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PRODUCT ENGINEERING: DEVELOPMENT OF A STAND-UP PADDLE BOARD FOR WHICH CUSTOMERS, A LOOK AT ACCESSIBILITY

Pedro Paulo Dantas da Silva

Centro Universitário Jorge Amado,
Graduation Student in Production
Engineering

Carina Santos Silveira

Orientadora - Centro Universitário Jorge
Amado, Master in Engineering - Email:

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Abstract: The practice of sports for the disabled represents the application of rehabilitation philosophy and principles at the highest level. The *Stand-Up Paddle* it is one of the most complete sports and provides a variety of benefits both for individuals in general and for people with some type of physical disability. Thus, the objective of this study is to present the benefits that the use of the board adapted from *Stand-Up Paddle* can provide individuals with neurological injuries with motor sequelae, through the development of an adapted product, under anthropometric and task performance conditions, which enables the inclusion of the aforementioned in water sports, in addition to helping them in the process of recovery and rescue of senses, optimizing their respective treatments. The development of this board optimizes the participation of people with disabilities in that sport, reducing risks, improving performance, restoring self-esteem and providing collective reintegration through a product designed and adapted exclusively for people with some type of disability, respecting and dialoguing with their respective specificities.

INTRODUCTION

Relying on the advent of technology and its apparatus, the product engineer has the function of creating, transforming and improving any product in addition to keeping it in operation. Thinking about human need and customer satisfaction, product engineering aims at developing products in order to meet ergonomic, visual and functional aspects in a safe and quality way. According to Chiavenato (2005), product development is the area that takes care of all studies and research on creation, adaptation, improvements and improvement of products produced by the company. Thanks to product development, innovations arise: pioneering products, partial or total modifications to

existing ones, new features and technologies, different components, etc.

To build a product, you need to know what to do, who to do it for, when to do it, what to do it with and how to do it. According to Rozenfeld (2005), the development of a new product occurs through a business process, the PDP - Product Development Process, which starts from the identification of a market need later transformed into a new product. For this to happen, it is first necessary to translate the market need, technological possibilities and limitations, into project specifications for a product and its production process. With the increasingly competitive market, companies are being forced to become flexible with regard to production, acting more strategically in carrying out surveys of factors that may sound like imminent opportunities and threats imposed by the external environment.

This means creating differences between your product and those of competitors. It is not necessary to introduce radical differences, if only because most companies will not be willing to take risks by paying for such radical differences. It is necessary, however, to introduce differences that consumers can understand. And that requires practicing creativity at all stages of product development, from identifying an opportunity to engineering production. (BAXTER, 2000, p. 26).

Also thinking about social welfare, product engineering is concerned with developing products to serve a certain group, which is the disabled, aiming at minimizing secondary deficiencies, the integration of the individual together with society and the adherence of a special public in the market, also covering a series of benefits that the integration to the sport will provide in the aid to the recovery of the senses. However, serving people with physical disabilities entails a high cost for production, therefore products intended for this public are considered inaccessible,

in addition to the existence of numerous obstacles that people with disabilities are constantly subjected to, they restrict the physical and your mobility.

In order to develop specific products for this public, there is the definition of adaptation given by NBR 9050, which says that it is the space, building, furniture, urban equipment or element whose original characteristics were later changed to be accessible.

Accessibility is the possibility and condition of reach, perception and understanding for the safe and autonomous use of spaces, furniture, urban equipment, buildings, transport, information and communication, including its systems and technologies, as well as other services and facilities open to the public, public, for public or private use for collective use, both in urban and rural areas, by people with disabilities or reduced mobility. (NBR, 9050).

According to the Brazilian Institute of Geography and Statistics (IBGE, 2010) “studies indicate that currently around 45 million Brazilians have some type of disability”. Faced with the need to develop a more accessible product (in order to reach the aforementioned public - which is undeniably significant - by building their loyalty), the indispensability of serving them arises, respecting their demands and specificities that are emerging, adhering to an inclusive discourse that seeks equity through the adaptation of a product, responding to the desires of a market that is always on the move. With the aim of promoting accessibility to the practice of sports, this project aims to develop a product capable of enabling the wheelchair user to practice *Stand Up Paddle*, which is a form of surfing with the help of a paddle.

METHODOLOGY

In the methodological process of developing new products, it is necessary to plan, through techniques and methods, what the objective

is to do, to whom it is intended and how it will be executed. The responsibility of the designer or project team extends throughout the process, from the establishment of project specifications to detailed instructions for manufacture, use, disposal or deactivation, in addition to paying special attention to safety and the environment.

The methodology, according to Hugo Lagranha (1996), is a specialized activity of a technical-scientific, creative and artistic nature, with a view to the conception and development of projects of objects and visual messages that systematically equate ergonomic, technological, economic, social, cultural and aesthetic, which concretely meet human needs.

Munari (1998) reports that “the design method is a series of necessary operations, arranged in a logical order, with the objective of achieving the best result with the least effort”.

The systemic development of products, associated with process technology, will allow for the reduction in the use of material and energy inputs, the optimization of production and the prediction of ways to dispose of the product at the end of its useful life. Such factors punctuate the power to synthesize the vision of the productive chain and the global conception of the product, which involves from strategic and productive aspects, to technological aspects. New products are goods or services that differ significantly in their characteristics or intended uses from products previously produced by the company. For the definition of new products, the famous systemic development must be considered, as well as the identification of the needs of customers, users, consumers and entrepreneurs, transforming all the data collected in the research into attributes for these products, whether they are: appearance, shape, function, material, packaging, label,

color, flavor, aroma, brand, image and services (after-sales and warranty). These attributes must be linked to innovation.

Thus, this article will adopt the methodology proposed by Rozenfeld (2006). According to the model proposed by Rozenfeld (2006), the PDP (product development process) can be divided into 3 macrophases: Pre-Development, Development and Post-Development; where such macrophases are subdivided into phases and activities, as illustrated in figure 1.

The author suggests that the three macrophases be subdivided into activities: informational design, conceptual design, detailed design, preparation for production and product launch. Among the existing activities in the proposed design methodology, activities from the conceptual design to the detailed design will be covered (table 1).

Phases	Activities
Information project	Product Problem Definition Briefing Survey and Analysis of Manufacturing Tasks Analysis of Similar Products Design Requirements and Constraints Definition of Product Specifications
Conceptual project	Detail of the subsystems
Detailed project	Product Configuration

Table 1– Product development stages

SOURCE: Author himself, 2016.

The informational design phase aims to define all the necessary information for the product under development to be able to meet the needs and expectations of customers, informing the specifications known as target specifications that it must present. Then, in the conceptual project, the product conception is outlined, presenting the existing alternatives for the solution of the problems to be avoided; subsequently, the selection of the best suggested proposals is made, which must meet the pre-established criteria, exposing in

this case an abstract conception of the product. Finally, it is the turn of the detailed project, where all the specifications that the product must present are exposed and then sent to the production itself. In this step, the final layout of the product is configured. Environmental factors actively participate in the development of any product, assigning limits to wear and tear to nature. According to Manzini and Vezzoli (2002), sustainability refers to the use of natural resources without exceeding their regeneration capacity, always allowing their renewal to happen naturally.

PRODUCT DEVELOPMENT

INFORMATION PROJECT

After defining the product, it is necessary to proceed to the informational project phase, where the necessary information will be defined so that the product meets the needs of consumers. The activities carried out in this phase will be dealt with later.

DEFINITION OF THE PRODUCT PROBLEM

Spinal cord injured people, due to their limited conditions, have several altered motor functions that lead them to a sedentary lifestyle, sport has been considered a unique resource in rehabilitation programs for the physically disabled, as it allows the individual to use their abilities and learn skills that will contribute to their performance in favor of their rehabilitation potential. Sport also collaborates in the prevention of secondary disorders and in the social, physical and psychological rehabilitation of people with disabilities.

The problem found in the definition of the product is characterized due to the fact that people who use wheelchairs, to enjoy the *Stand-Up Paddle* sport, need some adaptations that make their physical integrity

and the good for personal use vulnerable, thus culminating in the urgency of improving the existing product so that it can offer security and efficiency to potential users. The current systems and procedures used to practice the sport expose some negative aspects, mainly in its production/installation for wheelchair users. Figure 2 then elucidates the main problems observed.

The practice illustrated in Figure 2 is extremely harmful for wheelchair users, as it puts their physical integrity at risk, after all, that board was not designed to serve a wheelchair, which is made of sharp material and can slide on it at any time; it also doesn't offer any stability to the practitioner; demand from the disabled person a greater effort in handling the oar, after all he will be at an inadequate height and in an unfavorable position for the movement and dynamics necessary to use it; the wheelchair and its composing material will be compromised in the medium term by being in contact with sea water; in addition to the imminent risk of an accident and, in this case, the individual would be exposed to greater risks, since the wheelchair could injure him and/or even result in a second injury, all these factors compromise the performance of the wheelchair practitioner. modality.



Figure 2 – Wheelchair user improvises the chair for personal use on a board.

Source: www.cantinhodoscadeirantes.com.br (2016).

When analyzing the *Stand-Up Paddle* boards, it was possible to identify that in

the improvised fixation with the wheelchair several problems stand out where the use in this improvised way does not provide safety, mobility and comfort to the wheelchair user. With this, it is necessary to avoid such problems from proposed solutions to produce a new product. Thus, the following Needs are listed:

- Need for a chair designed for the board;
- Eliminate or minimize the possibility of the board tipping over;
- Appropriate dimensions for wheelchair users;
- Stability of the board at sea;
- Safety for SUP practitioners;
- Use of equipment that prevents the use of a wheelchair for daily use, preventing wear and tear;
- Appropriate aesthetics for conventional Stand Up Paddle boards;
- Reduction of physical effort required for paddling.

ANALYSIS OF SIMILAR PRODUCTS

After evaluating the task, it is necessary to analyze similar products in order to suggest proposals that can be used in the future. In order to commit the least number of failures to the adapted board, several products can be mentioned. Similar boards, illustrated below, were analyzed.

Among the similar products presented, the EPS board can be highlighted, considering that it is very functional. Boards made of EPS block (styrofoam) are the significant majority on the market today.

They are cutting-edge materials that reflect on the quality and price of the board. Recently the trend, also among imported boards, is the use of vacuum lamination, which gives a better

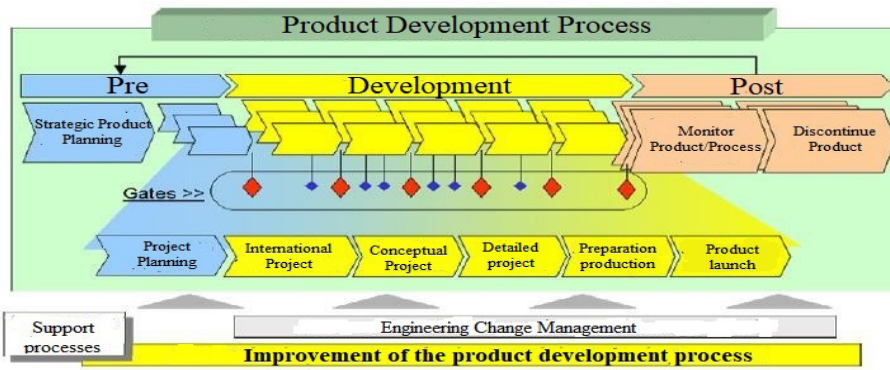


Figure 1 – Overview of the PDP model, according to ROZENFELD.

Source: ROZENFELD, Henrique et al, 2006, p. 44.

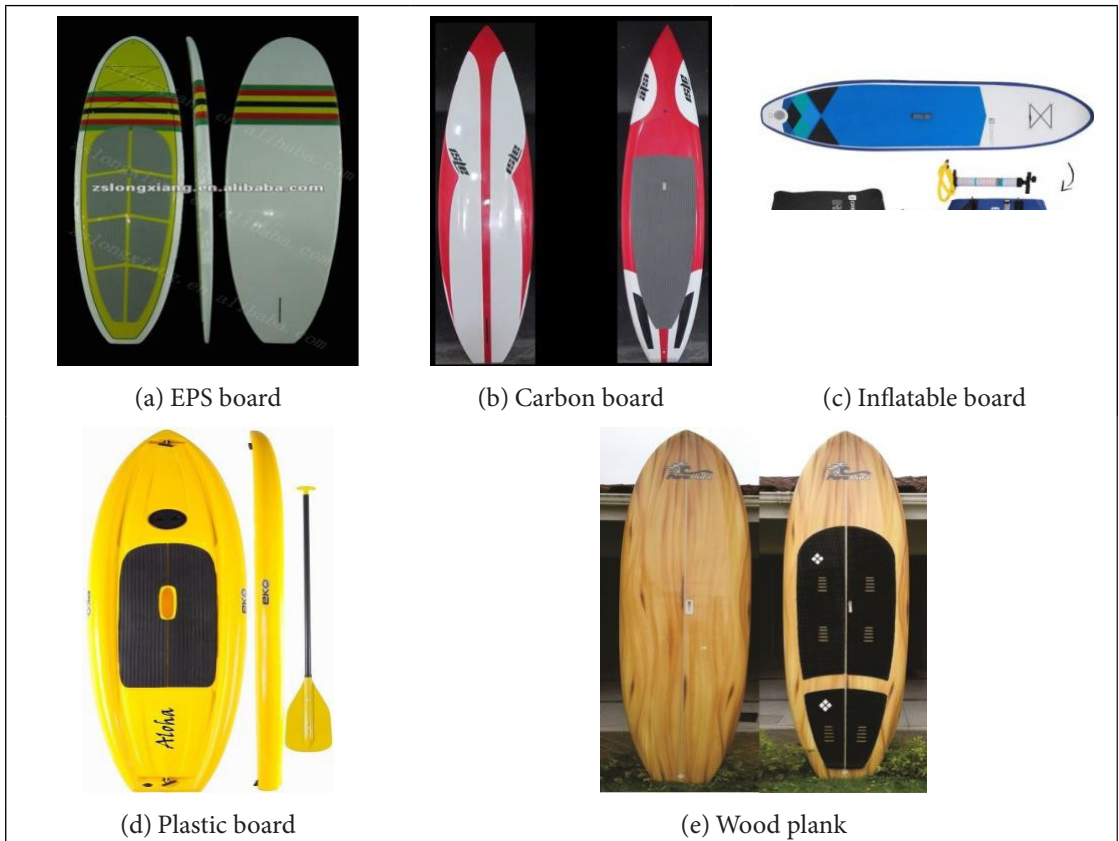


Figure 3 – Analysis of similar products.

Source: The author, 2016.

NEEDS	PROJECT CONCEPT
Need for a chair designed for the board	Install attachment points between the chair and the board
Eliminate or minimize the possibility of the board tipping over	Install movable lateral stabilizers for the board
Wheelchair-friendly dimensions	Meet the anthropometric dimensions of wheelchair users
Surfboard stability at sea	Adaptation of a special paddle for wheelchair users
Safety for the <i>Stand-Up Paddle</i> participant	Meet the anthropometric dimensions of wheelchair users to ensure the stability and safety of the user
Use of equipment that avoids handling the wheelchair on a daily basis, saving wear and tear	Avoid the provisional installation of wheelchairs on the boards and apply suitable material - resistant to sea air, in the production of the board
Appropriate aesthetics for conventional <i>Stand Up Paddle</i> boards	Avoid the provisional installation of wheelchairs on the planks
Reduction of physical effort required for paddling	Application of anthropometric dimensions of wheelchair users and adaptation of rowing

Table 4 - Needs X Design Concept

Source: Author himself, 2016.

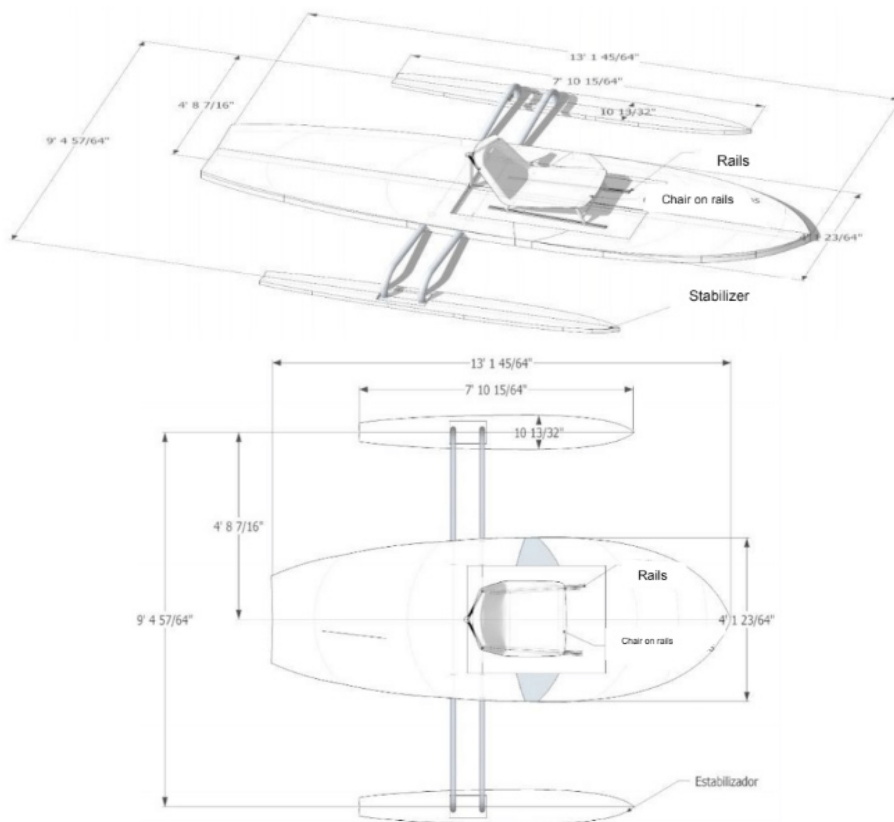


Figure 9 - Adapted surfboard sketch, top side view

Source: The author, 2016.

finish and greater resistance to the board. It is important that the board has a breather valve – this is a piece that allows the EPS block to “breathe”, reducing the effects of heat on it.

ANTHROPOMETRIC STUDY

For the adapted board to be effective, it must present some fundamental characteristics, which will offer quality and usefulness to the product, making it essential. This way, there are the requirements and restrictions that must be taken into consideration, when designing the product. According to Almeida (2006), the description of design requirements and constraints must take into consideration, several items that the product must meet, such as technical, usability and ergonomic requirements.

It is worth mentioning that the product to be produced has dimensions compatible with the ergonomic needs of a wheelchair user, since it will not be necessary to change the chairs, but only adjust them to the body measurements of each user. As for the dimensional requirement, anthropometric data must be taken into consideration, in order to maintain adequate dimensions of the chair *versus* the board and, consequently, the movement of the wheelchair user.

According to the IBDD (Brazilian Institute for the Rights of Persons with Disabilities), the use of a wheelchair imposes limits on the execution of tasks by making it difficult to approach objects and reach elements above and below the radius of action of a seated person. The difficulty in front and lateral displacement of the trunk suggests the use of a comfort range between 0.80m and 1.00m for activities that require continuous manipulation, as shown in figure 4. The shape of the board must be such that it is visually pleasing, without being influenced in the assembly and disassembly of the accessories. The fitting of the accessories on the board

must have a high seal, preventing infiltration, in addition, the way of coupling the parts must be easy, practical and safe, avoiding future risks and facilitating maintenance.

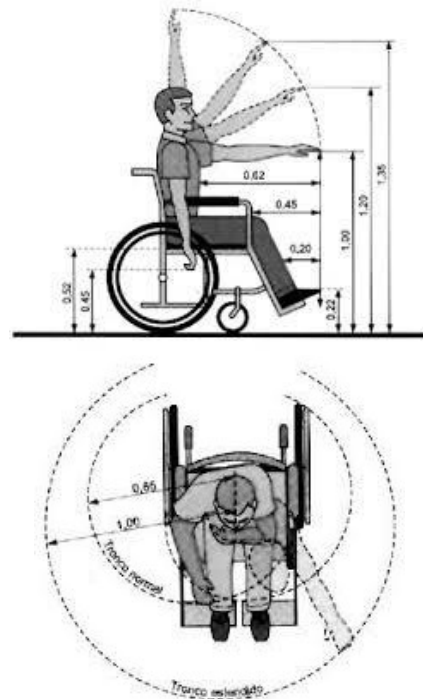


Figure 4 – Anthropometric data of the wheelchair user

Source: <http://www.ibdd.org.br/arquivos/acessibilidade.pdf> (2002).

In addition to anthropometric issues, product dimensions can be interfered by material selection and suitability to board standards for SUP practice. Bearing in mind that the wheelchair user intends to make the most of the adapted board, it is necessary that the board be produced with a material that provides the minimum necessary safety and comfort. With regard to design restrictions - technical characteristics, it is essential to highlight the material with which the product will be manufactured. According to Lima (2006), some aspects must be analyzed in order to help in the selection of the most appropriate material, which are distributed in five groups: operation, use, manufacturing/marketing, ecology, norms and legislation.

Thus, it is suggested the use of an expanded polystyrene - EPS, as it is, in addition to being resistant, an environmentally possible element to be recycled, being able to meet the design requirements. Vacuum coating is indicated, which will provide even more resistance to impacts and infiltration. The seat attachment points for the wheelchair user must also have a perfect seal.

The dimensions of the boards currently used and suitable for SUP practitioners were surveyed, and the product under development must be produced in compliance with such sizes, in order to make it possible to use it properly.

CONCEPTUAL PROJECT

In order to define the final specification of the product, it is essential to detail the subsystems, that is, to analyze all the parts that will compose the product under development. In the case of the production of a board for wheelchair users, the existing subsystems are: board, chair, stabilizer and paddle.

The board will have its dimensions altered to accommodate a chair suitable for the disabled, in its center there will be fixing points with aluminum plates - suitable material for being stainless, light, low cost, therefore accessible - in addition there will also be movable stabilizers on the sides of the board. board in order to offer the user of the new board the certainty of greater stability, thus avoiding the risk of the board tipping over with the wheelchair user. In the center there will be an EPS chair, with an adjustable seat to adjust to users, taking into consideration, different weights and circumferences (chart 4).

With regard to the oar, having as a parameter its conventional length - whether it is adjustable or fixed - which has a minimum height of 1.70 m and its material is usually common or coated aluminum. Based on studies carried out at guard points and leasing

of boards commonly called keeping room, in Salvador, height incompatibility for wheelchair users is identified with regard to ergonomic aspects. The new rowing measure must not exceed 1.30m, whether it is adjustable or not, and it is recommended that its composition be made of balsa wood, as it is a lightweight, resistant material with a low and viable cost benefit.

Figure 8 shows a balsa wood oar, which has a very special aesthetic aspect, in addition to being lightweight and resident. These oars are made of glued wood blocks and receive a resin treatment to make them waterproof.



Figure 8 – Adapted balsa wood oar
Source: <http://remo-stand-up.com.br> (2016).

The rower illustrated in figure 8, according to ergonomic considerations, is considered ideal for wheelchair users, and has specifications as shown in the table below. The measure established for the adapted rowing was concluded through studies with people who row seated, where its size (1.30m) can be adjustable or not.

SIZE	1.30 m (meters)
HANDLE	In “T”
WOOD	Ferry
FINISHING	Fiberglass and PU varnish

Table 3– Wheelchair accessible rowing specifications

Source: Author himself, 2016.

DETAILED PROJECT

After selecting the best alternative

generated for each subsystem, it was possible to draw up a sketch, helping to visualize the final configuration of the product to be developed. Figure 9 shows the outline of the proposed adapted *Stand Up Paddle* board, built based on the best alternatives for each subsystem and measurements.

FINAL CONSIDERATIONS

It is known that the life of a disabled person is full of difficulties in terms of logistics, the routine itself is already made up of a series of obstacles that they need to face in order to obtain a minimum of quality of life and dynamism due to symptomatic unpreparedness and negligence. of a society that does not have an inclusive and plural character. Accessibility is an emerging need that has been gaining strength and repercussions in recent decades, however, the absence of public policies and remedial measures in instances that apply to their daily lives is notorious. When this is cut to the reality of sports, the picture worsens, in sports these obstacles are potentiated and, to the detriment of this, access and permanence of people with disabilities in sports are rare. Currently, if a wheelchair user wants to practice *Stand Up Paddle*, it will be necessary

to attach his wheelchair to the board so that it is attached to it using improvised ropes.

When it comes to adapted or included products, it is possible to observe several existing projects, due to the high demand for these products, we are already living in a moment of rise and debate of the needs of previously neglected minorities, in addition to the fact that the product developed affects minimally or does not significantly affect the environment in a negative way and benefits an audience that until recently the market did not contemplate.

The work presented recommends that, a posteriori, the project be perfected and materialized for the commercialization of the product that could serve as a mechanism of assistance to the public in a wheelchair, as a subsidy for gearing and moving a specific market, also providing utility to local keeping rooms in the city of Salvador in the short term., but the objective is also to expand to capitals and coastal cities that are home to the practice of *Stand Up Paddle* with the conventional board, the opportunity to join an inclusive and accessible market through the acquisition of the adapted product, increasing its range of reachable public.

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