Design of a Handheld Liquid Capsule Dispenser

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01-06-2020

1. Introduction

Vortice Water Solutions plans to place a new product on the market after seeing a certain trend in syrup based soda's. Combining this trend with the ever increasing market share of reusable water bottles, Vortice Water Solutions sets out to redesign the packaging of syrups.

Through NovelT SMART, Vortice Water Solutions sought after the help from the University of Twente. The project started off with a meeting in which the scope was discussed, as well as existing plans and idea's. Vortice Water Solutions already had a target group in mind and conducted a business validity case through No Nonsense Technical Solutions from here on NNTS. The project started off with a problem definition phase with the interview and NNTS' report as the basis. The research questions cover the design process of a product in three categories each related to the other. First, a design and a 3D model is made. This design phase takes various values and requirements into account to accommodate Vortice Water Solutions' ideas. This 3D model and a more detailed use case scenario allows us to make further decisions such as material selection.

The material selection is the second phase in this investigation. As this product is in direct contact with the syrup it needs to be produced conform EU law and regulations. Using a material selection program, a list of promising materials were selected. These materials were then subjected to a force study based on the 3D model in order to recommend a suitable material for the product.

After selecting the material, the production processes involved were inferred by combining the constraints of the material with the 3D model. From the production processes we could calculate the expected cost to produce such a product. This product price was compared to existing sodas and syrups already on the market. After evaluating with the stakeholder Vortice Water Solutions, it was concluded that with proper marketing, the price is justified.

The product design was delivered to Vortice Water Solution during the prototyping phase. This is the next logical step in the design process but was not included in the scope of this investigation. However the report concludes with a list of recommendations for further research.

2. Research goal and research Questions

2.1. Research goal

The goal of the research is to design a product that dispenses highly concentrated liquid from capsules into 3rd party reusable water bottles which appeals to the target group. With the added intention of reducing plastic waste by providing an alternative to single use sports drinks. This goal will be explored using fields such as ergonomics, design styles, material properties and production processes among others.

2.2. Research questions

The main research question can be formed as such:

What are the properties of a suitable liquid capsule dispenser to dispense concentrated liquid into tap water that fits the lifestyle of the target group?

This question cannot be answered directly and is subsequently broken down into 3 parts. These three sub questions describe the three aspects of a product; Design, material choice and pricing.

1. *What is the best suited design to deliver force from the hand to the capsule in an ergonomic way?*
    a. *What style does the target group generally prefer in design aspects?*
    b. *What are the material constraints on the designed parts?*
2. *What are the properties and constraints of food-safe materials?*

a. *What material is best suited for the capsule to make the capsule sustainable from an end user perspective yet still be structurally sound?*

3. *What will the approximate cost be for the final product?*

2.3. Research methodology

The challenge is to design a handheld capsule dispenser turning tap water into energy drink, more specifically, the mechanism to dispense the concentrated liquid into the bottle. The properties range from material choice to design of the product and the price of the product. These properties are explored in this research.

The overall outline of the methodology can be found in Figure 2-1. The overall methodology consists of the three research questions, each individual methodology will be discussed and explained in the following paragraphs.

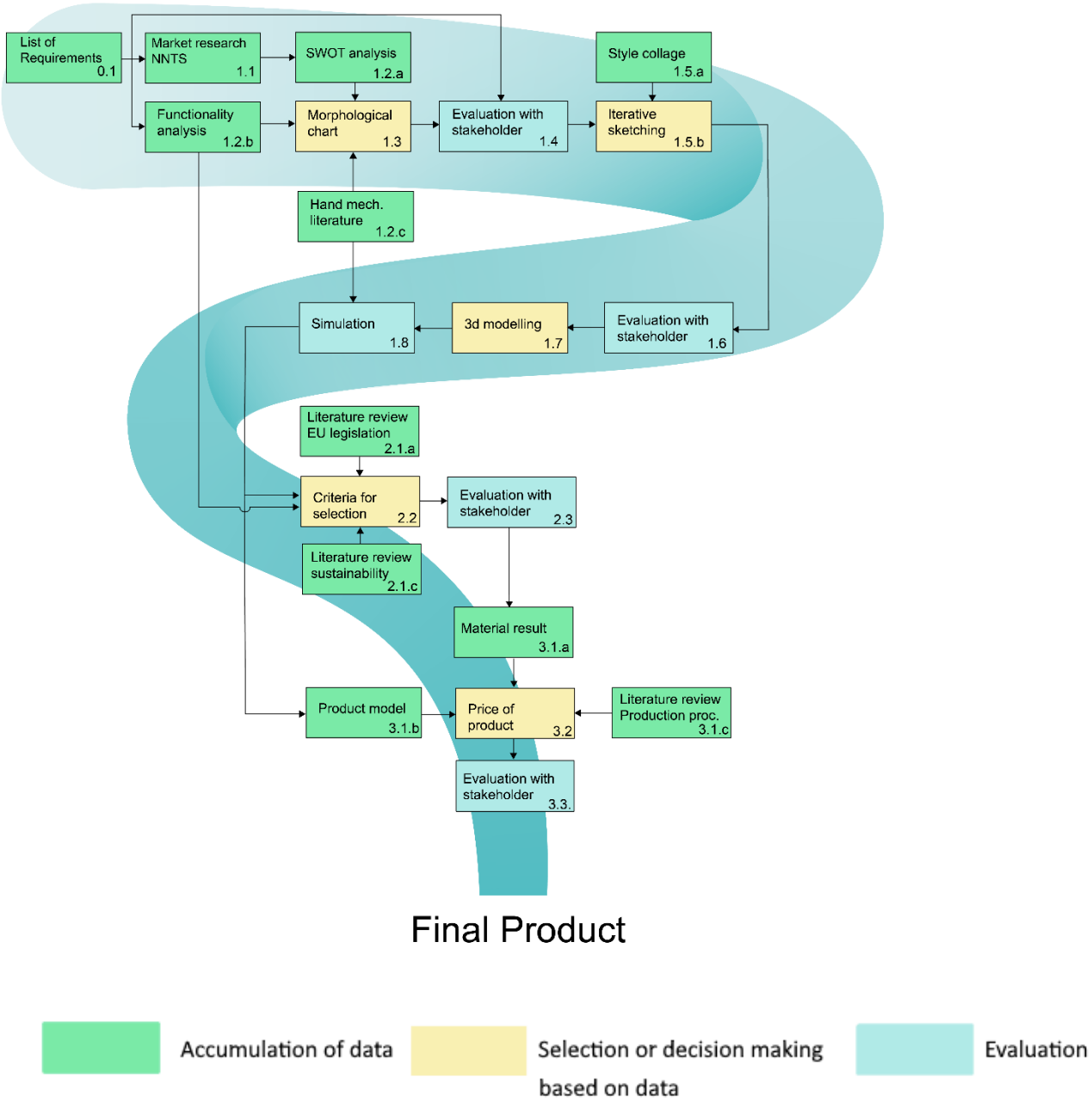

Figure 2-1 Overall research methodology

The product will start out with an investigation of the problem definition. From this definition, a list of requirements, hereafter a LOR, will be made. This LOR will be prioritized using the MOSCOW method. The requirements will be graded according to the necessity of the proposed function. And as such, it is only logical that the mechanism with which the product is to function is the primary basis of the product. Without the mechanism, the product would be

dysfunctional. The next most important aspect is usability. If the product is too impractical to operate, the product will not be used and thus will not sell. This presents the first research sub question (RQ-1).

RQ-1. What is the best suited design to deliver force from the hand to the capsule in an ergonomic way?

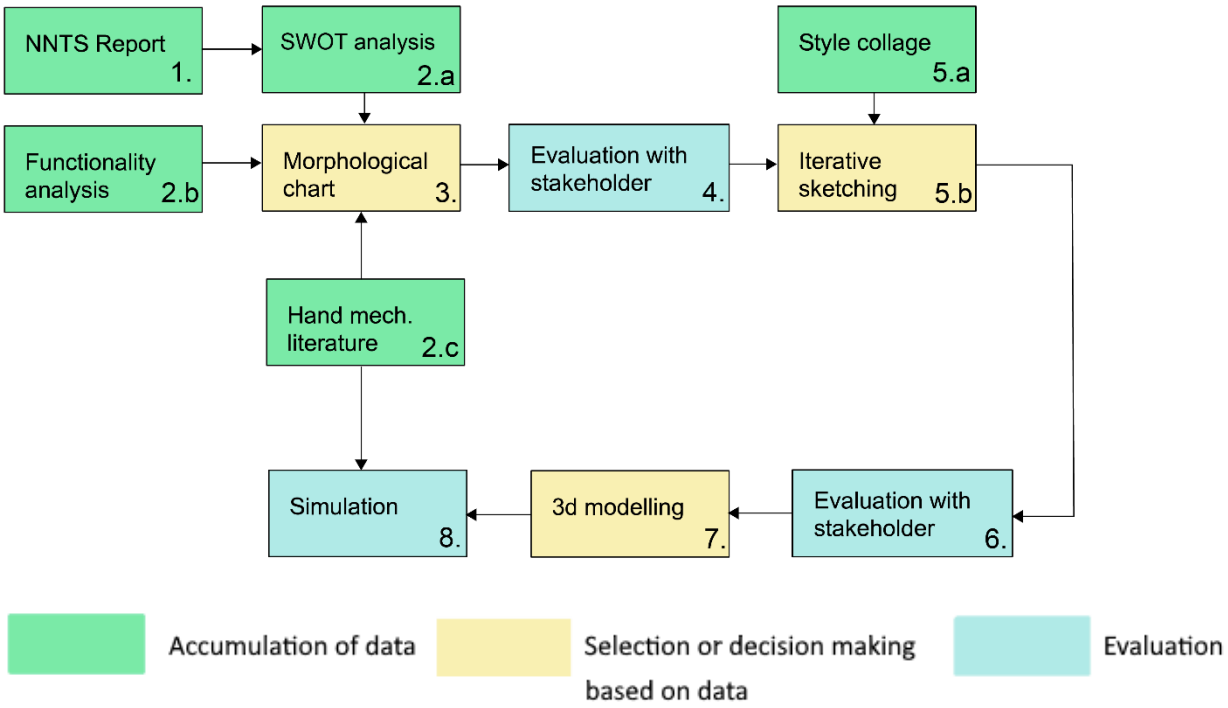

Figure 2-2 Research methodology outline of RQ1

The mechanism in question will be developed using multiple analysis techniques and uses many iterative processes. From feedback of the stakeholder and simulations, improvements will be made to the design. The end goal of the first question is to have a 3D model of the product with a list of constraints. To get these constraints, the steps as shown in Figure 2-2 will be followed.

1. A market research in the database of the NNTS report will show which companies score highest in similarity to the proposed final product.
2. From this list, a top selection will be made and further investigation into these brands helps to identify possible solutions for the design problems and required functionality using a SWOT analysis (2.a). Next, a function analysis will be conducted to see what functions the final product needs in order to fulfil the requirements and -if time permits- the wishes of the client (2.b). However, the required input of force generation is still missing in the variables. Thus a literature research in the mechanisms of the hand will show how the hand is able to generate force in multiple ways (2.c).
3. From all the inputs mentioned in 2., a morphological chart will be drawn. This allows for many rough iterations and possible solutions to the design problem.
4. These iterations need filtering and evaluating. This is done by an evaluation with the stakeholder. The filtered iterations will be presented and explained and an interview will show which solution(s) the stakeholder prefers.

The product should not only be functional but the style of the design needs to appeal to the target group. Also, the product needs to have its own identity associated with the brand so it is easily recognised. This leads us to the first sub question of research question 1.

RQ-1a. What style does the target group generally prefer in design aspects?

5. To give answer to this question, a style collage will give the stakeholder and designer an impression of the brand and the target group. This helps the iterative process by acting as a guide or starting point, blending in preferred styles of the target group and incorporate key values of the brand (5.a).
   Subsequently, from the evaluation with the stakeholder conducted in 4., a selection of possible iterations will be picked and further developed. Many smaller iterations will be sketched to find out what design works,

designs will be made in combination with the style collage of the target group and Vortice Water Solutions (5.b).

6. After a suitable design is picked, this is again verified with the stakeholder in a similar way the previous evaluation was conducted.
7. Next, a 3D model will be created according to the chosen sketch.

In order to break the capsule, force must be exerted on the capsule. The capsule should however, not break during transport thus a specific amount of force will be required to burst the capsule. This presents us with the final sub question.

RQ-1b. What are the material constraints on the designed parts?

8. Finally, the model presented in the previous step (7.) will be tested and adjusted during simulations comprising of tensile and compression forces in accordance with the results of the hand force literature mentioned previously in (2.c). This force simulation study will show the maximum amount of force the material should handle, and the amount of force that is generated on the capsule and if this is reasonable for a human. The result from this simulation will be a list of constraints for all of the possible parts and the final product. These constraints include the possible production methods based on the geometry of the design, to material constraints. This list will help in choosing the best suited material later on.

The second sub question involves choosing the right materials for the final product. These steps are described in Figure 2-3

RQ-2. What are the properties and constraints of food-safe materials?

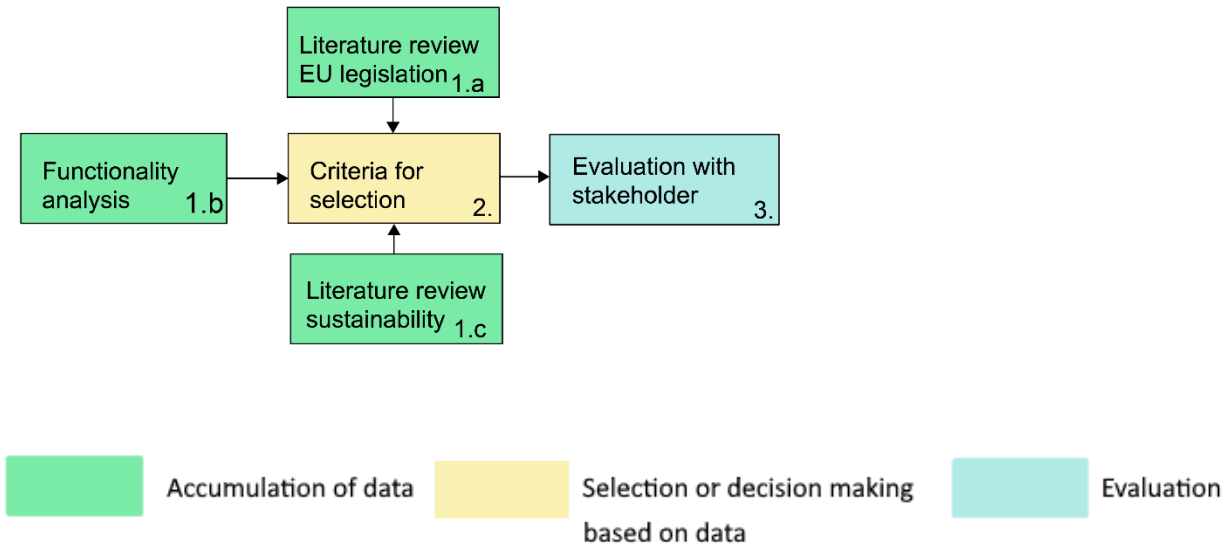

Figure 2-3 Research methodology outline of RQ2

1. Products coming into direct or indirect contact with consumables should heed the guidelines of the EU if the product is to launch onto the market of a country affiliated with the EU (1.a). These guidelines can be found online thus a review will suffice. Another criteria for the product material is the use of the product itself. This has already been established in the functionality analysis in RQ1-2b. this will be combined with the product parts and how they are intended to be handled by the user (1.b).

Besides being food safe, the stakeholder also mentioned that the product should have sustainable qualities to reflect the brand Vortice Water Solutions. This presents the first sub question of RQ-2.

RQ-2.a What material is best suited for the capsule to make the capsule sustainable from an end user perspective yet still be structurally sound?

1. (continuation) According to the stakeholders wish, the product needs to be sustainable. Meaning the product should not have lasting impact in nature and furthermore the product should consist of sustainable materials, these constraints will be taken into account for the selection criteria(1.c).
2. From the results of 1.a a list of materials that are safe to be used for food related products will be evaluated across all the criteria mentioned in 1.b and 1.c.
3. Based on the results of 2. A second evaluation will be made using criteria derived from the stakeholder himself. The stakeholder will be asked what aspects of sustainability and functionality he prioritizes over the technology and materials used.

The result of this research question will be a selection of the preferred material(s) to be used in the product. This leads us to the third research question. It combines the model, the material and the proposed production processes to give answer to the final research question.

RQ-3. What will the approximate cost be for the final product?

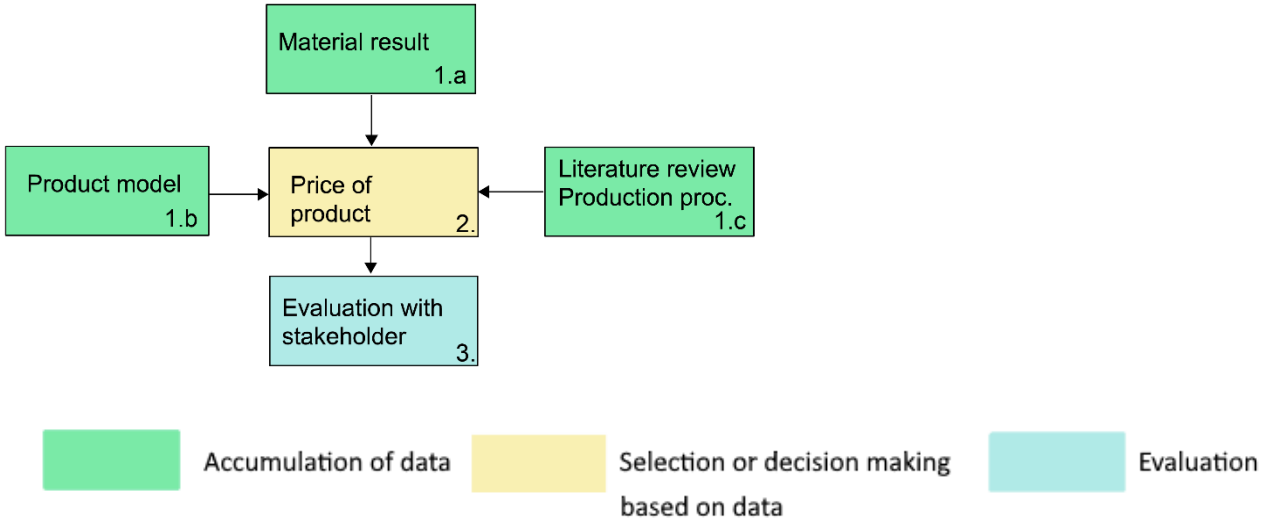

Figure 2-4 Research methodology outline of RQ3

1. With the materials chosen from the evaluation in RQ-2.3. (here 1.a) and the 3D model from RQ-1. (here 1.b) allows us to visualize the product in its final version. From this version we can estimate what processes are necessary to produce such a product according to literature on the production processes used (1.c).
2. After calculating how much material is needed and what processes are utilized. It is possible to give an estimate of the cost price of the product.
3. This price of the product will be checked against the target group spending habits and how much they are currently paying for similar products. This will be evaluated during an final interview with the stakeholder where all the aspects are explained and the pricing will be discussed.

2.4. General research flow and thesis outline

The Research flow of the research is pretty linear, as research question 2 & 3 build upon the results of research question 1. It is believed, looking at the outline of the research questions, that research question 1 will take the most amount of time. All methodologies combined gives us an overview of the whole research presented below. The report starts off with the list of requirements. The LOR is used as a basis for a lot of the analyses in RQ1. After chapter **Error! Reference source not found.** which concludes RQ1 with a 3D model, a material is picked in chapter **Error! Reference source not found.** based on the criteria that have been explored in RQ2.

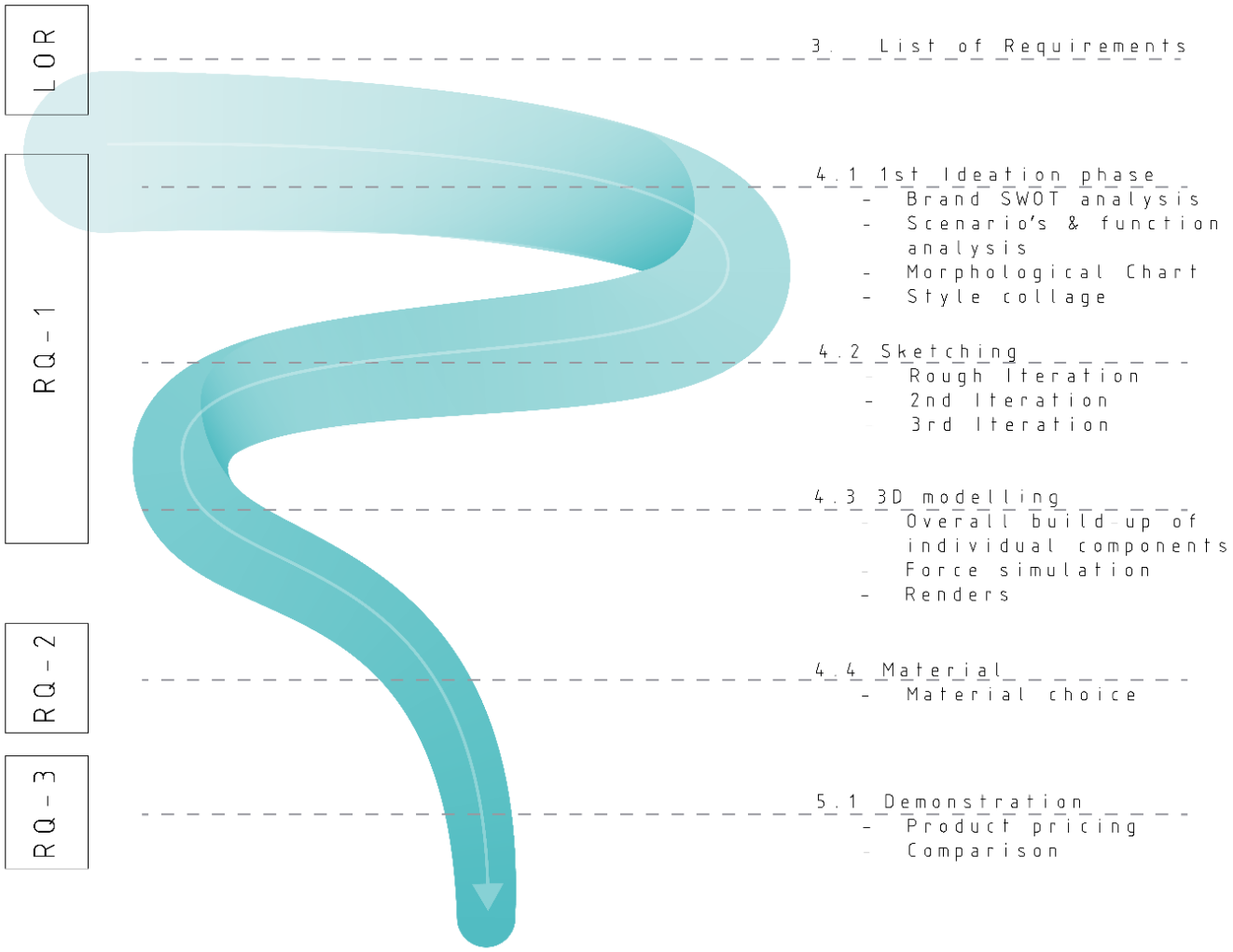

Figure 2-5 Thesis outline