26th International Congress of Mechanical Engineering
Associação Brasileira de Engenharia e Ciências Mecânicas
November 22-26, 2021, Virtual Congress, Brazil

COB-2021-XXXX
MERGING THE JOB-TO-BE-DONE THEORY WITH TRADITIONAL PRODUCT DEVELOPMENT PROCESS: AN APPLICATION TO MOTORCYCLE'S ACCESSORY DESIGN
26th COBEM

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Abstract. *The motorcycle market in Brazil, especially in the Trail segment, has shown above-average growth compared to the general fleet. However, there is still a low variety of accessories that fulfil the users' needs and expectations. The opportunity to help designers in developing accessories focused on users' needs through the adaptation of traditional product development approach was identified. This work proposes the merge of recent user-centered theories and design tools with traditional product design, and presents an application on the design of a multifunctional device for transporting and storing objects on motorcycles. The Jobs To Be Done (JTBD) was selected and used as the theory to support the user-centered design concepts. In this development, tools such as the Value Proposition Canvas and Brainwriting are applied to support the identification of the consumer profile and the proposal of solutions, based on data collected by surveys. Related and merged with the mentioned theory, the PRODIP model was selected and applied as the traditional product design process, particularly the preliminary design, also known as embodiment design phase, due to the technical support for the development of products, in other words, the discretization of the device in subsystems and details of its components; the geometric modeling of the solution; the design by structural analysis; and critical analysis of the solution with application of improvements. As a result of the systematic approach proposed, a product was obtained with a greater focus on the needs of users, with different changes and functionalities in comparison with the other options available on the market. It is understood that there is a positive impact on the result of the project by merging other methods to the traditional product development process in order to add different approaches and design tools according to the objectives of each scope.*

Keywords: *Accessories for motorcycles. Jobs To Be Done. Value Proposition Canvas. Brainwriting. PRODIP.*

1. INTRODUCTION

The motorcycle market in Brazil has been expanding significantly in recent years, as shown by data from the National Federation of Automotive Vehicle Distribution (FENABRAVE, DATA). In 2018, the sales of motorcycles in the national territory showed an expansion of 10.5%, compared to the previous year, followed by an increase of 15% in 2019, compared to 2018. (FENABRAVE, 2018; 2019). Also, the studies carried out by Abraciclo (DATA) indicate that within this motorcycle market, the Trail segment (identified as motorcycles with a vocation for mixed use on paved and off-road terrain) is the second most significant in Brazil, representing a portion around 20% of the total models sold (ABRACICLO, DATA). However, there is still a low supply of national accessories that adequately meet the needs of these users. Among these accessories, the most used is the trunk (or case), a container for storing and transporting objects on the motorcycle. Most examples of cases available on the market are divided into two patterns: more accessible options, but extremely simple, with low security and reliability; and high-cost options, with better construction quality, but also limited to the basic functions of a compartment, not justifying its market value.

In view of the growing demand for motorcycles in the Trail segment in Brazil (and consequently for related accessories), the opportunity to develop a product for the storage and transport of objects on motorcycles was identified, focusing on the needs of users, aiming to serve them with more effectiveness than current options. The goal of this work is to develop an object storage and transport device for use on motorcycles (OSTDM) in the Trail segment, according to Integrated Product Development Process (PRODIP) methodology, and user-centered design concepts, by applying the theory of Jobs to Be Done.

Created by Anthony W. Ulwick, Jobs to Be Done (JTBD) is a theory for developing user-oriented products and services by defining the work they want to do. Thus, the JTBD theory is based on two facts: The first is that the consumer purchases a product or service with the purpose of performing a "work"; and the second is the market's greater receptivity to new products and services that do the job better and/or do so at a lower cost. (ULWICK, 2018). According to Ulwick (2018): "While Job to Be Done is the theory, Outcome Drive Innovation (ODI) is the process that puts it into practice".

(Adapted from ULWICK, 2018). ODI is a process for designing strategy and innovation whose objective is to support companies to conceptualize and develop new solutions that make JTBD better and/or cheaper. ODI promotes the relationship between a company's value-creating activities and user-defined performance metrics related to the work they want to do. On this application of ODI, some user centered design tools were used on the solution proposition stages. These tools are the Value Proposition Canvas (VPC), and Brainwriting. The VPC is a tool to support the generation of value proposition for products and services, which allows establishing clear and direct relationships between two dimensions of analysis: The user profile (composed by user's information of Jobs, Pains and Gains) and the value map (composed by solution's information of Gain Creators, Pain relievers, and Products and Services). (OSTERWALDER et al., 2015)

Once all the fields are determined, the tool allows establishing a direct relationship between the parts of the two sides of the VPC, that is, relating the Gain Creators with the Gains, Relievers with the Pains and Products and Services with the User's Work. In this work, the CPV tool will be used to support the determination of the main attributes of the product so that it meets the gains expected by the user and reduces or eliminates their pain while performing the work (JTBD). According to Schroer, Kain and Lindemann (2010), Brainwriting, or 635 method, was created by Professor Bernd Rohrbach in 1969 based on the creativity tool already known as brainstorming. It is a progressive method where ideas are generated under the inspiration of external ideas through a sequence of discrete steps that are repeated. In this work, the Brainwriting method will be used in an adapted way to support the creative steps of solutions for the attributes and functionalities that the product should have to meet the user's JTBD.

The ODI supports the gathering, organization and processing of input information from the users, of similar solutions available on the market, and partially supports the development of a conceptual solution. The PRODIP, in its turn, is a methodology for product development which presents three macro phases. In the first macro-phase, Planning, the project plan is defined following the guidelines of the Project Management Institute (PMI). The second macro-phase is Design, in which the product's technical solution and its manufacturing plan are developed, through informational, conceptual, preliminary and detailed design stages. Implementation is the third macro-phase where the product is produced, made available to the market, and validated the project. (BACK et al., 2008). The figure 1 presents PRODIP flowchart. It is important to state that the preliminary design phase regards the solution embodiment in terms of layout, dimensions, optimization and specifications, which will comprise the final product solution before the manufacturability evaluation performed in the detailed design stage.

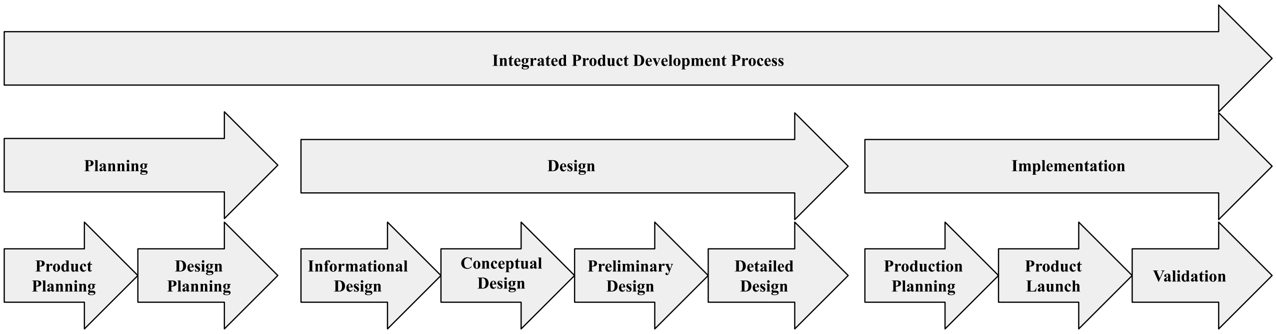


Figure 1. Prodip flowchart (adapted from Nedip).

2. Systematical use of JTBD in PDP

The flowchart presented on Figure 2 regards the proposed activities necessary to merge the use of the JTBD theory with traditional product development process. Through the execution of the activities, data will be gathered, organized and refined to contribute to the development of products with better fit and alignment with users' needs and expectations.

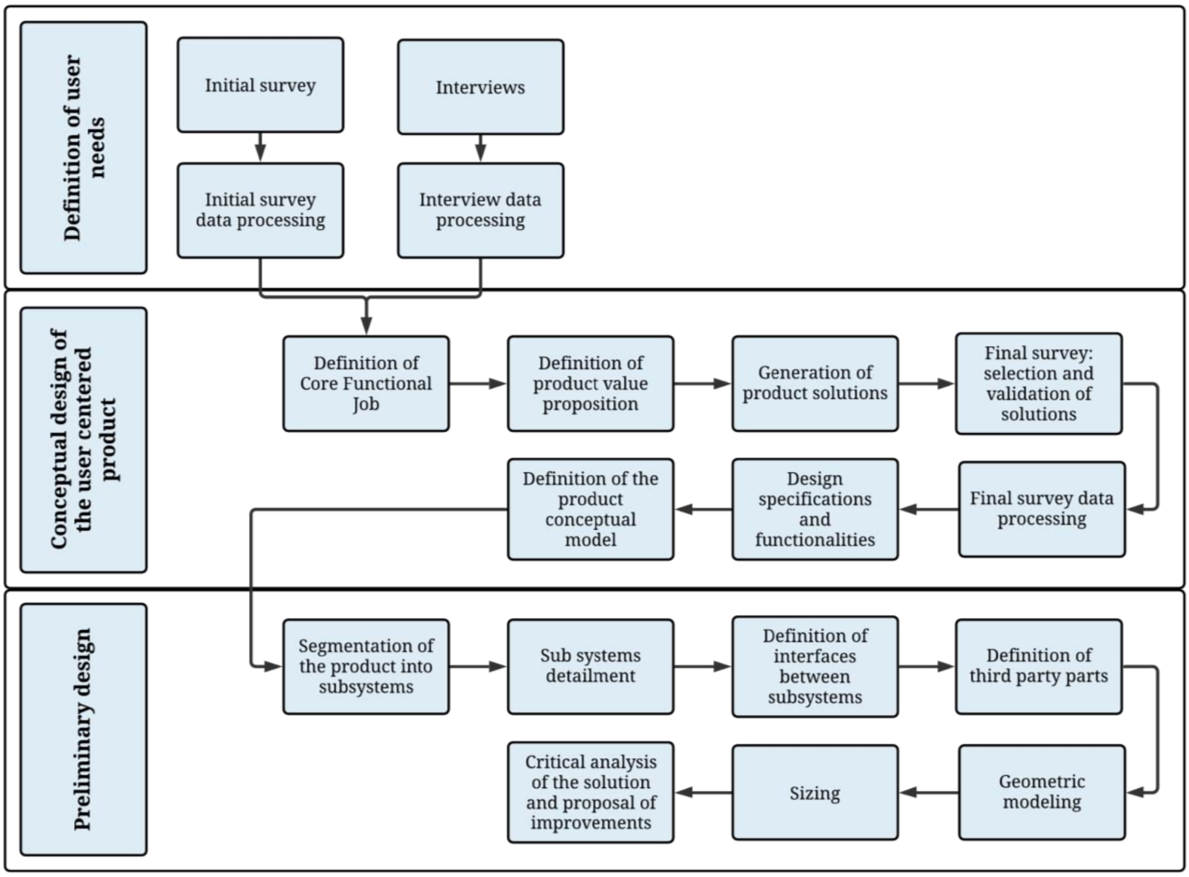


Figure 2. Systematic flowchart.

In order to facilitate the understanding and to address the proposal to the domain of application proposed, the flowchart (Figure 2) will be discussed according to the application. Initially, data will be collected from users of motorcycles in the Trail segment. The scope of the form includes personal information (e.g. age, sex, marital status and monthly income), the solutions used for transporting objects on their motorcycles, as well as their perceptions, whether in positive or negative aspects of these solutions used. These data can be acquired through users of similar products, through phone calls and videoconferences, to survey a questionnaire available via electronic form on social networks and motorcycle clubs of this style of motorcycle and usage profile.

The collected data is then analyzed to determine the user profiles of the trail segment, while the answers regarding the positive and negative aspects identified in their current solutions may be converted into performance attributes. Additionally, in this survey, users can be consulted as to the degree of relevance of some criteria related to the product. Such criteria (defined by the proponent) must be used to categorize the solutions in the solution generation phase, detailed further ahead. Once the initial research data has been analyzed and processed, the TFP will be defined, according to the guidelines of ODI.

Then, the product's value proposition is determined through the CPV and Brainwriting tool, with their respective activities developed in parallel to identify and determine the attributes of the solution (relievers, gain creators and product) that are compatible with the respective user attributes (pains, gains and work to be done). It starts with the determination of the user profile (right part of the CPV), then switching to the generation of solutions in Brainwriting, based on the CPV data and users' responses.

The Brainwriting process can be carried out only by the proponent, where the proposed solutions will be categorized according to metrics arising from the results of the initial survey. The rotation of the creative process may take place by alternating the categories of solutions, performed every 6 minutes according to the literature. As the attributes addressed will not cover the entire scope of the product, at this stage the proponent also adds attributes that he considers relevant to the project. Then, a selection of solutions must be made by the proponent according to constructive feasibility, manufacturing and performance criteria in meeting the user's needs. Some solutions that present different possible alternatives (or that are excluding) will be made available to users for selection and evaluation, through a form, as done in the initial survey. The scope of this research includes questions such as desirable load capacity and volume, external finishing, and evaluation and weighting of extra features.

Once the users' responses are analyzed, the value map (left part of the CPV) is defined, paying attention to the proper agreement between its respective items present in the user's profile. In other words, the value map will be constructed so that the relievers cancel out the pains and the gain creators are directly related to the gains perceived by the user. Finally, the selected set of solutions and functionalities is used to define the design specifications and subsequently generate the conceptual model of the product, in the form of 3D modeling produced in a CAD software.

The preliminary design of the product begins with its discretization into subsystems, through the analysis of its functions and interfaces with other components. For this, the 3D modeling mentioned in the previous section is used as a basis. Then, these subsystems are detailed, describing their main components and their functioning as a whole. Having determined the components of the subsystems, then the interfaces between the subsystems can be defined, through the analysis of the contact regions between them. For that, an interface matrix was used, which allows the organization and identification of interfaces between all subsystems. Then, interface elements were defined (rubber profiles, screws, rivets, etc.), when applicable, for each of the identified interfaces, to ensure the proper functioning of these connections.

In the next step, the components that might be purchased externally and installed to complement the product are determined. It seeks to preferably use standardized components, aiming to reduce the design and manufacturing costs of the final product, as well as (in most cases) increase its level of reliability and repeatability. At this stage, one looks for components available on the market that are more similar or better attend to the proposed solutions of the conceptual model of the product. Once the subsystems are discretized, the interfaces and components acquired externally are defined, the necessary data for the design of the preliminary geometric modeling of the product are obtained, using the SolidWorks software. This step is used to verify that the design is adequate and functional according to the project guidelines. Changes and improvements can be made if deemed necessary. To design the modeling, it starts with the modeling of outsourced components, either from the dimensional drawings provided by the manufacturer or by acquiring the modeling file, when available. Then, the components adjacent to these are modeled, or their conceptual modeling is used, paying attention to the proper compatibility and functionality of the set and improving it, if necessary.

Once the preliminary modeling is finished, the solution sizing is carried out. In this work, this step will be limited to a subsystem of the product. Initially, possible candidates are selected from the literature for the material and geometry of the components to be dimensioned, and a design safety factor based on recommendations found in the literature. Then, boundary conditions are defined with the loads that the product will possibly be subjected to during its use, especially in a severe use condition, to create heavy duty scenarios. Such scenarios will be determined by the proponent, based on the analysis of severe conditions of motorcycle use found in the trail segment's public media and social networks. These scenarios will be used in simulations for structural analysis, performed in CAE software. Based on the simulation results, the performance of the pre-selected materials (their respective allowable stresses, according to the design safety factor) are compared with the structural requirements in the use scenarios (von Mises equivalent stress). Finally, the material and geometry of the components under analysis is determined.

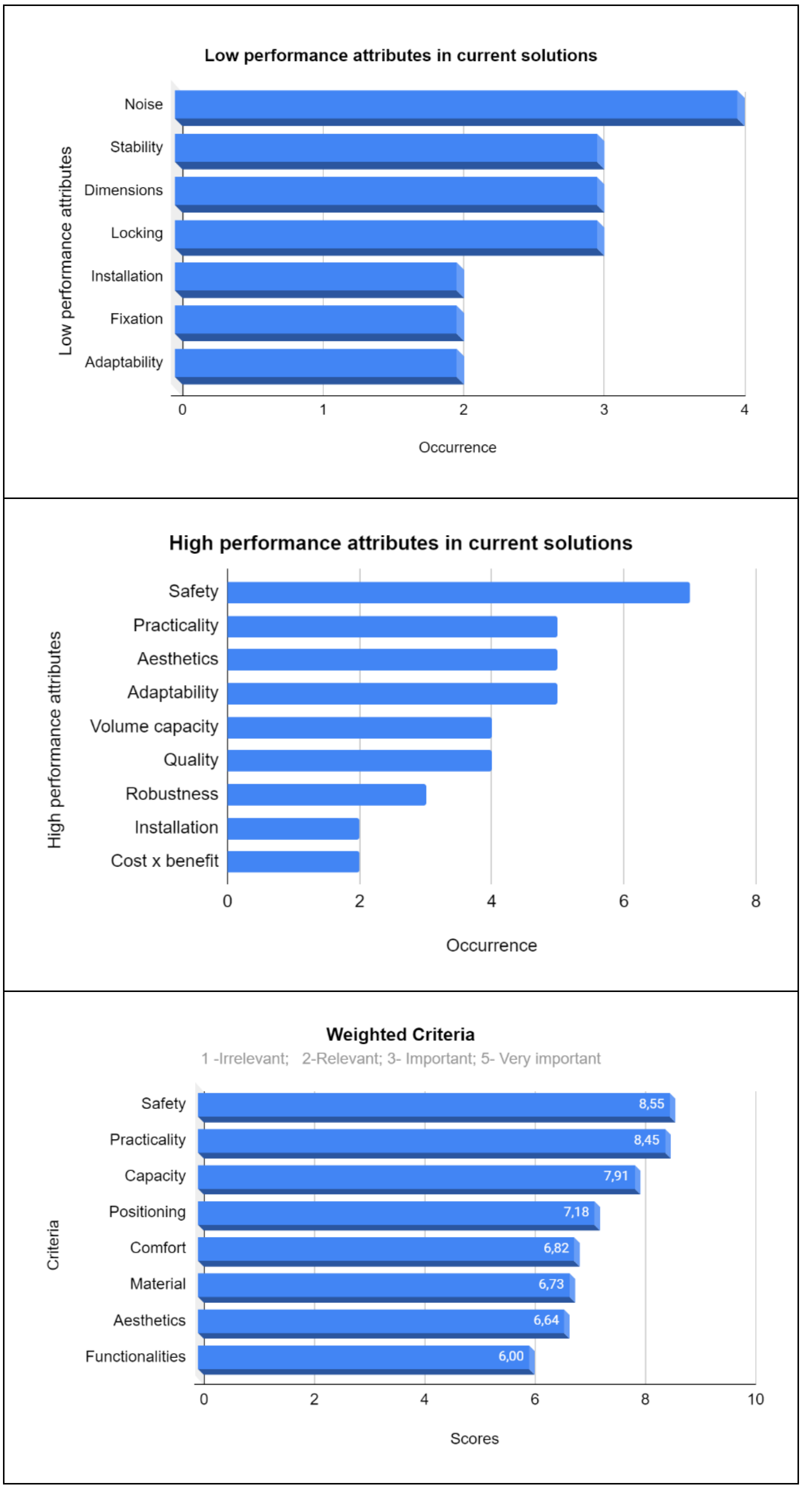
The preliminary design of the device is finalized with a critical analysis of the final solution, looking for possible failures or problems not identified in the previous stages of design, which could affect the performance or use of the product. For this, the use of the product is simulated using preliminary geometric modeling. From this analysis, improvements are made to the solution, if any possibility of improvement is identified.

3. APPLICATION AND RESULTS

3.1 Conceptual Model Development

On the initial survey, a questionnaire was distributed by electronic form to several online groups of trail segment motorcyclists and trail motorcycles fan clubs. 26 answers were collected in a 2 weeks period. In a general view, the survey data related to the user indicated a polarized profile, where more than 70% of the participants fall into two age groups: between 25 and 30 years old, with 42%; and over 50 years old, with 30.8%. The same happened with the salary ranges, where 46.2% declared income between R$1,000 and R$5,000, and 30.8% between R$5,000 and R$10,000. Marital status was also well divided between single (50%) and married (42.3%). On the other hand, the answers were given mostly by males (88.5%). The data related to products and solutions for transporting their belongings on motorcycles also presented some scattered (or polarized) responses. The highest ranges of motorcycle displacements declared (in cubic centimeters or “cc”, a common way of determining motorcycle size) were between 251 and 500 cc (34.6%) and between 501 and 1000 cc (23.1%). The main purposes of using the motorcycle (possibility of multiple answers) were leisure (76.9%) and daily locomotion (38.5%), while the condition of majority use of the motorcycle was as a rider (88.5%). The main device used in the transport of belongings on the motorcycle was the top case (box installed in the luggage compartment of the motorcycle, located in the rear, behind the passenger seat), selected in 69.2% of the responses, followed by side saddlebags (boxes or bags located on the sides of the motorcycle, below the passenger seat), 23.1% of respondents.

In the form made available to motorcycle users, some questions also aimed to identify and assess some of the criteria, pre-selected by the proponent, related to the product to be developed, in order to determine the degree of importance of these to users. The criteria assessed in the research were: Capacity; Comfort; Aesthetics; Extra features; Material; Positioning on the motorcycle; Practicality; and security. For evaluation, users attributed a degree of relevance to each criterion, namely: Irrelevant; Relevant; Important; and Very Important. Then, weights were assigned to the degrees of relevance (1 -Irrelevant, 2 -Relevant, 3 -Important and 5 -Very Important, respectively), according to the Fibonacci sequence, to facilitate the graphic visualization of the results. Subsequently, the weighted average for each criterion was calculated, according to the assigned weights. The weighted criteria were later used to categorize the proposed solutions during the execution of Brainwriting. The participants also were asked to answer 3 open questions related to the positive and negative points of the solutions they currently use and what would be the characteristics of an ideal device for transporting their belongings on the motorcycle. The answers were analyzed by the proponent and converted into attributes, to simplify the analysis, resulting in some loss of information. These results are shown in Figure 3.



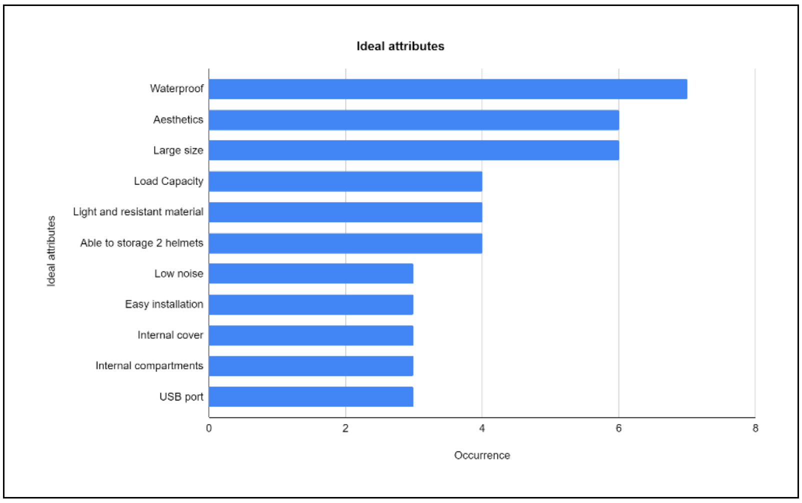


Figure 3. Initial survey results.

With the assessment results, a Value Proposition Canvas (VPC) was elaborated, as shown in Figure 4. For each item in the value map (left part of the VPC) regard a respective item in the user profile (right part of the CPV). For each necessity (pains) and expectation (gains) ideas were generated during a Brainstorming session.

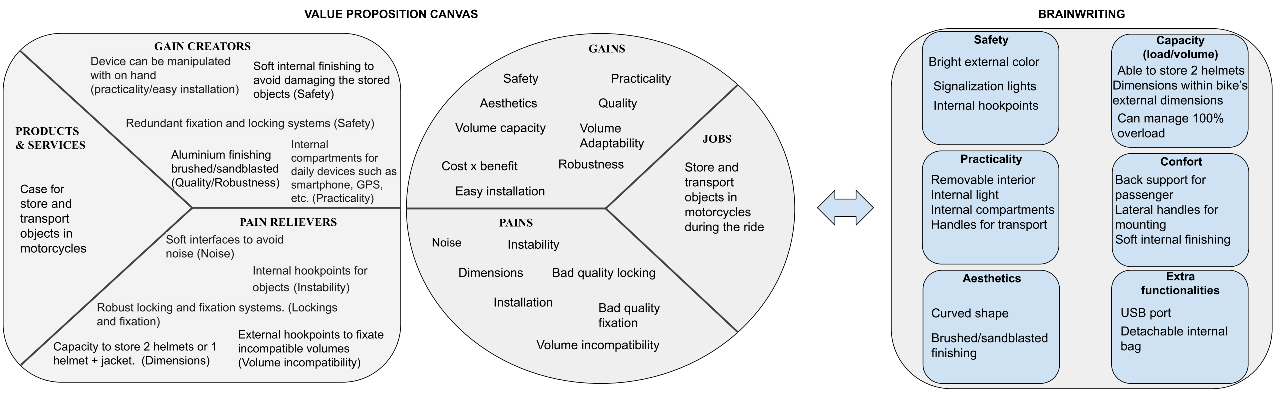


Figure 4. Value Proposition Canvas (left) and some selected ideas on Brainwriting (right).

After delimiting the ideas applicable to the project, some of them were selected for validation through an electronic form, made available for potential users, in the same way as the initial survey form. The survey returned 26 answers that were evaluated and resulted in the design specifications and functionalities presented on Figure 5 below.

Specifications

Specifications	Value/Characteristic	Observations
Structure material	Aluminium	Light, Ductile, good structural performance
Load Capacity	15 kg	As per survey result
Volume Capacity	> 50 liters	Minimum volume to store 2 helmets (as per geometric modeling evaluation)
External finishing	Matte paint	As per survey result
Internal finishing	Fabric	Easy to manufacture and handle as a bag
Structure Shape	Curved	As per survey result

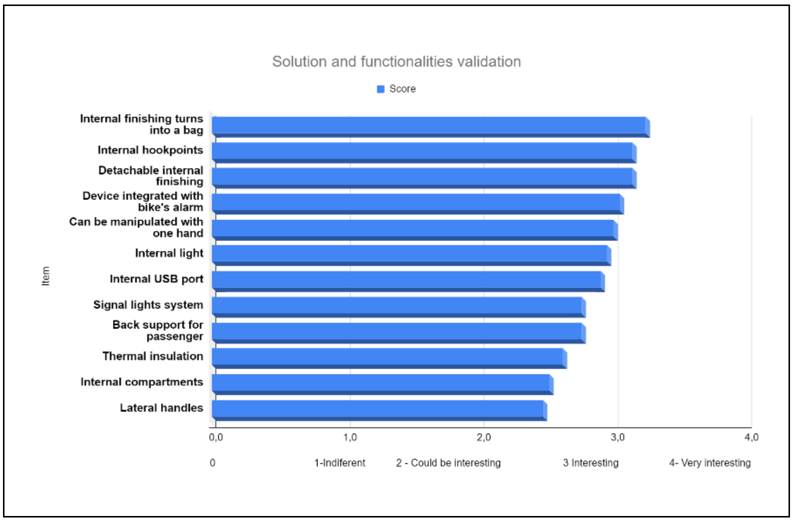


Figure 5. Final specifications and functionalities for conceptual solution.

Finally, the conceptual model of the product was developed according to the specifications and functionalities, shown in Figure 6. Its general shape results from the requirement to fit 2 helmets inside. Hence, the structure format is so that it can accommodate an envelope containing 2 large helmets inside, thus delimiting its minimum dimensions and format compatibility.

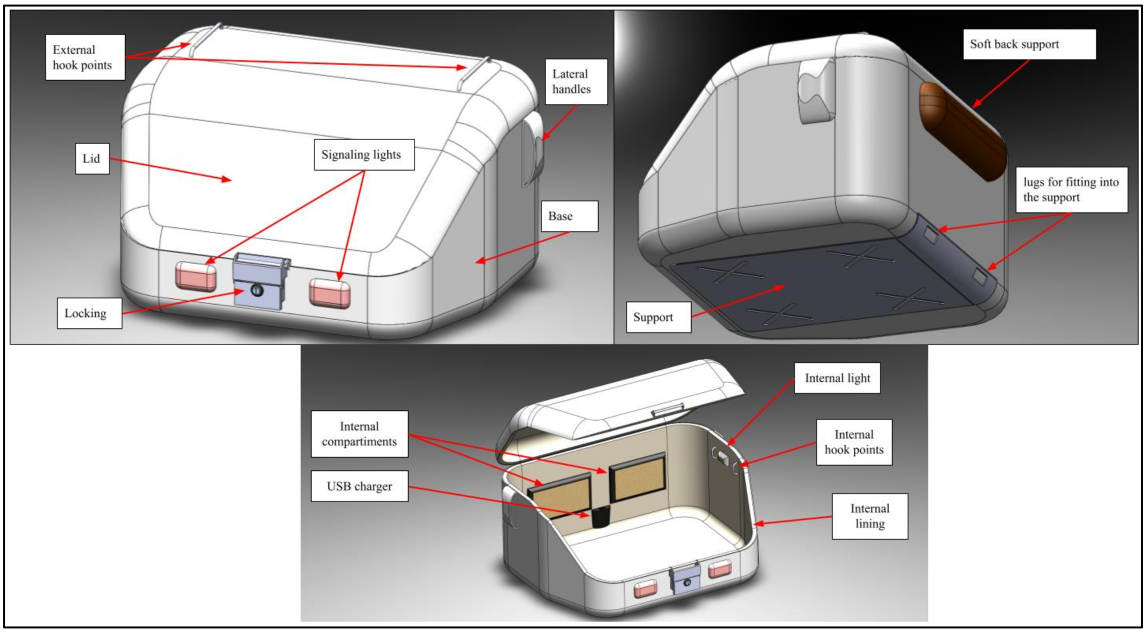


Figure 6. Final specifications and functionalities for conceptual solution.

3.2 Preliminary Design Development

In the preliminary design phase the conceptual solution was divided into 5 subsystems, illustrated in Figure 6-A: Interface (I); Main Structure (MS); Electric (E); Indoor lining (IL); and Lock (L). These subsystems were later detailed into components and the interfaces between the subsystems were defined, such as the respective interface elements (bolts, rubber profiles, magnetic buttons, etc.), when applicable. On the next step, the third-party components were selected by a market research for standard and consolidated solutions to the subsystem's components.
Having defined every component for the solution, a geometric model was created (shown in Figure 4.6-B), this time with high fidelity to the final product.

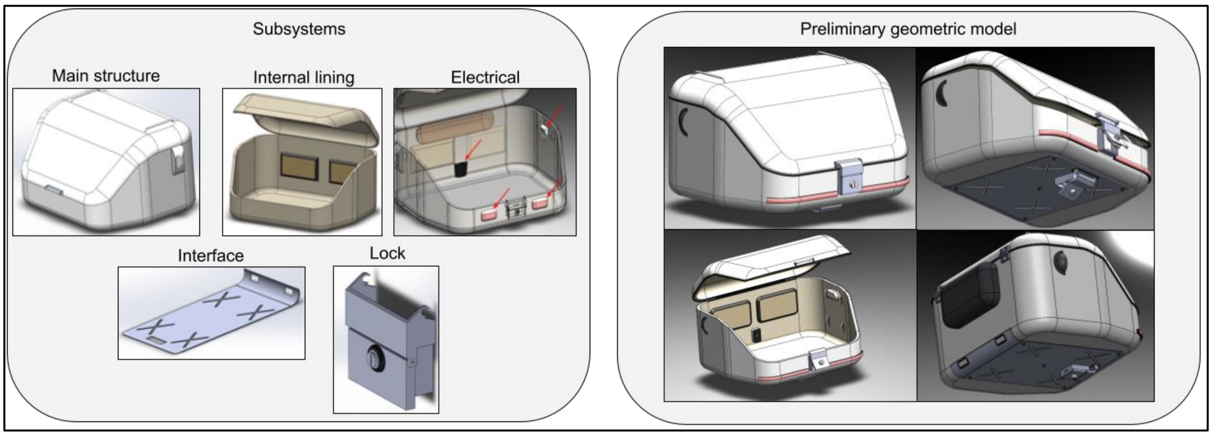


Figure 7. Subsystems (left) and preliminary geometric modeling (right).

In this work, the sizing of the main structure (base and lid) disregarded other peripheral components. A statical structural analysis simulation was performed on ANSYS software, considering some boundary conditions described in 4 scenarios, and 3 pre-selected materials and thickness for the subsystem, as shown in Figure 8. The motorcycle considered for analysis was the BMW R 1250 GS, leader in sales in the Big Trail [1]category. The sizing criteria considered was such that, at any point in the structure, the equivalent von Mises stress is equal to or less than the allowable stress. The latter is given by the yield stress of the selected material divided by the safety factor.

Boundary condition scenarios

Scenario 1	Scenario 2	Scenario 3	Scenario 4
• OSTDM 100% overload (30 kg) • Passenger leaning the back over the device • Motorcycle in maximum acceleration (1 g) and uphill (45 º)	• OSTDM 100% overload (30 kg) • Motorcycle in maximum deceleration (1 g) and downhill (45 º)	• OSTDM 100% overload (30 kg) • User lifts the motorcycle upright from the ground by pulling it from the OSTDM main structure	• Dynamic pressure caused by a laminar wind flow of 72 m/s (~260 km/h) against the anterior device wall

Materials	Yeld Stress (Pa)	Admissible Stress (Pa)	Safety factor	Thickness
Aluminium 1050	3,5 E+7	1,2 E+7		1,5 mm
Aluminium 5052	6,9 E+7	2,3 E+7	3,0	2,0 mm
Aluminium 6061	2,6 E+8	8,7 E+7		3,0 mm

Figure 8. Boundary condition scenarios and pre-selected material/thickness options.

As for the order of execution of the analysis, it started with the material and thickness configurations of lesser performance (1050 and 1.5 mm aluminum respectively), and more severe boundary conditions (scenario 1). The simulation result showed that this configuration did not meet the dimensioning criterion, presenting points with the equivalent voltage above the allowable voltage value. For subsequent simulation, the conditions described in scenario 1 were maintained and the material was changed to 5052 aluminum, and then to 6061 aluminum, where again they presented points with equivalent stresses above the acceptable value. A second round of simulations was carried out, under the same conditions as the previous ones, except for the thickness of the MS, this time with 2mm. The first simulations, using 1050 and 5052 aluminum, did not show satisfactory results. The following simulation, carried out with 6061 aluminum, resulted in values of equivalent stress lower than the allowable stress, meeting the design criterion. Having a positive result for the configuration of 6061 aluminum and 2 mm thickness, we proceeded to the simulations under the conditions of scenarios 2, 3 and 4, where all presented equivalent stress values below the allowable voltage. These results were already expected since these scenarios are milder than the first. The results of these simulations are shown in Figure 9 below. Therefore, the aluminum material 6160 and a thickness of 2mm were defined for the main structure.

[1] Source: Motonline Accessed on April 14th 2021.

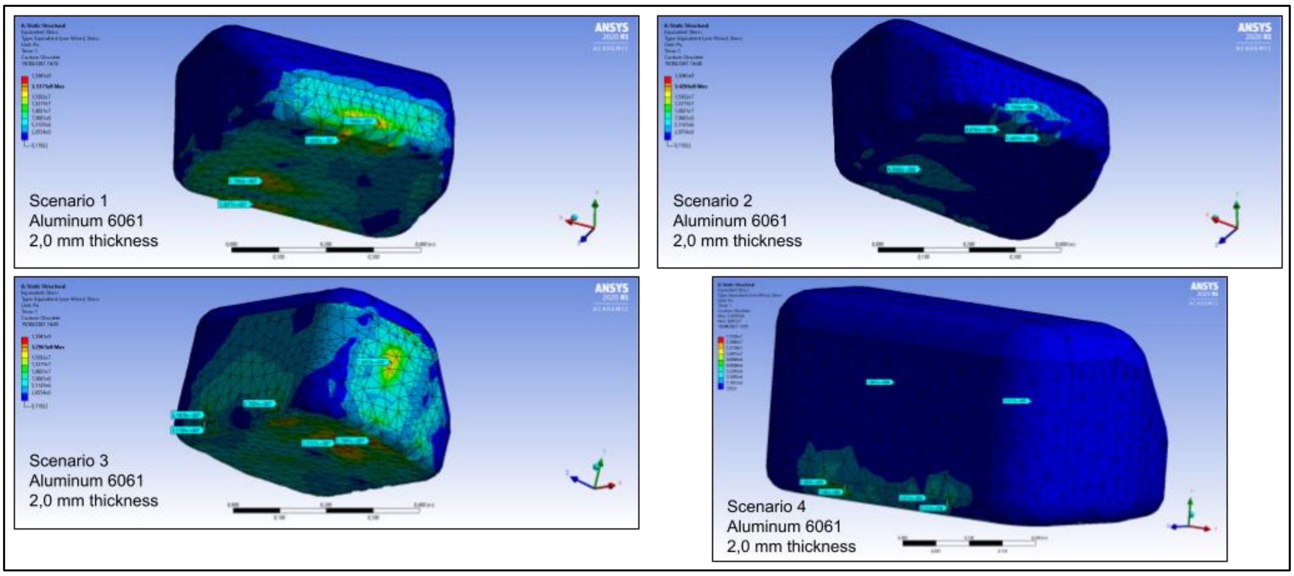


Figure 9. Static structural simulation results.

Using the geometric modeling of the solution, its behavior was analyzed regarding the routine procedures of use (fixing and removing the motorcycle, opening and closing the cover, and locking the cover and base). Some improvement points were identified in the following subsystems: lock geometry (to provide a better locking and make the locking procedure more assertive); main structure (additional handle to open the lid); interface (relocation of mounting holes to avoid interference between the motorcycle structure and the bottom lock) and internal compartment (fabric handles to detach the internal bag from the main structure). Finally, the final improved design of the solution preliminary design is shown in Figure 10.

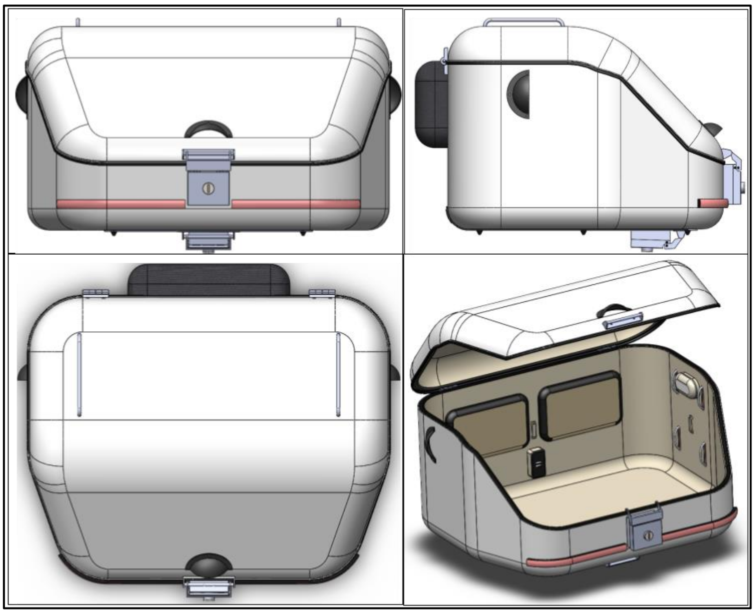


Figure 10. Final solution of OSTDM.

4. CONCLUSION

As described in the first chapter, in this work the design of a device for storage and transport of objects in motorcycles for the Trail segment was developed, according to user-centered design concepts, through the theory of Jobs to Be Done and the PRODIP model. From the data collected from users of similar products and the use of support tools aimed at user-centered projects, a solution was created with unique features compared to what is available on the market, with due attention to the elimination or reduction of the main problems identified by consumers.

For the development of the conceptual solution, the PRODIP model was used, more specifically its preliminary design phase. As it is a model, with very distinct and defined phases, it allows variations and adaptations with remarkable ease, so that it was not difficult to use it in conjunction with Job To Be Done theory.

On this development, JTBD theory has enabled the proponent to gather, organize and process important information from the users, thus aiding to create a product with unique desired functionalities, such as internal lights and detachable internal bag, reaching the consumers' needs further than the current options. The PRODIP, on the other hand, has enabled the quick and systematic conversion of the conceptual solution into a viable and manufacturable real product. Therefore, the merge of these processes has shown positive results in this design process by making good use of valued input information and effectively converting the solution idea into a feasible product.

Such systematization can be applied in virtually any context of user-centered design. The proposal to add other theories, tools, and methods to the PRODIP model can bring advantages in the product development process, making it more agile and assertive, enabling different approaches and greater alignment with the business model.

The result obtained from this hybrid product development process was a device that aggregates and shapes the functionalities required by users while performing the work they want to do (store and transport their objects on the motorcycle) and presents additional features that aim to facilitate and complement such work.

Some difficulties may be pointed out during the process of merging the JTBD theory and PRODIP model. From JTBD theory, it is premised on the finding of the user needs, i.e. the job that the user is trying to get done. For this, as the theory recommends extensive interactions and proximity with the users, thus requiring considerable time and resources to do so, it was found that this recommendation may not always be possible or practical, at least not for a long period of interaction. Thus, it is suggested as a possible point of improvement to this work, to perform more interactions with the users during the conceptual design phase, especially to evaluate their response during and for the final conceptual model. The input data gathered with this interaction may be very rich, allowing designers to refine a better product, at the expense of possible difficulties or complexities for processing and converting the refinements into design parameters for later use on PRODIP phases. From PRODIP model side, being a flexible model, it has the positive aspect of presenting different tools to support each phase and activity, but then it also brings the responsibility to the designer to evaluate and select or even (in this case) adapt these tools towards their need and goals, and thus requiring a critical analysis to select the most suitable one instead of just picking any option "from the shelf".

It is expected, with the proper continuity of the project (patent filed, prototyping, and the detailed design for manufacturing), that the resultant product will add to the national motorcycle accessories market and more assertively meet the needs of users, which go beyond than most currently available solutions offer, demonstrating the potentiality of the framework proposed.

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6. RESPONSIBILITY NOTICE