso de produtos similares, mas seu dimensionamento possui diferenças.	Concordo Totalmente	As expectativas do usuário foram satisfeitas.
02	COMPATIBILIDADE	Discordo Parcialmente	A utilização de itens externos que não estão previstos no produto, causou insegurança em relação ao uso do Produto.	Discordo Parcialmente	Não se sentiu seguro em relação às bases dos membros.
03	CAPACIDADE	Concordo Totalmente	Fornece de forma completa com as necessidades do Produto.	Concordo Totalmente	Falta em equilíbrio do usuário na utilização do produto simultaneamente com o sistema de rodas.
04	RETRO ALIMENTAÇÃO	Concordo Parcialmente	Não há interrogações relativas à interação dos membros do Produto.	Concordo Parcialmente	Não há dificuldades de armazenamento no armazenamento do produto.
05	PREVENÇÃO DE ERROS	Discordo Parcialmente	Não possibilidade de erro de fixação em superfícies parcialmente aderentes.	Discordo Parcialmente	Não há um feedback de transição das membros.
06	CONTROLE DO USUÁRIO	Concordo Parcialmente	Certo ao manuseio do Produto, deve-se utilizar sempre as duas mãos para sua manipulação.	Concordo Parcialmente	As mãos podem perder o equilíbrio quando o produto se deslocando no período.
07	CLAREZA VISUAL	Concordo Parcialmente	O idioma utilizado (inglês) no manual de instalação impossibilita a sua leitura.	Concordo Parcialmente	O idioma utilizado (inglês) no manual de instalação, impossibilita a sua leitura, e resulta na falta de uso na primeira tentativa.
08	PRIORIZAÇÃO DA FUNCIONALIDADE E INFORMAÇÃO	Concordo Parcialmente	O Produto é de fácil uso após seu entendimento.	Concordo Totalmente	Falta de fixação correta através de travas aderentes.
09	TRANSFERÊNCIA ADEQUADA DE TECNOLOGIA	Concordo Totalmente	A utilização do sistema de sucção em produtos similares, com maior desenvolvimento, pode facilitar as A/Ds.	Concordo Parcialmente	Utilização de peças aderentes.
10	EVIDÊNCIA	Concordo Totalmente	Atualmente, não se entende o objetivo funcional do Produto.	Concordo Totalmente	Necessidade de verificação de qual se percebe o produto está fixado.

Figure 11. Questionnaire 10 Principles of Jordan- Users.

Source: Prepared by the authors (2021).

The answers showed that the first considered two principles unsatisfactory, because they did not meet the needs of use, namely: Compatibility (02) and Error Prevention (05). Five principles partially met: Consistency (01), Feedback (04), User control (06), Prioritization of functionality and information (08) and Evidence (10). In relation to those that meet the needs, three principles were identified: Capacity (03), Visual clarity (07) and Adequate technology transfer (09).

In relation to the second User, the result showed that three principles do not meet the needs of use, namely: Compatibility (02), Error Prevention (05) and Visual Clarity (07). Six principles partially met: Capacity (03), Feedback (04), User control (06), Prioritization of functionality and information (08), Adequate technology transfer (09) and Evidence (10). In relation to those that meet the needs, only one principle was identified, being Consistency (01).

The responses of non-attendance reported in relation to compatibility and error prevention show that expectations regarding the operation of the product were low, due to the fixing time and the obligation to insert locks. The manual written in English impaired the understanding of the product and this influenced the safety in the use of the product, as it did not provide visual feedback to verify the fixation.

The problem that stood out, as it was perceived by both, was the apparent lack of security. In this regard, User I reported that "there is a possibility of errors in fixing on partially adherent surfaces" and User II that "he did not feel safe in relation to the suction cup locks". To reduce this problem, some modifications have been proposed, such as: emitting a light or sound



signal to identify when it is fixed to the surface and demonstrating with visual and tactile resources, when the vacuum of the suction cup is detaching.

In the evaluation of the two, 6 principles were classified as "partially meets". For User II, one of these was capacity, as there was a lack of balance in the use of the product, simultaneously with the wheelchair. According to NBR 9050:2020, in order to make it possible to use grab bars by wheelchair users, it is necessary to install two bars on the side wall, one positioned horizontally and one vertically, in addition to a horizontal bar on the back wall, thus ensuring more safety for use. The User pointed out the lack of information on the usefulness of the product, especially at the time of installation and uninstallation.

The users proposed some modifications to the product, such as the use of a single suction cup actuation system, having a greater visual highlight at the activation site, the use of a light and sound signal to identify when the product is correctly fixed to the surface and is contained in a package with information in Portuguese, explaining the form of installation, use and uninstallation.

Finally, based on the results of the evaluations and justifications, a list of Design Requirements (Figure 12) was elaborated, divided into the Reference Blocks (Product, User and Context), which will serve as a basis for future similar projects.

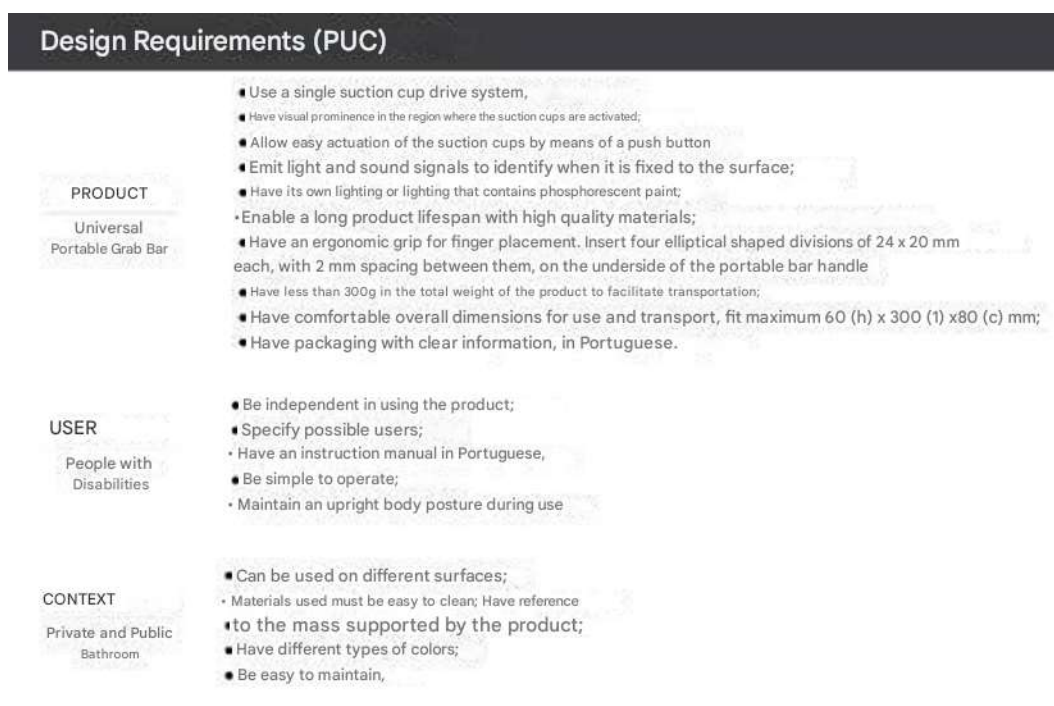


Figure 12. Product Design Requirements, User and Context.



Source: Prepared by the authors (2021).

8. CONCLUSION

The study focused on the use of the portable grab bar, specifically during the task of sitting and getting up from the toilet. Through the usability evaluation, it was possible to identify that insecurity in use was a problem perceived by both users and that, in addition, the product has barriers in its usability, due to lack of clarity on how to use it correctly.

From the activity performed by the two users, it was observed that both of them were inexperienced with the product, emphasizing the importance of Jordan's principles in helping the users evaluate the product. It can be observed that, although the product is intended to provide greater safety to users, they reported situations in which the product did not meet their expectations, causing a possible non-use.

In the available literature, there are no studies focused on the portable grab bar, only with the fixed models, so it was not possible to have a critical comparison with previous studies. This fact highlights the importance of the scientific contribution of this work, which evaluated and proposed improvements for an Assistive Technology with great potential for use that, until then, had not been evaluated with a user-centered methodology.

This study presented the results of a usability evaluation of a portable grab bar, with improvement proposals divided into three blocks. It is intended in future articles to present a product model with the modifications pointed out in the results, with the objective of meeting most of Jordan's principles in a new evaluation of users.

Due to the pandemic period in which this study was carried out, there was no possibility to carry out the usability test with more users, which would consequently help researchers to see more patterns in the responses. In any case, the participation of two users with very different characteristics and also in different contexts, made it possible to have greater security in the scope of the evaluation.

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