

Product Development of Adaptable Mobile Holder

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MASTER THESIS



Product Development of Adaptable Mobile Holder

With the aim of measuring and analyzing movement
patterns.

Charlotte Abrahamsson Kwetzer



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With the aim of measuring and analyzing movement patterns

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Abstract

This report describes a product development process of a carrier for mobile phones. The product development process is based on the description in Ulrich and Eppinger [1]. Including what steps should be followed to achieve a final product that meet decided requirements. The work is performed in cooperation with the company Medotemic AB.

Through an application, the mobile phone can measure the user's movement pattern and draw conclusions about either the user's running technique or how the user's rehabilitation is going. The purpose of the degree project is to design a carrier for different types of mobile phones. It should be placed centered at waist height and be useful for different ages and body shapes. The purpose of the carrier is to facilitate the measurements of the application.

The product development process includes identification of customer needs, determination of goal specifications, concept generation, concept selection, testing of various concepts, determination of final specifications/concepts. To identify customer needs, interviews were held, and questionnaires were sent out to future customers in both target groups; runners and rehabilitation patients, to get an as broad overview as possible of the possible needs. Prototypes were built for physical testing with people of different ages and body shapes. Finally, a final concept was presented with a possible choice of material.

The thesis project resulted in a unique and simple design created as a waist bag adapted for all types of mobiles, ages, and body shapes.

Keywords: Product Development, Design, Prototype, Carrier, User-friendly

Sammanfattning

Denna rapport behandlar en produktutvecklingsprocess av en bärlösning för mobiltelefoner. Processen bygger på den beskriven av Ulrich & Eppinger [1] som beskriver produktutvecklingsarbetet och vilka steg som bör följas för att uppnå en slutgiltig produkt med uppfyllda behov. Arbetet utförs i samarbete med företaget Medotemic AB.

Via en mobilapplikation kan mobiltelefonen mäta användarens rörelsemönster och dra slutsatser rörande antingen användarens löpteknik eller hur väl användarens rehabilitering går. Syftet med examensarbetet är att designa en bärlösning för olika storlekar av mobiltelefoner. Den ska vara placerad centrerad i midjehöjd och vara användbar för olika åldrar och kroppsformer. Syftet med bärlösningen är att förenkla mätningarna i applikationen.

Produktutvecklingsprocessen inkluderar bland annat identifiering av kundbehov, fastställande av målspecifikationer, konceptgenerering, konceptval, testning av olika koncept, fastställning av slutgiltiga specifikationer/koncept. För att identifiera kundbehov intervjuades och skickades det ut formulär till framtida kunder i båda målgrupperna; löpare och rehabiliteringspatienter, för att få en sådan bred överblick som möjligt. Prototyper byggdes för fysisk testning med personer i olika åldrar och kropps-konstellationer. Slutligen presenterades ett slutgiltigt koncept med möjliga materialval.

Examensarbetet resulterade i en unik och enkel design utformad som en midjeväska anpassad för alla typer av mobiler, åldrar och kroppsformer.

Nyckelord: Produktutveckling, Design, Prototyper, Bärlösning, Användarvänlig

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Lund, June 2021

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1 Introduction

This chapter presents the background behind the project and the goal with the Master Thesis. It also presents delimitations and ethical considerations.

1.1 Background

Medotemic AB is an e-health company that combines care visits with objective movement monitoring at a distance. Sensor data is retrieved via a mobile phone when patients walk or run. Algorithms based on this data are analyzed and provide biofeedback in the form of various movement measures. The goal is to reduce and prevent asymmetrical walking patterns through adapted training programs but also give the opportunity to those who want to get an improved running technique. The results can be shared with care providers as a follow-up or with a running coach.

To measure these movement patterns, the mobile phone must be worn at the waist, centered on the lumbar spine for best results, when measuring. The result is registered in the application *Mystep* that can be downloaded on the phone. To give the customers a more precise result when measuring and to continue to develop and improve the application Medotemic needs a carrier for the mobile phone to be able to complete necessary tests.

1.1.1 Primary Customers

1.1.1.1 Rehabilitation Patients

The first customer group is aimed at people in need of rehabilitating an injury. It is primarily a tool for physiotherapists to measure progress and a complementary tool in their work. The carrier should be used by elderly as well as younger patients. It is for everyday use and is mainly applied when the patient is walking.

1.1.1.2 Runners

The second customer group is aimed at runners who want to improve their running technique and preventing injuries. The carrier is mainly used when the patient is running.

1.2 Goal

The overall goal of the project is to design a carrier that is adaptable to different mobile phones and that can easily be applied at waist level on the user. The product must also be designed to fit both rehabilitation patients and runners. Below are the given criteria from Medotemic.

1.2.1 Given Criteria

The carrier has to meet several criteria to serve its purpose. Listed below are the given criteria by the company Medotemic AB and the main guidelines for the design of the carrier.

- Stylish design for both everyday use and sport
- The mobile phone must not be shielded by the material. (Metal wires or similar that screen GPS signals picked up by the cell phone).
- Comfortable and easy to use.
- Simple and functional to handle for the elderly.
- Useful for all body types.
- Easy to attach to the back at waist height.
- Fit different types of mobiles with different shapes and sizes.
- The mobile phone must be still during walking and running.
- Cheap to manufacture.

1.3 Delimitations

Due to the current Covid19 situation there arose some limitations when performing the project. The virus has limited how interviews and tests are carried out. In order to not contribute to an increased spread of infection, the number of people performing physical tests has been minimized and the interviews have been held remotely. The thesis has been written at home and not at Medotemic's office.

Another limitation was that the mobile application could not be used when performing the tests. It had problems with its GPS signal which made the collected data useless. This made it impossible to test the product as a whole, with both the application and the carrier.

1.4 Ethical Consideration

When presenting materials, no consideration was made concerning the location of material manufacturers and which labor is used to manufacture the material. The working situation of the people producing the material is not considered, which includes the possibility of poor working conditions and child labor that is more and less common in certain areas.

When creating the final prototype, no regard concerning the environment was taken, it was too difficult to find an environmentally friendly substitute when such a small amount of fabric was needed.

2 Methodology

The following chapter presents the planning of the Master Thesis. It also describes what approach, theory, and tools that are used during the project.

2.1 Planning

The Master Thesis is an independent work that corresponds to 20 weeks of full-time studies. A Gantt chart shows the expected time for the necessary activities that are to be implemented during this period and are presented over weeks and days. The project contains planning, investigation, and analysis of the customer and of other carrier solutions on the market, idea generation, testing of concepts, improvements of the design and design for manufacturing. The Gantt-chart is found in Appendix A.

2.2 Approach

During the project, an investigative and systematic approach was used. With research of future customers and benchmarked products, a deeper understanding of the issue was developed. In order to produce a final product, systematical tests were performed using physical prototypes.

2.3 Theory

The approach that is mainly used is the design process described in Ulrich and Eppinger's *Product Design and Development*. [1] The reason why the literature was used is that it contains a clear and chronological order in how the design process should be performed. Its clear structure helps to remember every step in the process. The approach explained in Åsa Wikberg Nilssons et al. literature, *Design process and metod*, is also widely used during the project. [2] It contains good idea generation techniques that were considered helpful during the main part of the

project, and it also explained how the physical tests could be conducted. See Chapter 3 for further explanation.

2.4 Tools

Necessary resources for the project are a workshop for prototype construction and computer-aided design such as Solidworks. The workshop for prototype construction has been very helpful when building the physical prototypes used for testing and when building the final design. Solidworks was used when constructing drawings for manufacturing. Other important tools that have been useful are programs such as Excel, InDesign, and Photoshop. Excel was used when organizing data and tables during the project, and the Adobe programs were useful when editing figures and pictures. All the necessary tools are available in the student's home.

3 Product Development Process

This chapter explains the product development process used during this Master Thesis.

3.1 Product development according to Ulrich and Eppinger

This project will mainly follow the product development process explained by Ulrich and Eppinger in the literature *Product Design and Development*. The focus will mainly be put on the first phase, see Figure 1 below.



Figure 1 The Product Development Process [1, p.9]

Phase 1 consists of 7 steps where the focus will be put on the 6 first steps. The steps are shown in Figure 2. Parallely with the steps an economic analysis, a benchmarking of competitive products, and building of test models and prototypes were made. The first two steps are explained in Chapter 4, *Understanding the Needs*. The third step is more thoroughly explained in Chapter 5, *Concept Generation*. The fourth step is explained in Chapter 6, *Concept Selection*. The fifth step is explained in Chapter 7, *Testing*, and the sixth step is explained in Chapter 9, *Final Concept*. The steps are divided into different chapters because every step consists of important parts that affect the process and outcome of the product.

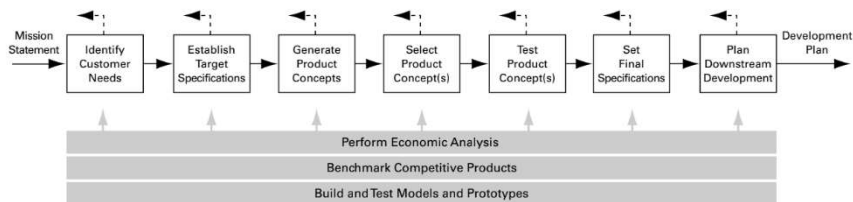


Figure 2 The Concept Development Process according to Ulrich and Eppinger [1, s.16]

3.2 Concept Generation According to Åsa Wikberg Nilsson et al

Methods explained in *Design – Process och Metod* will mainly be used when creating ideas and prototypes. [2] While *Product Design and Development* [1] helped with structure, and *Design – Process and Metod* helped with the creative thinking and creating ideas “outside the box”. They complement each other well in order to create a product with both a functional and design aspects.

4 Understanding the Needs

This chapter presents methods and information collected in order to understand the needs of the product and necessary information to fulfill these needs. It also explains the target specifications set for the product. The chapter discusses Ulrich & Eppinger's [1] first two steps, identifying customer needs and establishing target specifications.

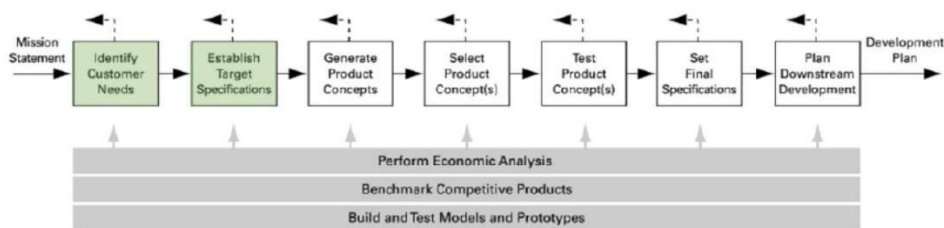


Figure 3 The Concept Development Process, step 1 and 2, [1]

4.1 Identifying Customer Needs

At the beginning of the project, criteria are given from Medotemic AB, describing properties necessary for the product for it to serve its purpose. Nevertheless, it is important to collect the customer's opinions to make sure that no need is left out and that the product fulfills market demand. This chapter describes the process of finding customer needs.

4.1.1 Four Steps to Identify Customer Needs.

Identifying customer needs is made according to Ulrich and Eppinger [1, p.75] The steps that are followed are listed below.

1. Collect raw data from customers.
2. Interpret the raw data in terms of customer needs.
3. Classify the needs (primary needs, secondary needs).
4. Establish the relative importance of the needs.

4.1.1.1 Data Collection

The first step to identify customer needs is to collect raw data from future customers. The methods that are used to collect data are interviews, held over a zoom-link, and questionnaires sent out on Facebook to future customers. [1] Multiple research methods were used in order to strengthen the conclusions drawn from each one of them.

4.1.1.1.1 Interviews

Five interviews were made, one interviewee had trouble finding a suitable time for the interview and chose to answer the questions by e-mail. The people interviewed belonged to both the rehabilitation and runners' group. Each considered experts in their different areas. In total two from the rehabilitation group got interviewed and three from the running group. The interviews were about 20-30 minutes long and the answers from the interviews were written down after each question to make sure that all-important information was documented. The physiotherapists were interviewed because it is important to understand what physiotherapists and their patients need when using such a product. The two physiotherapists were found through family contacts. Interviews were made with athletes that work a lot with running and running technique. The interviewees from the running group were found through a search on the internet, one worked as a running expert in a smaller company, and one of the interviewees ran his own company within the running industry. The third interviewee, from the running group, was also found through a family contact, she was an elite athlete within orientation. Unfortunately, no other interviews were made due to few responses. The interview questions were adapted to the different customer groups and can be found in Appendix B.

4.1.1.1.2 Questionnaire

Due to the low number of performed interviews, a questionnaire was created and posted on Facebook in three different running groups. The questionnaire reached 85 people of different ages and training levels. Of these 85 people, 54,1% had been through rehab. The questionnaire, therefore, reached both customer groups and conclusions regarding both groups could be made.

The questionnaire was built into three parts. To start with the person got to answer questions regarding running and running products that they are using today, if they use any. What do they like/dislike about them and what features do they consider being most important for such a product? They also got to rank from 1-5 the importance of different properties of the carrier. The same ranking returned in the

second part of the questionnaire, this time they were asked to think through a rehabilitation perspective. If they needed rehabilitation and instead were to use the product in an everyday context, how important would they then believe the different criteria to be? The answers were compared in order to see whether there were any differences between them. In the second part, they also got to answer questions regarding how they would like to place the mobile phone in the holder. The last part was asking questions concerning running and rehabilitation, asking questions to find out if it is possible to create a single product that matches the different customer requirements from these two customer groups. See Appendix C to find the questionnaire.

4.1.1.2 Interpretation of Customer Statements into Customer Needs

The customer statements from the interviews and the survey were translated into customer needs. This was done by expressing the need in terms of what the product has to do, as specifically as possible. The need should be expressed as a positive phrasing where words such as “must” and “should” should be avoided. The need should also be expressed as an attribute of the product if possible. [1] Many of the statements reappeared and could therefore be interpreted into the same need. In Table 1 below, an example of the customer needs and statements from one of the physiotherapists are shown, the complete list can be found in Appendix B for the interviews and Appendix C for the questionnaire.

Table 1 Customer Statement interpreted to customer needs.

| Customer data | | | |
|---------------------------|---|--|--------------------------------|
| Interviewee: | Camilla | Interviewer: | Charlotte Abrahamsson Kwetchez |
| Type of user: | Physiotherapeut | | |
| Question/Prompt | Customer Statement | Interpreted Need | |
| Achieve Usage | Discreet design, adaptable for children so that they could decorate it. | The product is discreet but adaptable for younger persons. | |
| | Discreet design for the older generation, preferable to place it under your clothes. | The product design is discreet. | |
| | The easier it is to use a product the more willing you are to use it, simplicity is very important. | The product is simple to use. | |
| | Older people can get help from others, such as home care staff. | The product can be applied by others on you. | |
| Important characteristics | If you are older it is important to be able to take it off at the stomach. | The product is removable at the stomach. | |
| | The easiest things are hard to handle for older people. Small features are too hard to handle. | The product design is made easy with only a few features. | |

4.1.1.3 Organizing the Needs into a Hierarchy

The needs are divided into primary and secondary needs. The needs are also categorized into different groups depending on which area they cover, for example regarding the design or the usage of the product. The more general needs became primary needs and the more specific became secondary needs. The difference between the primary and secondary needs is that often the secondary needs describe a way to help solve the primary need. The ones in bold are divided into primary needs and the ones with regular typing are divided into secondary needs. See Appendix D for the complete list. Below Table 2 shows the first 13 needs.

Table 2 A list of the 13 first customer needs

| Needs | |
|----------------|--|
| Need no | The Product is usable in all climates |
| 1 | The product is resistant to moisture. |
| 2 | The Product is designed to last over time. |
| 3 | The Product dries fast after use. |
| 4 | The Phone is securely attached to the product. |
| 5 | The Product is water and dirt resistant. |
| 6 | The product is tough and scratch resistant. |
| | |
| | The Product has several pockets for storage. |
| 7 | The product has the ability to store all the necessary stuff. |
| 8 | The Product can easily be combined with headphones. |
| | |
| | The design is discreet. |
| 9 | Stylish design for both everyday and sporty use. |
| 10 | It is possible to carry the product under your clothes while using it. |
| 11 | The product is discreet but adaptable for younger persons. |
| 12 | The design is not too big. |
| 13 | The product design is made easy with only a few features. |

After the needs were placed into subgroups importance ratings are made for the secondary needs. They are described with “*”, three “****” indicates a critically important need. If there is a “!” in front of the need it is denoted as latent. Latent needs are those that are important for many customers when using a product, but that the customer does not or cannot articulate in advance. The rating is based on assumptions of what needs are essential for the carrier to fulfill in order to achieve its functional purpose, in this stage, the customer opinion is not considered. Ratings of the first 13 needs that were made are presented in Table 3 below, the complete list can be found in Appendix D.

Table 3 Describes the importance rating of the secondary needs.

| Rating | Organizing Needs |
|---------------|--|
| | The Product is usable in all climates |
| ** | The product is resistant to moisture. |
| ** | The Product is designed to last over time. |
| ** | The Product dries fast after use. |
| *** | The Phone is securely attached to the product. |
| ** | The Product is water and dirt resistant. |
| * | The product is tough and scratch resistant. |
| | |
| | The Product has several pockets for storage. |
| ** | The product has the ability to store all the necessary stuff. |
| ** | The Product can easily be combined with headphones. |
| | |
| | The design is discreet. |
| ! | Stylish design for both everyday and sporty use. |
| * | It is possible to carry the product under your clothes while using it. |
| * | The product is discreet but adaptable for younger persons. |
| * | The design is not too big. |
| ** | The product design is made easy with only a few features. |

4.1.1.4 Establishing the relative importance of the needs

The rating importance of the secondary needs described in 4.1.1.3 does not consider the customers' opinions of the relative importance of the needs. Trade-offs must be made in order to create a product with a reasonable number of needs. The relative importance can be used to understand which needs are the most important for the customer and hence make the best trade-offs. Based on the answers from the interviews and the questionnaire, the needs were graded using relative importance, from 1 to 5, according to Ulrich and Eppinger's definition [1]:

1. Feature is undesirable. I would not consider a product with this feature.
2. Feature is not important, but I would not mind having it.
3. Feature would be nice to have but is not necessary.
4. Feature is highly desirable, but I would consider a product without it.
5. Feature is critical. I would not consider a product without this feature.

When the grading was made the number of answers were taken into consideration. Table 4 below presents a list of the first 13 needs with a number indicating the relative importance. The full list can be found in Appendix D.

Table 4 Relative Importance of the Needs

| Rating/Importance | | Organizing Needs into a Hierarchy |
|--------------------------|----------------|--|
| | Need no | |
| | | The Product is usable in all climates |
| 5 | 1 | The product is resistant to moisture. |
| 3 | 2 | The Product is designed to last over time. |
| 3 | 3 | The Product dries fast after use. |
| 5 | 4 | The Phone is securely attached to the product. |
| 4 | 5 | The Product is water and dirt resistant. |
| 4 | 6 | The product is tough and scratch resistant. |
| | | The Product has several pockets for storage. |
| 4 | 7 | The product has the ability to store all the necessary stuff. |
| 3 | 8 | The Product can easily be combined with headphones. |
| | | The design is discreet. |
| 2 | 9 | Stylish design for both everyday and sporty use. |
| 2 | 10 | It is possible to carry the product under your clothes while using it. |
| 2 | 11 | The product is discreet but adaptable for younger persons. |
| 3 | 12 | The design is not too big. |
| 5 | 13 | The product design is made easy with only a few features. |

After the grading of the relative importance, a selection of the needs was made, choosing only the ones considered most important. What had previously been 34 needs were reduced to 20. Table 5 below presents a list of the final needs.

Table 5 The 20 needs that are to be taken into consideration when designing the product.

| Chosen Needs | |
|---------------------|---|
| Need no | |
| | The Product is usable in all climates |
| 1 | The product is resistant to moisture. |
| 4 | The Phone is securely attached to the product. |
| | The Product has several pockets for storage. |
| 7 | The product has the ability to store all the necessities. |
| | The design is discreet. |
| 11 | The product is discreet. |
| 13 | The product design is made easy with only a few features. |
| | The Product is comfortable to use. |
| 16 | The product is comfortable without causing irritation. |
| 17 | The product does not interfere with the user's movements |
| | The Product is balancedly placed on the body. |
| 18 | The product is placed tight on the body. |
| 19 | The product is still when used. |
| 20 | The product is centered on the body. |
| | The Mobilephone is reachable in the Product. |
| 21 | The Product has an easy way to release/place the mobilephone in the holder. |
| 22 | The mobile phone can be reached when using outerwear. |
| 24 | The mobile phone can easily be reached. |
| | The product is priceworthy |
| 25 | The Product price fits well the customer expectations. |
| 32 | The product is cheap to produce |
| | The Product is easy to use in all ages. |
| 26 | The Product is easy to attach and release. |
| | The Product fits different types of mobiles with different shapes and sizes. |
| 29 | The holder is adjustable to different phone sizes. |
| | Useful for all body constellations |
| 30 | The Product is adjustable to different body sizes. |
| | The mobile phone must not be shielded by the material. (Metal wires or similar that screen GPS signals picked up by the cell phone). |
| 31 | Keys and kreditcards is placed on the side of the phone. |
| 33 | The material does not contain metal |

4.2 Establishing Target Specifications

This chapter explains the process to create the necessary target specifications for the product. The target specifications are based on the information given by the project provider and the identified customer needs and are a method described by Ulric and Eppinger [1].

4.2.1 Establishing the Target Specifications.

The target specification's purpose is to give information to the product developer on what must be fulfilled to please the customer. In comparison to the customer needs the specifications give a more precise description and is more explicit. [1]

To create target specifications a list of metrics is made. The list of metrics is created from the list of needs that was established. It is assumed that a translation from customer needs to a set of precise, measurable, specifications is possible and by meeting this specification, the customer need will be fulfilled. The metrics are ranked in order of importance. To create the list of metrics one must consider what measurable characteristic each need can be described by. The need might be described by more than one metric. The list of metrics is made as objective as possible, however, some metrics are marked with "subj" for subjectivity where objectivity is not possible. It is preferable to use objective metrics as far as possible to help understand and engineer the product. However, when it is not possible to objectively describe the product, it can be left as subjective.

To establish qualitative specifications, benchmarking is made on the current market. In this case, the benchmarking was based on products that were most used by the people answering the questionnaire. See Appendix E to view the table of benchmarked products.

Based on the information received from the benchmarking and the identified needs from the customers, ideal and marginal values are set. The ideal value is the value to strive for in the product development phase. However, there are also marginal values that is acceptable. The purpose of the marginal and ideal values are to aid the concept generation and selection, and for improving products in later stages. The marginal and ideal values are decided by looking at benchmarked products and compare their properties with the ones desired for the carrier. By looking at what measurements these products have it becomes easier to decide which values the final products should strive for. The marginal values are decided by looking at the largest conceivable value the product could have and still fulfill the needs. The ideal value is decided by taking the value from the product that are considered fulfilling the needs in the best possible way. For example, the weight was chosen from the lightest product on the market, as the product should be comfortable and not interfere with

the user's movements. Table 6 below presents the marginal and ideal values that were decided.

The specification regarding material was left undefined due to the research that must be made within the subject before an exact material can be chosen. There are many aspects to be taken into consideration when choosing material due to the many needs that must be fulfilled. See need 5,16,31 and 32 in Table 4.

Table 6 The List of Target Specifications with Ideal and Marginal Values

| Target Specifications | | | | | | |
|-----------------------|-----------|------------------------------------|-----------|------------|--------------------------------|--------------------------|
| Need No. | Metric Nd | Metric | Units | Importance | Marginal value | Ideal value |
| 11,13, 25 | 1 | Visual appearance | Subj. | 4 | Discreet | Discreet |
| 21, 22, 24,26 | 2 | Easy to use | Yes/no | 5 | Yes | Yes |
| 29 | 3 | Adjustable phone holder size | Yes/no | 5 | Yes | Yes |
| 18,19,20 | 4 | Steady attachment | Yes/no | 5 | Yes | Yes |
| 5,16,33, 32 | 5 | material | - | 5 | Undefined | Undefined |
| 7,29 | 6 | Volume | L | 4 | 0,2-0,8 | 0,6 L |
| 17 | 7 | Weight | kg | 3 | <250 g | 70 g |
| 16, 17 | 8 | Comfortable | Yes/no | 4 | Yes | Yes |
| 1 | 9 | Moisture resistant | Yes/no | 4 | Yes | Yes |
| 30 | 10 | Product Size | mm | 4 | L: adapt. H: 40-120 T: 1-20 | L:660-1200, H:40, T:5 |
| 7,31 | 11 | Compartments | quantity | 4 | 1 | 2 |
| 17 | 12 | Does not affect the users actions | True/Fals | 4 | True | True |
| 4 | 13 | The phone is secure in the product | Yes/no | 5 | Yes | Yes |
| 25, 32 | 14 | Price | kr | 3 | 250-350 kr | 250 kr |

4.3 Important Data

This part presents the limited values that must be considered in order to meet the most important needs and requirements of the product.

4.3.1 Adaptable Dimensions

Two of the most important requirements of the product are that it should have *adjustable size* and that it should be *adaptable to different phone sizes*.

4.3.1.1 Waist Dimensions

The same product should thus work for people with a small waist as well as a larger waist.

Because the main users of the product are grown-ups, the elderly, and athletes, the adaptable sizes will be based on standard measurements for grown-ups. Children's sizes will not be taken into consideration.

The standard waist sizes for males and females are presented in Table 7 and Table 8 below. The measurements are considered standard for the different sizes.

Table 7 Waist Chart for Men

| Size | 42/XS | 44-46/S | 48-50/M | 52-54/L | 56-58/XL | 60-62/XXL |
|----------|-------|---------|---------|---------|----------|-----------|
| Waist cm | 72 | 76-80 | 84-88 | 92-96 | 100-104 | 108-112 |

Table 8 Waist Chart for Women

| Size | 32/XXS | 34/XS | 36-38/S | 40-42/M | 44-46/L | 48-50/XL |
|----------|--------|-------|---------|---------|---------|----------|
| Waist cm | 60 | 64 | 68-72 | 76-80 | 85-90 | 96-102 |

In Table 8 it can be read that women with size 32 have the smallest waist of 60 cm and in Table 7 men with size 62 have the largest waist size of 112 cm. To meet the requirement of an adjustable waist size it would be desirable to make a product that can be as small as 60 cm and as large as 112 cm.

4.3.1.2 Phone Dimensions

The smartphones of today differ in size depending on the brand and model. In order to understand the range of measurements needed it is necessary to look at the different models and compare them to get a span that fits well with the smartphones, people use today.

In order to do this, many different models and brands were compared, this included the most common smartphones today were investigated as well as smartphones adapted for seniors. Table 9 below presents the size chart for the different models i.e. - width, height, depth, and weight. In the end, a marginal and ideal value range was decided for the dimensions the product should vary between in order to be adaptable.

The marginal and ideal values were decided by looking at the range between the smallest values and the largest values. Since the holder should work for different phone sizes, according to one of the critical needs, it was important that it was adaptable for the models that are commonly used today. The ideal values were calculated directly from the lowest and highest values of the existing models. However, since the smartphone market is very volatile, margins were added to the marginal values because the smartphones can both get smaller and bigger in the future, this will give the product some space for future development.

Table 9 Benchmarking Smartphones

| Smartphones | | | | | | | | |
|------------------------------|-----------------|-----|-----------------|-----|-----------------|-----|--------|-----|
| Product name | Width | | Height | | Depth | | Weight | |
| Doro 8035 | 70,1 mm | | 148,6 mm | | 9,48 mm | | 171 g | |
| Apple Iphone 12 Pro | 71,5 mm | | 146,7 mm | | 7,4 mm | | 189 g | |
| Apple Iphone SE/ iPhone | 58,6 mm | | 123,8 mm | | 7,6 mm | | 113 g | |
| Apple Iphone 12 Pro Max | 78,1 mm | | 160,8 mm | | 7,4 mm | | 228 g | |
| Iphone 12 mini | 64,2 mm | | 131,5 mm | | 7,4 mm | | 133 g | |
| Iphone 6S | 67,1 mm | | 138,3 mm | | 7,1 mm | | 143 g | |
| iphone 11 Pro | 71,4 mm | | 144 mm | | 8,1 mm | | 194 g | |
| Asus Zenfone 7 Pro | 77,3 mm | | 165,1 mm | | 9,6 mm | | 230 g | |
| Asus ROG phone 3 | 78 mm | | 171 mm | | 9,9 mm | | 240 g | |
| Huawei P20 Pro | 73,9 mm | | 155 mm | | 7,8 mm | | 180 g | |
| Huawei P40 | 71,1 mm | | 148,9 mm | | 8,5 mm | | 175 g | |
| Huawei P40 Pro | 72,6 mm | | 158,2 mm | | 9 mm | | 209 g | |
| Motorola Edge Plus | 71,3 mm | | 161 mm | | 9,6 mm | | 203 g | |
| OnePlus 8 | 72,9 mm | | 160,2 mm | | 8 mm | | 180 g | |
| Poco F2 Pro | 75,4 mm | | 163,3 mm | | 8,9 mm | | 218 g | |
| Samsung Galaxy Note 9 | 75,2 mm | | 161,6 mm | | 8,3 mm | | 194 g | |
| Samsung Galaxy S9 | 68,7 mm | | 147,7 mm | | 8,5 mm | | 163 g | |
| Sony Xperia | 73 mm | | 158 mm | | 9,9 mm | | 193 g | |
| Xiamo mi 10 | 74,8 mm | | 162,6 mm | | 8,96 mm | | 208 g | |
| Samsung Fold 2 | 68 mm | | 159,2 mm | | 16,8 mm | | 282 g | |
| Nokia 7,2 | 75,2 mm | | 159,9 mm | | 8,3 mm | | 180 g | |
| Nokia 7 Plus | 75,6 mm | | 158,4 mm | | 8 mm | | 183 g | |
| Doro 8080 | 73,6 mm | | 156,7 mm | | 8,72 mm | | 175 g | |
| iPhone 4 | 58,6 mm | | 115,2 mm | | 9,3 mm | | 137 g | |
| Range for measurement values | Min | Max | Min | Max | Min | Max | Min | Max |
| Marginal Value | 58,6 - 78,1 | | 115-171 | | 7,1-17 | | 113 g | |
| Ideal Value | 55 - 80 = 25 mm | | 110-180 = 70 mm | | 6,5-17 = 10,5mm | | 300 g | |

4.4 Reduced Mobility in Older Adults

This part enhances what happens in the human body when aging. One important aspect is that the product should be useable for older people, therefore, it is important to further investigate in what way older people can be limited in motion in order to adapt the carrier in the best possible way for all users.

4.4.1 An Aging Body

According to Brun Ulfhake, professor at Karolinska Institute in Stockholm, people are designed to be perfectly functional for about 30 years. After the age of thirty symptoms are shown indicating biological aging. [3]

4.4.1.1 Muscles

As a result of aging muscles and strength decrease. By the age of 80, the average person has lost half of the muscular mass. It is especially type II muscle fibers that are lost, and these are the fast muscle fibers. It is the muscle fibers that help you rise from the floor without support. [4]

4.4.1.2 Balance

When aging, the balance deteriorates which is partly due to muscle loss. The moveability in the back and feet also decreases and are both important for balance. [4]

4.4.1.3 Joints

Joints become less elastic as you get older, which impairs mobility. Many older people suffer from the joint disease osteoarthritis where the cartilage is destroyed and can affect the finger, knee, and hip joints. [4]

4.4.1.4 Multi-joint movements

As the human body ages, movements become less smooth and slower. Deficits are shown in the coordination of bimanual and multi-joint movements. Multi-joint movements are those combining the use of two joints in the same movement. For example, moving the elbow and shoulder simultaneously. Science shows that degeneration of the proprioceptive system and cerebellum can affect and contribute to the deficit in multi-joint coordination of the elderly. [5]

4.4.2 Aging Hands

It is not only the human body that ages, but as we get older our main tools, the hands, seem to change.

4.4.2.1 Arthritis

As mentioned in Section 4.4.1.3 it is very common to suffer from joint disease when getting older. This is called arthritis and can affect the hands especially among the elderly. Arthritis in the hands can make it hard to do everyday chores and can be very painful. [6]

4.4.2.2 Loss of Strength

It is very common that as we age, we lose strength in the hands. A loss in grip strength can consequently complicate everyday tasks. [6]

4.4.2.3 Less Dexterity

As we get older our dexterity deteriorates and things that seem natural and simple to do become incredibly challenging. Things that require detailed work become

harder to perform. Things like using a phone with small buttons are a great example of an action like this. [6]

5 Concept Generation

This chapter describes the used method for concept generation, the third step in Ulrich and Eppinger's model of the process, see Figure 4 below. The concept generation includes the decomposition of problems into subproblems, internal search, external search, and results from the concept generation.

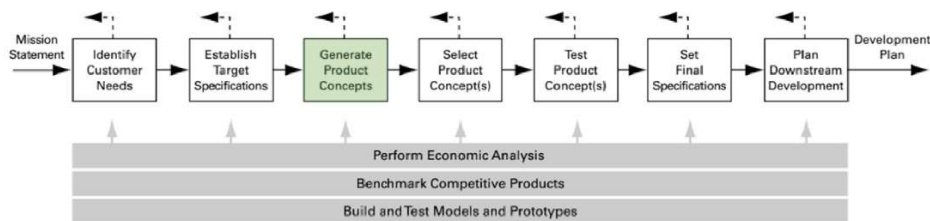


Figure 4 The Concept Development Process, step 3, [1]

5.1 Main Problem

The main problem is to design a product that is adaptable to different sizes of mobile phones as well as body sizes. The product must be useful in both everyday use where the patient may be old and have problems with certain movements, it must at the same time, it must be usable by athletes out in the running tracks. How the product should look and feel when used might not match for the two customer groups. A too sporty design might not be useful for everyday use, while a too ordinary design might not be suitable for running. The challenge is to create a concept that fits both customer groups equally.

5.1.1 Subproblems

To simplify the concept generation, the main problem is decomposed into subproblems. This is made based on the actions that are possible to make with the

carrier. For example, applying it to the body, moving with it, applying the phone to the carrier, etc.. The actions are presented in Table 10 (left column) with supplementary subproblems (right column). The design and economic aspects of the product are not actions themselves but nonetheless important to consider when designing the product therefore they were created as their own subproblems.

Table 10 Describing the subproblems of the product.

| Clarifying the Problem | | |
|--|---|---|
| Decomposition by sequence of user action | | |
| Apply the Product on the body | → | The product is placed tight on the body. Adjustable size |
| Apply the phone to the product | → | Adjustable phone size Simple functions Usable for elderly |
| Use the product when moving | → | Balanced placed Comfortable Usable in all climates |
| Measure movements | → | Still when in use Material |
| High reachability of the phone | → | Easy to place Easy to reach |
| Discreet Design | → | Storage possibilities Simple design Few features |
| Economical aspects | → | Cost to manufacture Cost to buy |

5.2 Search Internally

To generate new concepts an internal search was made. This is done by brainstorming about the subproblems and then combining the different ideas from the different brainstorming, forming new concepts and products.

5.2.1 Brainstorming

The brainstorming was divided into five sections directly six of the actions correlating to; *Apply the product on the body*, *Apply the phone to the product*, *Use the product when moving*, *High reachability of the phone*, *Measure movements*, and *Discreet Design*. The material and economic aspects were not taken into consideration in this early step. The ideas from the different brainstorming sections were combined to form new concepts. The sketches that were produced during the brainstorming are presented in Appendix F.

5.2.2 Paper Prototypes

To get an understanding of which disadvantages and advantages different concepts might have, simple prototypes were made of the designs that best met the product criteria and where it was considered to exist an opportunity for development. New concepts were also formed along the way and included in this step. Appendix F presents the prototypes with a description.

5.3 Search Externally

During this phase of the concept generation information was gathered from external sources. The methods used were interviews of lead users, benchmarking of related products, and creation of mood boards.

5.3.1 Interview of Lead Users

At the beginning of the project interviews of potential lead users were made. A lead user is a person that is first with discovering the existence of a demand for the product. They know what works and what does not work better than anyone with similar products on the current market. [1]

The lead users were from the customer segment presented in Section *1.1.1.2 Runners*, the persons interviewed were people working as coaches to runners and were runners themselves.

Only two interviews with physiotherapists were made from the other customer segment, *1.1.1.1 Rehabilitation Patients*. It can be discussed if they can be classified as lead users or not. Nevertheless, they possess a large amount of knowledge regarding the possible users and what their needs and demands are.

The information received from these interviewees were partly used to create the weighted values of the criteria used for the concept selection later, see *Chapter 6 Concept Selection*. The information was also used for idea generation, where tips were given of what features might be important or less important to use on a product, for example, sharp edges on components and to put focus on the simplicity of the user-interaction.

5.3.2 Benchmarking of Related Products

To understand how competitors have solved similar problems and satisfied the same criteria, a benchmarking was done on existing products. The full list of benchmarked products can be found in Appendix G. The products' properties and materials are documented. Things like the use of elastic fabrics and larger waistbands are examples of ideas that were created when looking at the benchmarked products.

MIIBELT NEW AND IMPROVED



Figure 5 Benchmarked Product: Miibelt New and Improved

5.3.3 Mood Board

To get an understanding and feeling of the needs that the product should fulfill, several mood boards were created. They were created with the purpose of giving inspiration to the idea generation sequence. The needs that were touched were

Discreet design, Simplicity, Few features, Still Placement, Tight fitting, Moisture resistance, and Cheap design.

Mood boards are created to achieve the right feeling so that the product ends up with the wanted features. The Discreet mood board below is inspired by transparency, discreet colors, movements, and soft-shaped products. Most of the ideas that came from the mood boards concerned the outer look of the carrier and not that much the function. See Appendix H to view the rest of the mood boards.



Figure 6 Discreet Mood Board

5.4 Explore Systematically

Five main concepts for the holder that will be a part of the carrier were produced. The holder is the phone carrier. When the idea generation sequence was done, a lot of ideas had been produced. The different concepts describing the holder solution is a combination of many ideas that were built upon the same function, and therefore they were assembled into only five concepts, see appendix F to explore the ideas and prototypes in detail. The concepts of the holders are presented as main ideas with development potential, and marked with the letter A-E. The concepts for the holders are combined with three attachment solutions that describe the way the carrier is attached to the user's body. The reason why the concepts generated were

divided this way was because it was seen as the two most important features of the carrier; how to adapt it to different phone sizes and body sizes. It was not obvious in this stage that one of the attachment solutions were better than the other, while at the same time, it was not obvious that one of the concepts for the holder was better than the other. The different concepts of holders and attachment solutions was considered necessary to be evaluated before complete concepts of an entire carrier could be assembled. Combinations with the holder concepts were made with the attachment solutions, leading to 14 different carrier solutions for deeper investigation.

5.4.1 The Concepts

The five concepts are presented shortly below and further explained in Appendix I. All concepts are drawn with a waistband to better illustrate the idea of the holder.

5.4.1.1 Concept A

The waistband is spun around a bag where the mobile phone is placed. When the strap is tightened around the waist, it is simultaneously tightened around the mobile phone and holds it in place. Figure 7 illustrates concept A.

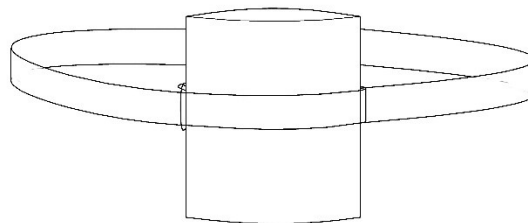


Figure 7 Illustration of Concept A

5.4.1.2 Concept B

This concept is based on the idea of having different sized pockets that fit different sizes of mobile phones. The user chooses the pocket that best fits their mobile phone size. The concept can be designed in many different visual appearances and combined with other pockets for necessary storage. Figure 8 illustrated concept B.

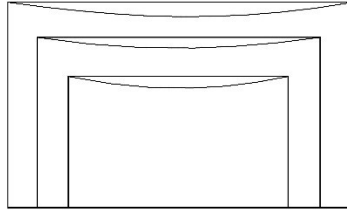


Figure 8 Illustration of Concept B

5.4.1.3 Concept C

This concept is based on the product material. With an elastic pocket, any size of mobile phone can fit the pocket and at the same time takes up less space. The pocket can be closed with various methods such as zippers, push-button or Velcro. Figure 9 illustrates concept C.

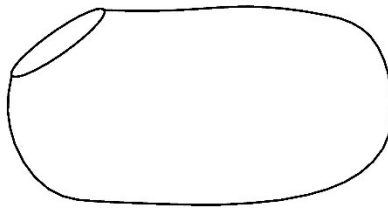


Figure 9 Illustration of Concept C

5.4.1.4 Concept D

For this concept, the idea is that clamps made of plastic or similar material are placed at a certain distance between each other so that all mobile phone sizes can be placed between the clamps. The concept can be further developed with a cover to protect it from external stress. Figure 10 illustrates concept D.

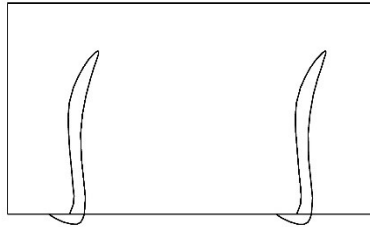


Figure 10 Illustration of Concept D

5.4.1.5 Concept E

The idea behind concept E is to adjust a pocket for the phone to the right size by placing clamps that can be modified to fit the size of the phone and adjust the pocket size. Figure 11 illustrates concept E.

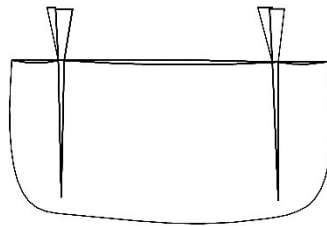


Figure 11 Illustration of Concept E

5.4.2 Attachment Solutions

There are three attachment solutions that have been more thoroughly looked at and combined with the five different holder concepts, presented above. The Figures 12-14 are examples of how the solutions might look.

*5.4.2.1 Small Band Around the Waist – **SB***

An attachment solution is a small waistband. It is adjustable to different waist sizes and is buttoned in the front, making it both easy to attach and detach. The small waistband has a thinner width which creates an anonymous appearance.

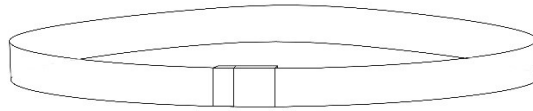


Figure 12 Illustration of how a small waistband might look like.

5.4.2.2 Large Band Around the Waist – LB

The second solution is instead a large waistband with the same width that is obtained from the holder and that later decreases into a thinner band. The thinner ending is used to minimize the irritation from the button device, by allowing it to be smaller. The button device placed on the side. The idea of the thicker waistband is to offer greater stability and a weight distribution from the weight of the mobile phone.

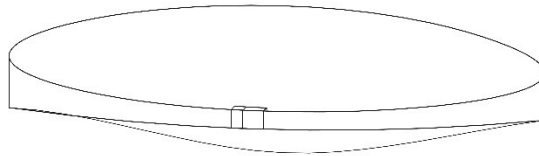


Figure 13 Illustration of a large waistband might look like.

5.4.2.3 Clamps that are Applied on the Trousers – CL

The third attachment solution is designed as a clamp that is applied to the users' trousers. This solution can be used on all body types because it is applied directly to existing garments.

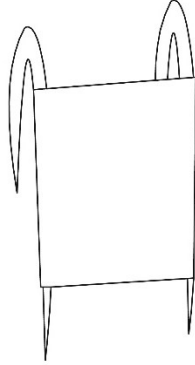


Figure 14 Illustration of how the clamp solution might look like.

5.4.3 Combinations

Table 11 below describes the combinations of the concepts with names.

Table 11 Concept Combinations

| Name: | Concept of Holder: | Attachment Solution: |
|--------------|---------------------------|-----------------------------|
| A: SB | Concept A | Small Band |
| A: LB | Concept A | Large Band |
| B: SB | Concept B | Small Band |
| B: LB | Concept B | Large Band |
| B: CL | Concept B | Clamp |
| C: SB | Concept C | Small Band |
| C: LB | Concept C | Large Band |
| C: CL | Concept C | Clamp |
| D: SB | Concept D | Small Band |
| D: LB | Concept D | Large Band |
| D: CL | Concept D | Clamp |
| E: SB | Concept E | Small Band |
| E: LB | Concept E | Large Band |
| E: CL | Concept E | Clamp |

6 Concept Selection

This chapter presents the concept selection process, it consists of two different methods, concept screening and concept scoring. This chapter also presents developed physical prototypes.

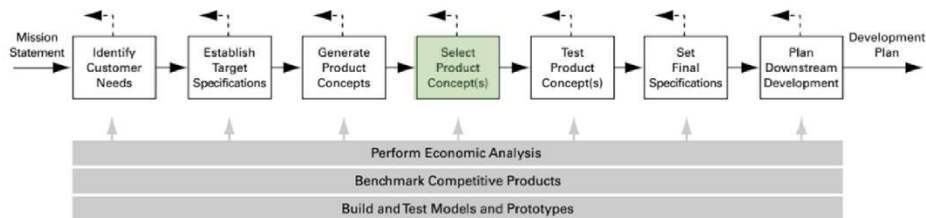


Figure 15 The Concept Development Process, step 4

6.1 Concept Screening

Concept screening is a method that helps decide which concepts to keep for further development and which concepts to exclude by comparing the concepts to an existing product on the market. This is because it is not reasonable to further develop 14 different concepts. In this case, the comparison was made against the Miibelt, see Chapter 5 Section 5.3.2. The reason why this reference product was chosen was that it exhibits similar properties the product that is to be developed. For example, it fits different sizes of mobile phones and is also designed to fit different body sizes. No other product that was benchmarked was adjustable to all smartphones and body sizes and it was for this reason the Miibelt was chosen. See Appendix G for more information regarding the Miibelt and the other products that were not chosen. [1]

Based on the reference product, a comparison and rating were made between the concepts and the reference product.

A selection matrix was prepared, which referred to criteria that touched important characteristics and needs for the product. It was based on the needs, *critical needs*,

necessary needs, and *desirable needs*. The division was built on the relative importance of the needs that were made at the beginning of the process, see Chapter 4. If the concept seemed better in a requirement than in the reference product it got a positive grade (+), if it seemed as good as the reference it instead got a neutral grade (0) and if it did not fulfill the same capacity as the product, it got a negative grade (-). The concept screening is presented in Table 12 below.

Table 12 Concept Screening

| Selection Criteria | Concepts | | | | | | | | | | | | | | |
|--|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|--|
| | A | | B | | | C | | | D | | | E | | | |
| | SB | LB | SB | LB | CL | SB | LB | CL | SB | LB | CL | SB | LB | CL | |
| Critical Needs | | | | | | | | | | | | | | | |
| The holder is adjustable to different phone sizes. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| The Product is adjustable to different body sizes. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| The Phone is securely attached to the product. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| The product is still when used. | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Necessary Needs | | | | | | | | | | | | | | | |
| The Phone is protected when in the product | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | |
| The product can be attached by older people with difficulties to move | 0 | 0 | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | |
| The product design is made easy with only a few features. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | + | + | - | - | - | |
| The product is comfortable without causing irritation. | 0 | 0 | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | |
| The product does not interfere with the user's movements | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| The product is resistant to moisture and outer stresses | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | 0 | 0 | 0 | |
| The mobile phone in the holder can easily be reached. | - | - | 0 | 0 | 0 | 0 | 0 | 0 | + | + | + | 0 | 0 | 0 | |
| The Product has an easy way to release/place the mobile phone in the holder. | - | - | 0 | 0 | 0 | 0 | 0 | 0 | + | + | + | 0 | 0 | 0 | |
| The Product can be used with all kinds of clothing | 0 | 0 | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | |
| Desirable Needs | | | | | | | | | | | | | | | |
| The product is placed tight on the body. | + | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| The product can store all the necessities. | - | - | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | |
| The mobile phone can be reached when using outerwear. | - | - | 0 | 0 | 0 | 0 | 0 | 0 | + | + | + | - | - | - | |
| The product can be placed under clothes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | |

| | | | | | | | | | | | | | | |
|--------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| The product is discreet. | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Score | | | | | | | | | | | | | | |
| sum +’s | 2 | | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5 | 5 | 0 | 0 | 0 |
| sum 0’s | 13 | 13 | 18 | 19 | 16 | 19 | 18 | 15 | 10 | 10 | 7 | 13 | 13 | 10 |
| sum -’s | 4 | 4 | 1 | 0 | 3 | 0 | 1 | 4 | 4 | 4 | 7 | 6 | 6 | 9 |
| Net | -2 | -2 | -1 | 0 | -3 | 0 | -1 | -4 | 1 | 1 | -2 | -6 | -6 | -9 |
| Rank | 8 | 8 | 5 | 3 | 10 | 3 | 5 | 11 | 1 | 1 | 5 | 12 | 12 | 14 |
| Continue? * | N | N | Y | Y | N | Y | Y | N | Y | Y | N | N | N | N |

*N=No, Y=Yes

6.1.1 Reflection Concept Screening

After the concept screening was made only six of the fourteen concepts were chosen for further investigation. The reason why eight of the concepts did not continue to the next step was because they received a lower score compared to the others and a negative score when comparing them to the reference product. Two of the six products that were approved for further investigation also received a negative score when comparing to the referenced product, however the difference was by only one unit (-1) and it therefore seemed evident to also continue with these two. It is important to keep in mind that the concept is not yet fully developed, and changes and additions can be made to improve them so that they can receive a higher score than the reference product. It might seem hard to exclude the concepts that received a score of (-2) however this was done to make the project feasible to handle. They also had limited development opportunities.

All the different versions of concept A and concept E were excluded after the concept screening. The development opportunities for these concepts were considered limited and therefore not relevant for deeper investigation. Concept A is dependent on the tightening mechanism received from the waistband which makes the mobile phone hard to reach quickly without having to discharge the entire product from the body. This design also creates limitations with regards to extra storage space. Concept E lacks the simplicity that is essential for the product. The user must tighten the clamps on both sides of the mobile phone. If the user quickly wants to release the mobile phone from the product, he or she must loosen the clamps again before reaching the phone. This extra step is not simple nor smooth enough to be considered a concept with potential for further development and therefore none of the three concept combinations from E are investigated further.

The concepts with the attachment solution consisting of a clamp were all removed, because, when we age, we develop a reduced mobility which makes it very hard to apply a product behind the back without increasing the risk of falling, see Section 4.4 *Reduced Mobility in Older Adults*. Using a clamp as an attachment solution would force a multi-joint movement that would be hard for the elderly and could

expose them to a high risk of falling and conclusively hurting themselves. This constituted a big reason why these concepts were already removed in the concept screening. There is also a high risk of imbalance when placing a clamp on the trousers. Also, because of the weight from the mobile phone the trousers can be weighted down and cause irritation when used.

6.2 Concept Scoring

The same criteria that could be found in the concept screening matrix is used for the concept scoring. The concepts that managed to get through the concept screening are now rated from a number 1 to 5 with the value described in Table 13 below. Based on the needs and wishes of customers and Medotemic, a weighting was made that described the importance of a criterion. The weighting was based on the relative importance of the needs and the hierarchy created in Chapter 4.

Every need received a weight, given in percentage, based on the answers given in the interviews, questionnaires and from Medotemic. The weight should represent the importance of each need and sum up to 100%. The scores are based on a comparison between the concepts and the reference product, the Miibelt. The weighted score is the product of the weight and score. Finally, the weighted scores are summed for each concept and compared to the reference product which has a value of three. If the concept receives a value larger than three it is considered better than the reference product, if it gets a lower value, it is considered worse. Table 14 presents the concept scoring.

Table 13 Value of the score rating

| Relative Performance | Rating |
|-----------------------------|---------------|
| Much worse than reference | 1 |
| Worse than reference | 2 |
| Same as reference | 3 |
| Better than reference | 4 |
| Much better than reference | 5 |

Table 14 Concept Scoring

| | | Concepts | | | | | | | | | | | |
|--|------------|----------|----------------|-------|----------------|-------|----------------|-------|----------------|-------|----------------|-------|----------------|
| | | B.SB | | B.LB | | C.SB | | C.LB | | D.SB | | D.LB | |
| Selection Criteria | Weight | Score | Weighted Score | Score | Weighted Score | Score | Weighted Score | Score | Weighted Score | Score | Weighted Score | Score | Weighted Score |
| Critical Needs | 32% | | | | | | | | | | | | |
| The holder is adjustable to different phone sizes. | 8% | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 |
| The Product is adjustable to different body sizes. | 8% | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 |
| The Phone is securely attached to the product. | 8% | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 |
| The product is still when used. | 8% | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 | 3 | 0,24 |
| Necessary Needs | 55% | | | | | | | | | | | | |
| The Phone is protected when in the product | 7% | 3 | 0,21 | 3 | 0,21 | 3 | 0,21 | 3 | 0,21 | 1 | 0,07 | 1 | 0,07 |
| The product can be attached by older people with difficulties to move | 7,5% | 3 | 0,225 | 3 | 0,225 | 3 | 0,225 | 3 | 0,225 | 3 | 0,225 | 3 | 0,225 |
| The product is easy to use | 7% | 3 | 0,21 | 3 | 0,21 | 3 | 0,21 | 3 | 0,21 | 4 | 0,28 | 4 | 0,28 |
| The product is comfortable without causing irritation. | 6% | 3 | 0,18 | 3 | 0,18 | 3 | 0,18 | 3 | 0,18 | 3 | 0,18 | 3 | 0,18 |
| The product does not interfere with the user's movements | 6% | 3 | 0,18 | 3 | 0,18 | 3 | 0,18 | 3 | 0,18 | 3 | 0,18 | 3 | 0,18 |
| The product is resistant to moisture and outer stresses | 5% | 3 | 0,15 | 3 | 0,15 | 3 | 0,15 | 3 | 0,15 | 2 | 0,1 | 2 | 0,1 |
| The phone in the holder can easily be reached. | 4% | 4 | 0,16 | 4 | 0,16 | 4 | 0,16 | 4 | 0,16 | 4 | 0,16 | 4 | 0,16 |
| The Product has an easy way to release and place the mobile phone in the holder. | 7,5% | 3 | 0,225 | 3 | 0,225 | 3 | 0,225 | 3 | 0,225 | 4 | 0,3 | 4 | 0,3 |
| The Product can be used with all kinds of clothing | 5% | 3 | 0,15 | 3 | 0,15 | 3 | 0,15 | 3 | 0,15 | 3 | 0,15 | 3 | 0,15 |
| Desirable Needs | 13% | | | | | | | | | | | | |
| The product can store all the necessities. | 5% | 3 | 0,15 | 3 | 0,15 | 3 | 0,15 | 3 | 0,15 | 1 | 0,05 | 1 | 0,05 |
| The product is placed tight on the body. | 3% | 3 | 0,09 | 4 | 0,12 | 3 | 0,09 | 3 | 0,09 | 2 | 0,06 | 2 | 0,06 |
| The mobile phone can be reached when using outerwear. | 1% | 3 | 0,03 | 3 | 0,03 | 3 | 0,03 | 3 | 0,03 | 4 | 0,04 | 4 | 0,04 |
| The product can be placed under clothes | 1% | 2 | 0,02 | 2 | 0,02 | 3 | 0,03 | 4 | 0,04 | 2 | 0,02 | 2 | 0,02 |
| The product is discreet. | 3% | 2 | 0,06 | 2 | 0,06 | 3 | 0,09 | 2 | 0,06 | 3 | 0,09 | 3 | 0,09 |

| | | | | | | | | | | | | |
|-------------|----------|--|-----|--|------|--|------|--|------|--|-----------|-----------|
| Score | 100 % | | | | | | | | | | | |
| Total score | | | 3 | | 3,03 | | 3,04 | | 3,02 | | 2,86 5 | 2,86 5 |
| Continue? | | | Yes | | Yes | | Yes | | Yes | | No | No |

6.2.1 Reflection Concept Scoring

Four concepts were chosen for further development after the concept scoring. The scores only differed with 0,01 units in some cases. This indicates that all concepts have potential. Nonetheless, two concepts did not receive as high score as the other and were therefore excluded. These were both based on concept D.

The four concepts that were chosen to be further investigated had a score very close to three which meant that they were neither better nor worse than the reference product. To improve the score of a concept, combinations of different concepts and parts of concepts could be developed. This was done during the next phase of the concept development.

The weighted values have not been discussed with future customers but are entirely based on the interviews, the surveys, and the company's wishes. given in an early stage of the process. There is a risk that the weighted values of the criteria are not entirely correct, and it would have been good to receive a second opinion on them from either Medotemic or future customers.

The concept screening and the concept scoring were not made by a team where bias could have been avoided but only based on a single person's own opinion and perceptions. This could have affected the results of the testing. To avoid this, it would have been appropriate to let other people score the different concepts from their perception to make sure that the right concepts are chosen.

6.3 Physical Prototypes

Physical prototypes were made to test the usability of the different design solutions. By creating physical prototypes close to realistic products things like errors, learnability, efficiency, and satisfaction can be understood and measured when testing them on users. The prototypes are based on the concepts that made it through the concept screening and concept scoring. [2]

6.3.1 Removable or Static Holder

Two different types of solutions regarding the holder are investigated in this stage. The first solution is that the holder is statically attached to the product and cannot be removed from it. The second solution is that the holder is removable from the product. The reason why this is tested is that it could be an advantage to have a removable holder if the user quickly would like to reach its properties without having to take off the entire product or fuss with a pocket behind the back.

6.4 Developed Prototypes

Five prototypes were developed and are presented below. They all differ slightly in size and design.

6.4.1 Prototype C.1: Thin Waist Bag with Releasable Holder

This prototype is a thin waist bag with a releasable holder. It is based on concept C. The main idea behind this concept is that it should be easy to reach the phone if something urgent happens like for example having to take a call. This prototype tests the removability of the holder, to find out if it could be a good solution to improve the criteria of high reachability of the phone. It should also be easy to place on the holder therefore, extra-strong Velcro is used as an attachment material. An extendable strap is used to achieve a tightening function and they are accompanied by clasps that can be tightened or loosened to fit the user's body. A traditional click buckle is used to attach the prototype around the waist. The material that the holder is made of is a four-way stretchable jersey fabric that allows the holder to expand to different phone sizes. Figure 16 presents Prototype C.1.



Figure 16 Carrier with Releasable Holder

6.4.2 Prototype C.2: Large Band Waist Bag with Several Pockets

This prototype is a large band design with several pockets for storing necessary items. It is also based on concept C. The band is decreasing in size so that it matches the thickness of the extensible band that creates the possibility for adjustment around different sizes of waists. The waistband is attached with a click buckle and made of a four-way stretchable jersey fabric which allows the holder to expand to different phone sizes. The thickness of the band helps to create stability around the waist and to distribute the weight from the items to a larger area. The close-to-the-body design allows it to be placed underneath clothes hiding it from the outer world. Figure 17 present Prototype C.2.



Figure 17 Large Band Waist Bag with Several Pockets

6.4.3 Prototype C.3: Thin Elastic Waist Bag

This prototype is built upon the characteristics of prototype C.2. It has several pockets for storage as well as a larger pocket for the mobile phone. The fabric used is Lycra, with highly elastic properties. Because of these properties, the pockets could be made smaller due to the large expansion rate. Once items are put in the pockets of the waistband the pockets expanded and created a larger area. The pockets have oblique cuts where the items should be placed. The idea behind this is too, with greater ease, be able to reach the items within the pocket. Figure 18 presents prototype C.3.



Figure 18 Thin Elastic Waist Band

6.4.4 Prototype B.1: The Several Pocket Waist Bag

Prototype B.1 is a thin waistband accompanied by a bag that consists of three pockets in different sizes. It is based on concept B. The three pockets are adapted to fit a range of different phones and the user chooses the pocket that best fits their phone. The fabric used in this prototype is jeans that have some elastic properties but not to the same extent as the Lycra used in prototype C.3. The design is very simple with an envelope-shaped cover that protects the phone. Instead of a click-buckle, a metal lock was used and adjustable buckles on each side of the metal lock to adjust the band to the right waist size without creating loose bands. Figure 19 presents prototype B.1.



Figure 19 The Several Pocket Waist Bag

6.4.5 Prototype B.2: Large Band with Pockets on the Side

This prototype is made of elastic jersey and attached the same way as prototype B.1, with a metal lock. The design of the prototype is like prototype B.1 with several pockets fitting different sizes of mobile phones, see concept B. The phone is placed on the side of the prototype. This is to make it easier to reach the phone quickly with a simple movement. The width of the prototype is large to distribute the weight of the mobile phone over a larger area. Figure 20 presents prototype B.2.



Figure 20 Large Band with Pockets on the Side

7 Testing

During this part of the concept development, testing of the products were made to ensure that the right concept was chosen for further development.

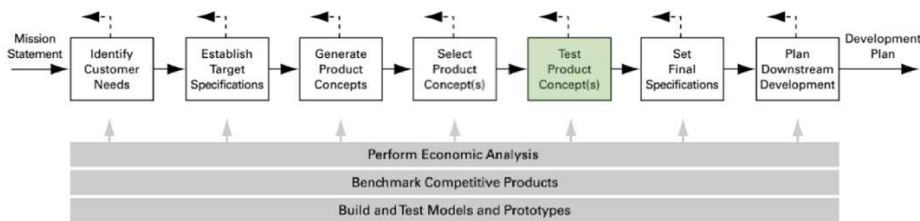


Figure 21 The Concept Development Process, step 5

7.1 Methodology

The concept testing follows the method described by Ulrich and Eppinger. [1] The goal of the testing is primarily to find out which concepts have potential, what advantages and disadvantages these concepts have, and which concepts are worth to develop further. The way the testing differs from concept screening and scoring is that the concepts now are tested on possible future customers using a physical prototype, instead of only comparing the theoretical concept with an existing product. In this phase, the ideas have been developed further from when they were in the concept screening and scoring phase.

Because the test occurs in an early stage of the concept development process and that it primarily intends to gather qualitative data the test is chosen to be made on a smaller sample size. [1]

People from both customer groups must be tested. It includes athletes who are out running and elderly people with limited mobility. Since the product must be adaptable to different phones and body sizes, people with different waist measurements must test the product. The tests must also be conducted with different sizes of mobile phones to measure properties such as comfort and stillness and to make sure these do not differ with the phone size.

The test persons are asked to perform a few tasks throughout the test, after each task the user gets to answer a questionnaire. After all the tasks are completed, the users are asked to answer an additional number of questions and to compare the different prototypes with each other. The test persons actions are observed and noted. Due to the Covid-19 situation, the test persons were close family and friends and consisted of seven people. The test persons had not before participated in the process before.

7.2 Results from the Testing

The results from both the answers collected in the questionnaire and the observations made during the test were analyzed. The opinions from the test persons are closely observed to find out if any pattern can be detected or any new perspective is created.

7.2.1 Grades from the Testing

The results from the testing are presented below where every comment and grade for each prototype is presented. The test person got to grade how well/badly something was working or how hard/easy tasks were to perform, see Appendix J. Depending on how the test person experienced the different carriers in different fields they got to give them a grade from 1 to 5. Where 1 is the lowest grade and 5 is the highest and the grade to seek in the final product. An average value from the test people had been calculated.

Table 15 Grades from 1-5 describing how the users experienced the prototypes when testing them.

| Prototype | C.1 | C.2 | C.3 | B.1 | B.2 |
|---|-----|-----|-----|-----|-----|
| Placing the phone in the holder: | | | | | |
| Small phone | 3,9 | 4,8 | 3,4 | 4,8 | 3,7 |
| Middle phone | 4,5 | 4,8 | 3,5 | 4,8 | 4 |
| Large phone | 3,8 | 3,6 | 2,8 | 4,8 | 4,2 |
| Attached on the body when moving | | | | | |
| Comfortability | 4,3 | 4,5 | 4 | 4,7 | 4,8 |
| Balanced placed around the waist | 5 | 4,5 | 4,4 | 4,9 | 4,8 |
| Safe storage of the phone | 4,5 | 4,4 | 3,7 | 4,4 | 3,7 |
| Well attached around the waist | 3,6 | 5 | 4 | 4,5 | 5 |
| Interaction with the phone | | | | | |
| Reaching the phone when on the body | 4,7 | 4,8 | 5 | 4,7 | 4,5 |
| Placement of phone when on the body | 2,2 | 4 | 2,9 | 3,7 | 3,2 |
| General opinion | | | | | |
| User-friendliness | 4 | 4,7 | 3,2 | 3,2 | 3,7 |

7.2.2 Prototype C.1: Waist Bag with Releasable Holder

Comments and observations from the test performances are presented in Table 16 below for prototype C.1.

Table 16 Comments and Observations from the Test of Prototype C.1

| | |
|---|---|
|  | <p>Comments:</p> <ul style="list-style-type: none"> + Easy to attach + Simple design + Hardly noticeable when moving - Hard to place the phone in the holder - Hard to loosen the holder from the Velcro - Shaky when walking/running - Hard to release/attach the phone from the holder <p>Observations:</p> <p>The loosening function created by the Velcro was not used and did therefore not serve its purpose. The holder was very shaky when walking and running.</p> |
|---|---|

7.2.3 Prototype C.2: Large Band Waist Bag with Several Pockets

Comments from the test performances are presented in Table 17 below for prototype C.2.

Table 17 Comments from the Test of Prototype C.2

| | |
|---|--|
|  | <p>Comments:</p> <ul style="list-style-type: none"> + Only one feature to adjust the band around the waist + Extra storage space + A larger band contributed to more distributed pressure around the body. + Easy to reach and place the phone - Hard to understand when the phone is centered - Unstable when attaching it to the body - The buckle loosens itself - The end of the band is loose and disturbing when moving - The cover that protects the items felt unstable - Too thin bag creates a risk of feeling the items chafing on the body - The buckle is unpleasant against the stomach - No indication of what is front and back on the Waist Bag. - Too short cover protecting the phone. |
|---|--|

7.2.4 Prototype C.3: Thin Elastic Waist Band

Comments and observations from the test performances are presented in Table 18 below for prototype C.3.

Table 18 Comments and Observations from the Test of Prototype C.3

| | |
|--|---|
|  | <p>Comments:</p> <ul style="list-style-type: none"> + Easy to reach the phone + Extra storage space + Hardly noticeable when wearing it - Unstable when placing it around the waist - The phone was not safe in the bag, close to falling out, and a high risk of theft - It glides down and irritates the stomach - Hard to know when it is centered on the back - Hard to place back the phone in the holder when the waist bag is on the body - A bit shaky when walking with it - Missing the larger band for stability. |
| <p>Observations:</p> <p>The older test person did not manage to place any of the three sizes of mobile phones in the holder due to the small elastic pocket which requires a large amount of dexterity.</p> | |

7.2.5 Prototype B.1: The Several Pocket Waist Bag

Comments and observations from the test performances are presented in Table 19 below for prototype 4.


Table 19 Comments and Observations from the Test of Prototype B.1

| | |
|--|---|
|  | <p>Comments:</p> <ul style="list-style-type: none"> + Easy design that fulfills its purpose + Good looking + Easy to reach/place the phone - The clamp was hard to use and understand - Hard to understand which pocket to place the phone in - No extra storage space - Too thin waistband with a risk of gliding up and down. |
| <p>Observations:</p> <p>When placing back the phone behind the back, the test persons did not know which pocket they should put it in which contributed to an unstable placement.</p> <p>It is easy to use the empty pockets as extra storage space for other items. This, however, would mean that the GPS signals are at risk of getting disturbed which must be avoided.</p> | |

7.2.6 Prototype B.2: Large Band with Pockets on the Side

Comments and observations from the test performances are presented in Table 20 below for prototype B.2.

Table 20 Comments and Observations from the Test of Prototype B.2

| | |
|---|--|
|  | <p>Comments:</p> <ul style="list-style-type: none"> + Comfortable + Balanced placed + Easy to reach/place the phone when on the body - The clamp was hard to use and understand - Scared that the phone would fall out - The loose end of the band was annoying - No storage possibilities |
| | <p>Observations:</p> <p>The test persons did not know which pocket they placed the mobile phone back into after taking a call causing instability and uncertainty the phone would not remain in the holder.</p> <p>It was hard to understand when the phone was centered.</p> |

7.2.7 General Comments from the testing

The results show that no single bag was better or worse than another, instead, it showed that there existed preferable properties on each of the bags. All test persons chose a different or different combinations of bags as their favorite.

In general, it has been noticed that the following properties are preferable to most of the users:

- Being able to place the phone in the holder after removing it without having to take off the carrier from the body.
- An indication that the bag is centered on the back.
- No loose ends of bands.
- A simple button function that does not create too much pressure against the skin.
- Extra storage space for smaller items
- A hole for headphone cords.
- A cover with a button to keep the mobile phone safe in the holder.
- A large band for stability.
- A pocket that is opened on the side of the waist bag.

7.2.8 Conclusions from testing

Some conclusions can be drawn based on the results from the testing. As mentioned before no bag was significantly better than any other and therefore a deeper analysis was made on the different properties to understand which of them ~~that~~ were advantageous or disadvantageous.

During the test prototype C.3 received quite a high score with regards to comfort, balanced placement, attachment, and reachability. Despite these high scores, prototype C.3 is not viewed as a good candidate for a final design. This is because it does not consider one of the important customer group, the elderly. Prototype C3 is made of elastic material which, for the elderly, is hard to manage. With their poor hand dexterity, it becomes almost impossible to place the phone properly in the bag. This is because these actions require dexterity and a certain amount of strength in the hands which rapidly deteriorates with age. Even though the rest of the test persons found many benefits with the elastic design, it does not take into consideration one of the important needs of the product. Therefore, this prototype got excluded.

Two of the prototypes (B.1 and B.2) were based on a holder design consisting of several pockets, fitting a different range of smartphones. This made it easy to place the phones in the holder when the prototype was detached from the persons. However, when trying to place back the phone after, for example, taking a call, it was not that simple to fit the phone into the right pocket. Especially if the test person would like to place it back smoothly, whilst still carrying the carrier behind their back. Choosing the wrong pocket could affect the data collection because the phone would no longer be stable in the holder and could start to jump up and down when the user starts moving. This shaky behavior could also affect the comfort of the user and end in a bad overall experience for him or her. Another aspect to consider is the possibility to store items above the phone. One of the critical needs is that the mobile phone does not get affected by any metal that can disturb the GPS signals which makes the collected data uncertain and unreliable. The extra unused pockets which did not fit the specific phone size-can easily be interpret as usable storage space and it should not be considered as self-evident that the users leave these pockets empty.

Prototype C.1 was equipped with a Velcro to make it possible to release the entire holder from the band to quickly reach the phone without having to work with it behind the back. This property was not used by the test persons during the test. Some of the test persons did not understand that the function existed while others chose not to use this function because the elastic band around the waist made it cumbersome. By trying to pull the holder off it would change the position of the waist bag and the holder would no longer be centered on the back. This would lead to an additional step of the task; the test person would have to fix the band to the right position after released the holder. Nevertheless, it can be discussed whether an on and off feature would be preferable if some other materials were used instead of Velcro, such as a zipper or push buttons. The conclusion made is that this was not

the case and that the most instinctive action is to directly try to reach the phone placed in the holder, or simply turn the band so that the holder can be reached from the front of the body without releasing the holder.

Important to note from Table 15 is that the prototypes that were felt to be the most well attached were prototype C.2 and B.2. What characterizes these prototypes is their wider band. Their holders extend slightly further than the others and ~~form~~ are a large part of each bag, which both result in narrower, stretchable pair of rubber bands and a button device. The larger band was perceived as more stable, and several test persons commented on how the weight from the mobile phone was distributed over the entire bag and not just over the part where the mobile phone was placed. As the holder on the bag was longer on these prototypes, it becomes a part of the waistband which helps tighten the bag around the waist. The mobile phone was therefore placed tighter against the back and was not perceived as shaky.

Another pattern that was found during the testing was that the test persons felt safer putting their phone in the holder if there was a clear way to close it. If the holder was open, they felt that the risk of it falling out was greater and therefore they felt more concerned and unwilling to use the waist bag.

The prototypes that receiving the highest score concerning the placement of the phone, both when placed on the body and off the body were prototype C.2 and B.1. these prototypes consisted of pockets with an opening almost the same size as the phone that was to be placed, which made it easy to place a phone into it. The other prototypes are designed with an opening smaller than the phone which complicates the action, especially for the older customer group. Prototypes B.2 got a lower score when looking at placing the phone. The reason why prototype B.2 got a lower score than prototype B.1, even though they were created upon the same function, and was because the pockets were made of elastic fabrics which was made slightly tighter in comparison to prototype B.1. This made it more difficult to place the phone in the pockets.

The prototype that was interpreted as the most user-friendly was prototype C.2 which, despite the positive feedback, still included a lot of potential for future development. Something that must be considered, since it affected the scores, was the buckles used. The buckles used in prototype B.1 and B.2 differed from the ones used in prototype C1-C3. The entire group of test persons struggled with the buckles used for prototypes B.1 and B.2. This might have affected the score for the user-friendliness and therefore the result cannot be directly translated. A closer look is made of parts that were considered user-friendly.

8 Material

This chapter discusses materials that are most suitable for creating a product that best meets the needs of the customers and Medotemic AB.

8.1 The Properties of the Bag

The material of the bag must meet several criteria to fulfill the requirements that are necessary for it to function. Since the bag partly is for outdoor use where there is a risk of rain and is to be used by runners that possibly will sweat, the material must be moisture resistant. There will not be any risk of damaging the phone when in the waist bag.

For the bag not to interfere with the measurements in any way, there must be no metal in the fabric that can interfere with the GPS signals.

The bag should not be too expensive to manufacture, the choice of material plays a big role in the cost of the product and therefore it is important to consider this aspect.

Another important aspect to keep in mind when choosing materials is their environmental impact. It would be advantageous if the bag was manufactured with a material that has an as small ecological footprint as possible.

8.2 Methodology

To find a material that matches the criteria of the bag, experts in the field were contacted. They worked as teachers and researchers in materials at Malmö University and Lund University, they helped with proposals for materials that matched the desired properties. They also helped recommend research gates for further studies of the materials.

In addition to expert help, a benchmark was made by looking at what materials other brands use to achieve the same goal.

8.3 Neoprene

8.3.1 Properties

Neoprene is a synthetic rubber that is produced by the polymerization of chloroprene. Synthetic rubber is manufactured from petroleum and offers various advantages over natural rubber. Advantages such as high tensile strength, elastic properties, oil and flame resistance, and resistance to degradation by oxygen and ozone. The material can also be waterproof and is therefore commonly used as material for wetsuits. The fabric was first produced by DuPont in 1930. [7]

8.3.2 Cost

Neoprene is a costly fabric due to its difficulties to produce it and to its valuable properties. No exact cost could be estimated. [8]

8.3.3 Environmental Impact

Neoprene is an oil-based non-renewable material that requires large amounts of energy when produced. The gases from the production of Neoprene can be hazardous and causes negative impact on humans and the environment. The material is produced in China and the United States where energy sources like oil and carbon are commonly used and emit large numbers of greenhouse gases. At the end of its life, Neoprene is not degradable. [9]

8.3.4 Substitutes

8.3.4.1 Recyclable Neoprene

According to The Runaway sport, Neoprene cannot be produced by recyclable materials because it would not deliver the same qualities as the original. The level of insulation decreases as the material is being recycled. Nonetheless, the Runaway team describes that the modern neoprene is using a large percentage of bio-degradable components, often reaching up to 85% of the overall composition, making the new types of neoprene be considered more eco-friendly, but this depends on where the material is produced, in the far east countries the majority of neoprene will still be produced from petroleum. [10]

8.4 Polyamide with PU-membrane

8.4.1 Properties

Polyamide, also known as its most famous form, Nylon, is a synthetic fabric. The fabric was also originally developed by DuPont in the mid-1930s. The benefit of polyamide fabric is its high durability and strength. The textile however is not as moisture resistant as other fabrics and does not retain heat as effectively. Therefore, to make the fabric water-resistant a PU-membrane can be added to the fabric. PU-membrane stands for Polyurethane membrane, which is a strong, flexible, and abrasion-resistant membrane. The membrane makes the fabric moisture-resistant and can be added to the polyamide fabric. [11][12]

Nylon can be elastic but to give the material good elastic properties it is common to mix it with elastane. Elastane can have different names and some common are, Spandex and Lycra. Elastane is a polyurethane-fiber and is very elastic and can be used in clothing. [18]

8.4.2 Cost

Nylon is today a quite inexpensive material. However, the price may rise a bit when applying a PU-membrane. No exact cost of the fabric could be found.

8.4.3 Environmental Impact

Polyamide is not a sustainable fabric; it is non-degradable and created by non-renewable sources, petroleum. When produced it emits pollutants via the water used to cool the polyamide to the ecosystems close to the manufacturing plants. The manufacturing process also releases nitrous oxide into the environment. Nitrous oxide is 300 times worse for the environment than carbon dioxide. [11]

The PU-membrane is not that environmentally harmful as many other plastics. When polyurethane breaks down, individual bonds break down between molecules and releases individual molecule into the environment. These molecules do not react toxic in natural environments. [13]

8.4.4 Substitutes

8.4.4.1 Biobased Polyamides

There exist biobased polyamides that are made of renewable resources from fats and oils. The Bio-polyamides have very good mechanical properties such as high tensile

strength, toughness, flexibility, resilience, and abrasion resistance. Advantages that they have over synthetic polyamide are for example lower moisture absorption, higher impact strength, and improved chemical resistance. The brand names of these bio polyamides are Rilsan, Vestamid, EcopaXX. [14]

8.4.4.1.1 Cost

When the request was made for the price, the manufacturers did not want to state this, therefore no comparison can be made between the bio-based fabrics and the synthetic. Only assumptions can be made that the bio-based is somewhat more expensive as it is a newer production and not manufactured to the same extent, with a so-far lower demand in the market.

8.4.4.2 Recycled Polyamides

It is possible to buy recycled polyamide today, which could be a great substitute for Synthetic Polyamide. The recycled polyamide is made from pre-consumer fabric waste but can also come from post-consumer materials, such as fishing nets. ECONYL is an example of post-consumer recycled nylon. ECONYL claims that for every 10000 tons of raw material, they save 70000 barrels of crude oil and avoid 65100 tons of CO₂ eq. emissions. They argue that they reduce the global warming impact of nylon by up to 90% compared with the material from oil. [16]

8.4.4.2.1 Cost

An exact picture of the price of ECONYL is not found. However, the CEO of Aquafil a large manufacturer of ECONYL argues that they try keeping the price down. Because of this, the price should not differ that much from Nylon and should over time approach the price of Nylon. [17]

8.5 Polyester

When looking at benchmarked waist-bags for sporty use, the most common material is polyester. For waist bags that require elastic properties a percentage of elastane is mixed with the material.

8.5.1 Properties

Polyester was developed in the 1940s by DuPont and it is also produced from raw oil such as Neoprene and Polyamide. One of the fabric's main qualities is that the fabric will not absorb water and the fabric does not wrinkle. A disadvantage with the fabric is that it easily gets hold of certain smells that is very hard to get rid of, such as body odor from sweating. It is moisture resistant and has high durability and strength. Polyester is the most common fabric to use in clothing today and is found

in over 50% of our clothing. The advantage to use this fabric for the waist bag is that it not necessarily must get treated with a PU-coating or similar to keep enough water out. [19]

8.5.1.1.1 Cost

Polyester is classified as an inexpensive fabric; no exact cost of the fabric could be established. However, the reason why it is used on such a large scale is because of its low cost. The production cost of polyester is less expensive and the one for polyamide, making polyester the cheapest alternative. [18]

8.5.2 Environmental impact

Polyester is also a material that has a large environmental impact. It is made of petroleum that is a nonrenewable recourse when manufactured fossil fuels are needed which means large emissions of CO₂. The production process also releases toxins into the environment which impacts the lives of many organisms.

Polyester is not biodegradable and can take several 100 years before it decomposes. This could mean a danger to animals if the waste ends up in nature. When it finally decomposes it releases methane that contributes to climate change.

As polyester is washed it releases microfibers into the water supply. These microfibers contribute to 31% of plastic pollution in the ocean and cause substantial harm to marine life. [20]

8.5.3 Substitutes

8.5.3.1 *Bio polyester*

Bio polyester is a material that consists partly or completely of renewable resources. One of the Bio polyesters is Polylactic Acid, PLA, which consist of 100 percent renewable resources. The biggest percentage of PLA is produced from cornstarch. PLA is produced from lactic acid by fermentation of natural sugars. Another bio polyester is PTT and is partly biobased and partly synthetic, the biomaterial used is either corn or biomass. A third bio polyester is PET, Polyethylene Terephthalate, also partly biobased. The biomaterial used is biomass. [21]

The biosynthetic fibers are likely to produce fewer greenhouse gases compared to products made from fossil fuels. Instead of nonrenewable resources, renewable resources can be used and therefore the potential to diminish climate change. [20]

8.5.3.1.1 Cost

The cost of the bio-polyesters is today more expensive than its synthetic counterpart. As the market is forced to change with the rising pressure on the environment, the prices tend to change and decrease as the demand increases. [21]

8.5.3.2 Recyclable Polyester

Recycled polyester is made of PET that can be found in plastic bottles. By using recycled polyester, seismic waste is being reduced. Recycled polyester has a smaller carbon footprint than virgin polyester. It can generate 79% fewer carbon emissions by manufacturing rPET than producing its virgin counterpart. By recycling plastics less plastic will end up in the oceans and affect marine life. [21]

Nonetheless, recycled polyester is not a fully sustainable alternative. It still releases microplastics when washed and contributes to plastic pollutions. When recycled the qualities of the fabric can be affected with for example less durability and chemicals from bottles can irritate the user's skin. [22]

8.6 Suggestion

Medotemic require the carrier to be cheap to produce, the production cost is affected by the material choice, therefore Neoprene is not considered as the best alternative. It cannot be bought recyclable, like the other two materials which is a disadvantage. Polyamide mixed with elastane and treated with a PU-membrane is a good alternative when looking at properties that are beneficial for the carrier. Nonetheless, polyester mixed with elastane seems to be an even greater alternative when looking at the price difference. Treated with a waterproof coating such as a PU-membrane it can withstand the outer stresses that it will be put against.

It is important to keep in mind that all of the original materials that are presented harms the environment because it is based on petroleum. Therefore, it is highly recommended to instead choose a biobased alternative as it does not have the same negative effect on the environment. Since biobased alternatives are produced to a small extent, they become expensive and might not be considered suitable for Medotemic. It is still recommended to choose a recycled alternative, Polyamide or Polyester, to reduce emissions and take responsibility for the environmental issue.

9 Final Concept

This chapter presents the final concept of the waist bag with a description of its different components and final choices.

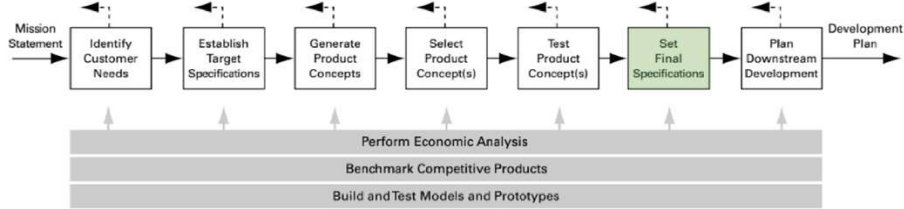


Figure 22 The Concept Development Process, step 6

9.1 The Different Components of the Waist Bag

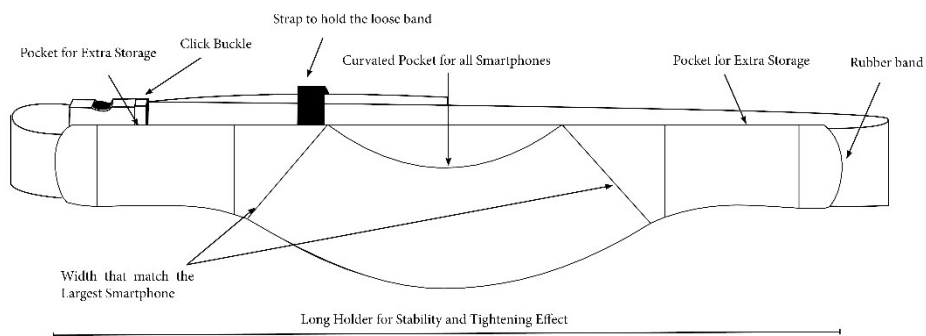


Figure 23 The Front of the Carrier with associated Components

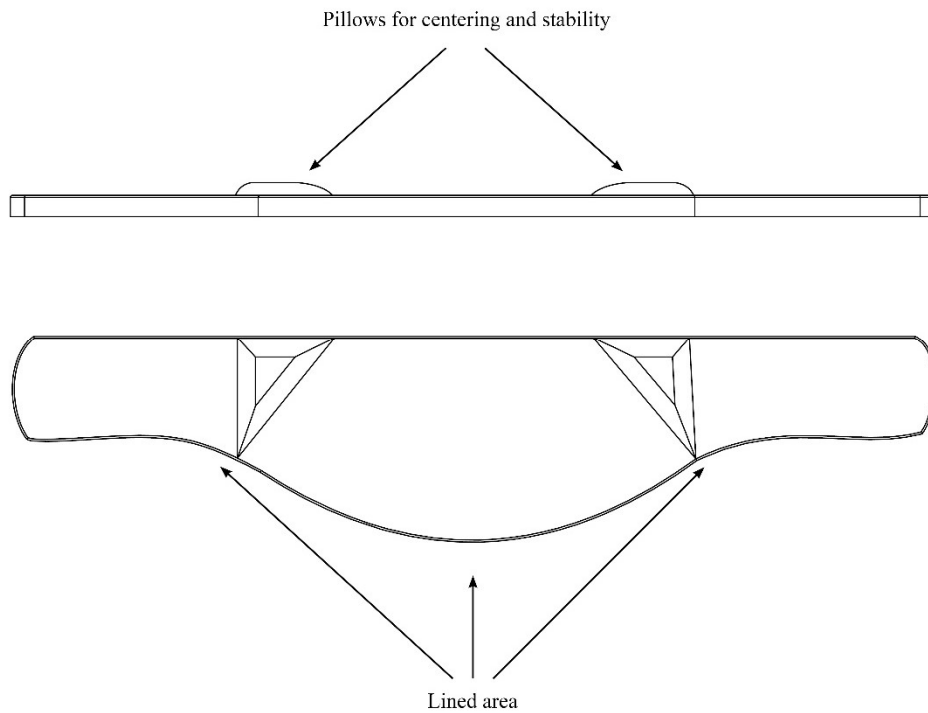


Figure 24 The Back of the Holder with its Components

9.1.1 The Size of the Holder

As can be seen in Figure 23 the bag is designed with a wide holder to create stability and distribute the weight from the phone over a larger area. This, to make the phone as imperceptible as possible. The holder is also long and created with a four-way elastic material, it helps to tighten the bag around the waist and keep it in the place it was first attached to the body. Due to its tight fit, it is possible to place the carrier under clothes without great visibility, giving the user the choice to hide it if desired. The holder has a width of 105 mm at its largest area and a length of 500 mm.



Figure 25 The final concept

9.1.2 The Pocket for all Sizes of Smartphones

The design of the holder is shaped like a horizontal c. The reason why it is created with this curvature is that it should fit several mobile phone sizes and at the same time keep the phone in place when moving. The opening for the pocket is created with a width that is slightly larger than the width of the largest smartphone. In this way, the user does not have to bother trying to stretch the fabric to get the phone into the holder, but instead, it can be easily pressed between the first part of the pocket. For the mobile phones to be placed stably in the pocket, the shape is changed so that it becomes narrower towards the middle part. As the fabric is elastic in four directions, the pocket can be reduced in width so much that it fits both the smallest phone as well as the largest and keep both in place. The C-shape also prevents the phone from slipping out of the holder. As it constantly receives pressure from the sides of the pocket, it keeps the phone stable once it has been placed in the holder.



Figure 26 Illustrations of the actions performed with the carrier, read from top left to bottom right.

Placing the opening on the sides of the pocket creates a smoother movement if the user for example needs to reach the phone during use. By having an opening on both the right and left sides of the pocket, it is adapted to both left- and right-handed people. With the larger opening for the pocket, the phone becomes easy to put back in the pocket again when placed on the body.



Figure 27 Illustration of a hand placing the phone into the holder.

Many of the test persons required a small opening for the cord of their headphones. By leaving the sides of the pockets open the cord can easily slip through the opening while kept close to the product without hanging loose and disturbing the user. Figure 28 illustrates the scenario.



Figure 28 Picture of how the headphone cord slips out the opening of the mobile pocket.

9.1.3 Pockets for Extra Storage

The larger holder provides space for extra storage. Two pockets are placed on each side of the phone pocket, see Figure 29, In the pockets, there is space to place small objects that can be important to bring when walking or running, such as keys and credit cards. The pockets are placed at a distance from the mobile phone pocket to prevent metallic items to disturb the GPS signals that the applications need for measuring the movements.



Figure 29 Pocket for extra storage

9.1.4 Lining

To create stability when removing and putting on the bag, the bag is lined. The lining also protects against objects that rub against the skin, such as keys and credit cards. The lining used is cotton, cotton is not an elastic material itself, but its cloud-like composition makes it possible to stretch it out without affecting the elasticity of the bag. If the lining is necessary depends on the material of the bag. When using Neoprene, the material is thick in itself creating stability when attached and protects the skin from keys and other sharp items.

9.1.5 Pillow for Stability and Centering

In the same way as the lining, the pillows help to stabilize the bag and make it firmer. The pillows are also placed on each side of the pocket on the back of the bag to indicate where the pocket is to make it easier for the user to understand when the bag is centered, see Figure 30. As the pillows are soft, it does not irritate the user. When the pillow is rotated along the body, you can feel them, but once the bag is put in place, they are barely noticeable due to its softness. The distance between the

pillows is decided by the size of the mobile phone pocket and not the user's waist size. Due to their low recognition when attached to the body this is not considered an issue and is not a source of irritation or discomfort. Some users might have the pillows placed closer to the side of the body and some might have them placed further on the back this should not make any difference. It is simply the relationship between the pillows that helps the user figure out when the bag is centered.



Figure 30 Pillow for centering and stability.

9.1.6 The Button Device

The button device used is a classic click buckle, as it is simple to use for everyone. The buckle is designed in two parts, see Figure 31 below. The static part is placed just after the holder ends, to make it possible for people with the smallest size to still get the tightening effect from the elastic fabric and rubber band. People are used to this type of clamping device and therefore know immediately how to handle it without any fuss. This improves the user-friendliness of the product. The fact that the buckle itself is quite large was seen from the beginning as a disadvantage because it was then considered to be a source of irritation and chafing. But after testing prototypes with the buckle, it was concluded that the button did not create irritation and was the most advantageous to use for the reason mentioned. The click buckle is a very common component in especially outerwear and rucksacks,

therefore it exists a lot of manufacturers and they are easy to get a hold of without costing too much. There are many different sizes but for this prototype, a 30 mm width click buckle was used to match the rubber band and to minimize the risk for irritation on the skin. In this case, only two button devices were tested during the testing of the physical prototypes. Another button function was looked at after the physical testing and could be a great substitute for the ordinary click button. This was a flat click buckle, see Figure 32, that could be easier to use for elderly people because it required less force to open and did not require the same amount of strength in the hand as the ordinary buckle. Unfortunately, this flat buckle was not tested enough for a proper conclusion to be drawn. Other solutions that exist were not deeper investigated which could have caused changes in the results. In the future this part can be further investigated in order to find the button device best suited for the product.



Figure 31 Classic click Buckle [23]



Figure 32 Flat click Buckle [24]

9.1.7 The Elastic Band

An elastic band is used to make the waist bag fit tight against the body. The stretching function creates a reassuring feeling that the bag is held in place and prevents it from sliding around or up and down during use. The strap fits close to the body without tightening and irritating. As the strap is adaptable and can be lengthened and shortened, the user can easily adapt the bag to his/her preference. The rubber band used had a width of 30 mm. The elastic band is sewn together with the edges of the holder. See Figure 33 for an illustration of how the elastic band is tightened.



Figure 33 Elastic Band for close-fitting

9.1.8 Strap to Hold the Loose Band

If you are a person with a small waist, there will be remnants of the strap that hangs loose and that jump around and irritate when the user moves. To prevent this belt from interfering during use, a strap is made into which the belt can be inserted. The strap is made of the same fabric as the bag and creates a tightening function that holds the end of the straps towards the waist and prevents it from disturbing the user. Figure 34 below illustrates how the strap helps carrying the loose end of the elastic band.



Figure 34 Illustrates how the strap carries the loose band.

9.1.9 Coloring

As it is desired that the waist bag should be discreet the color choices of the bag are very important. It should not stand out too much and therefore muted colors are selected, that are not too eye-catching. To match Medotemic's brand the colors below are selected from their logo. See Figure 35 below, the blue color to the left is the one used in the prototype. Black is used for the major parts.



Figure 35 Examples of the coloring of the bag

9.2 Economical Perspectives and Design Choices

9.2.1 Simple Design with as Few Parts as Possible

By designing the bag as simple as possible, it is possible to save on costs. By simple, it means that it is obvious for the user how to interact with the carrier. This simplicity entails that the design has fewer details which leads to fewer number of components used and reduced seams. Small changes in design can mean that the cost is reduced, for example choosing to make a cover of fabric instead of using a zipper. The design of the holder is very simple and requires only the use of almost exclusively fabric, it is the main part of the bag. The chosen fabrics are easy to sew compared to for example silk. The design only requires a handful of straight seams and it is not necessary to use a lot of different sewing techniques and subsequently requires no expensive producer.

9.2.2 Usage of Standard Components

To design a product that meets both user's and the Medotemic's expectations, important design decisions must be made, and considerations are taken. When

Medotemic is looking for a product that is cheap to produce, it was decided to primarily use already existing products that can be obtained on the market, to solve the design problems of the bag. During the process, it was concluded that designing specially designed solutions for the bag would mean that individual parts must be manufactured in a factory and entail high costs. This extra cost is not considered feasible in the quantity that the bag is to be manufactured. For it to be worth involving a factory, the amount of product that is expected to be sold must be very large.

When looking at the products that are available on the market it occurs that it exists different solutions to choose between, two of them were tested during the physical testing, Chapter 7. The one that was chosen was considered the most common and therefore most likely for people to understand how to use. To manufacture an own solution would not necessarily mean that it would work better than an already existing one, therefore it was considered more reasonable to continue with the standard components that can be found on the market. However, as mentioned earlier, this is a part that can be further tested and considered for future development.

9.2.3 Number of Components

All extra parts incur an extra cost. Products such as zippers, buckles, and buttons are items that involve an extra cost and an extra contribution to environmental emissions. By avoiding many different components production costs could be decreased. The current design consists only of one buckle. Instead of a zipper closing the cover that protects the smaller items, only fabric is used that is sewn at the edges to keep the cover down, see Figure 36.



Figure 36 Illustration of the cover protecting the pocket.

9.2.4 Material

It is up to Medotemic to decide which material they feel suits Medotemic and the product the best. From an economical perspective, the carrier could be manufactured with polyester and elastane exclusively, this would mean a quite moisture-resistant product but not waterproof, that is cheap to produce. Nevertheless, if Medotemic wishes to take an environmental responsibility it is recommended to look closer into the biobased alternatives or the recyclable. The material choice also depends on whether Medotemic feels that the product must be entirely waterproof or if it is preferable to produce only a moisture-resistant waist bag.

9.2.5 Details

Reflexes were added to the final product to get a final touch. This was never stated as a need but could despite that be a safety measure for users running or walking in the dark. Two stripes of reflexes are placed on both sides of the phone pocket. See Figure 36 for an illustration.

9.3 Fulfilled Needs

The chosen needs were compared with the final concept to see if the final design satisfied the needs that had been created earlier in the process. Table 21 below presents the results from the evaluation.

Table 21 Fulfilled Needs with explanation

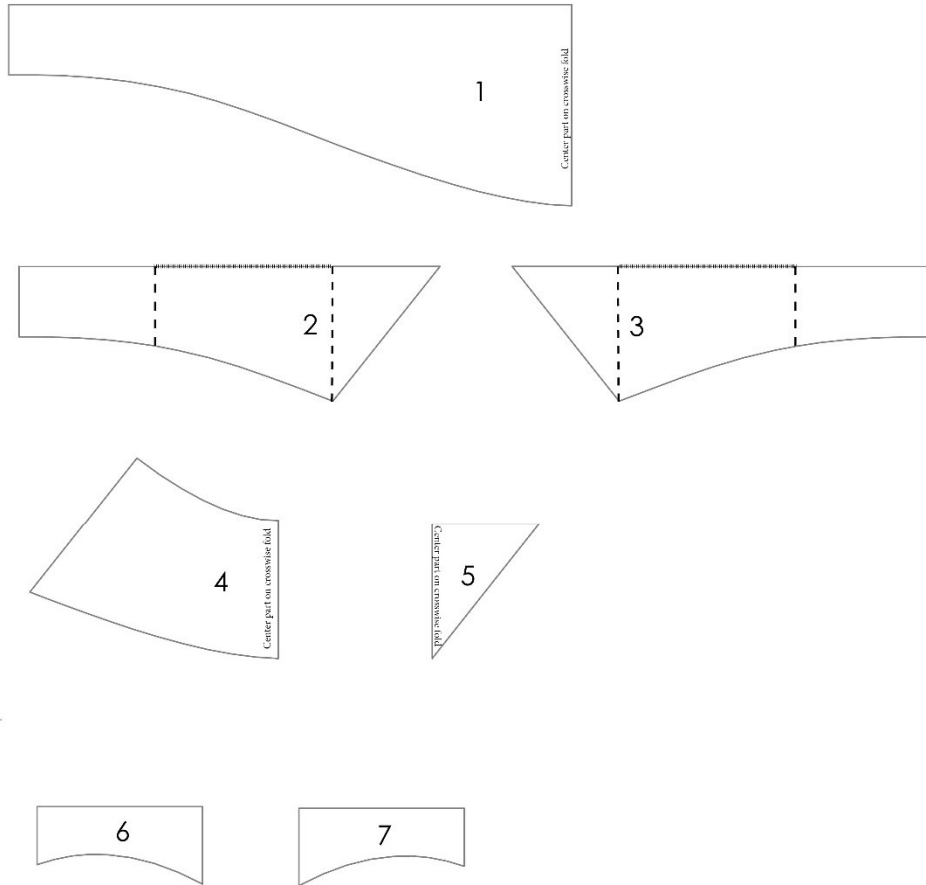
| Need no | Chosen Needs | Fulfilled? | How? |
|---------|---|--------------|--|
| | The Product is usable in all climates | | |
| 1 | The product is resistant to moisture. | Yes | The material presented in the report is moisture resistant. |
| 4 | The Phone is securely attached to the product. | Yes | The C-shaped pocket prevents the mobile phone to fall out. |
| | The Product has several pockets for storage. | | |
| 7 | The product has the ability to store all the necessities. | Yes | The final concept consists of two extra pockets for smaller items. |
| | The design is discreet. | | |
| 11 | The product is discreet. | Yes | The final concept consists of muted colors to prevent the product to stan out. |
| 13 | The product design is made easy with only a few features. | Yes | The final concept consists only of pockets and a click buckle. |
| | The Product is comfortable to use. | | |
| 16 | The product is comfortable without causing irritation. | Yes | The wide design creates stability and comfort, with no components that rub |
| 17 | The product does not interfere with the user's movements. | Yes | The waist bag fits close to the body, no loose ends of bands irritates the user. |
| | The Product is balancedly placed on the body. | | |
| 18 | The product is placed tight on the body. | Yes | The elastic material used keeps the product tight to the body. |
| 19 | The product is still when used. | Yes | The product remains in place when moving. |
| 20 | The product is centered on the body. | Yes | The pillows help the user center the product to the body. |
| | The Mobilephone is reachable in the Product. | | |
| 21 | The Product has an easy way to release/place the mobilephone in the holder. | Yes | The large opening of the pocket simplifies the placement/reaching of the phone. |
| 22 | The mobilephone can be reached when using outerwear. | Yes | The large opening allows persons with gloves reach the phone. |
| 24 | The mobile can easily be reached. | Yes | The open pocket makes it easy to quickly reach the phone. |
| | The product is priceworthy | | |
| 25 | The Product price fits well the costumer expectations. | Undefined | It depends on the final production price. |
| 32 | The product is cheap to produce. | That depends | It depends on the production cost and material choice. |
| | The Product is easy to use in all ages. | | |
| 26 | The Product is easy to attach and release. | Yes | With the use of a ordinary click buckle the product is easy to attach and release. |
| | The Product fits different types of mobiles with different shapes and sizes. | | |
| 29 | The holder is adjustable to different phone sizes. | Yes | The C-shaped pocket allows different sizes of phones fit stable on the waist bag. |
| | Useful for all body constellations | | |
| 30 | The Product is adjustable to different body sizes. | Yes | The rubber band is adjustable to fit sizes from 60-112 cm. |
| | The mobile phone must not be shielded by the material. (Metal wires or similar that screen GPS signals picked up by the cell phone). | | |
| 31 | Keys and kreditcards is placed on the side of the phone. | Yes | The smaller pockets is placed on the side of the phone pocket. |
| 33 | The material does not contain metal. | Yes | None of the material contain metal. |

10 Manufacturing Sketches

This chapter presents the manufacturing sketches of the holder and components of the bag.

10.1 Sketches of the Holder

| Part | Description | Quantity |
|-------------|---------------------|-----------------|
| 1 | Body | 2 |
| 2 | Right pocket part | 1 |
| 3 | Left pocket part | 1 |
| 4 | Mobile pocket | 1 |
| 5 | Pillow | 2 |
| 6 | Cover, right pocket | 1 |
| 7 | Cover, left pocket | 1 |



Scale 1:3
Paper Size: A4

Figure 37 The Bags different Parts

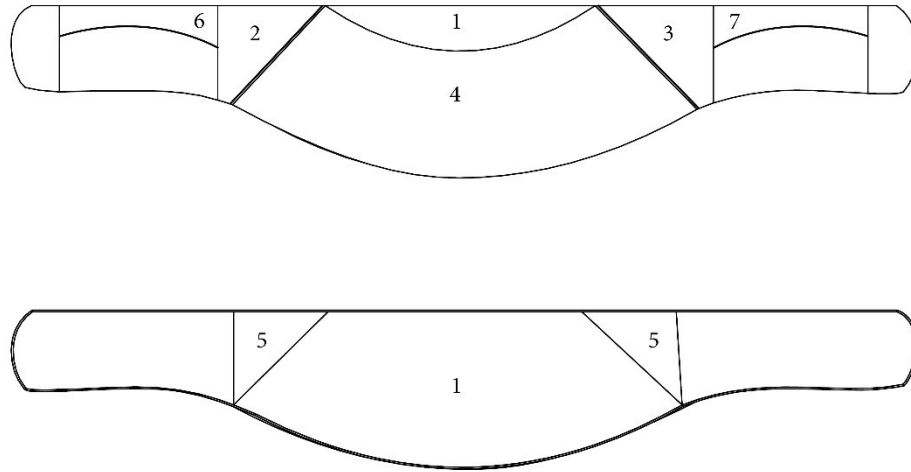


Figure 38 Bag with Sewn Parts

10.2 Additional Parts

| Part | Description | Measurements |
|------|------------------------|---------------|
| 8 | Elastic Band | 30mm x 450 mm |
| 9 | Click Buckle | 30 mm wide |
| 10 | Strap to hold the band | 60 mm x 30 mm |

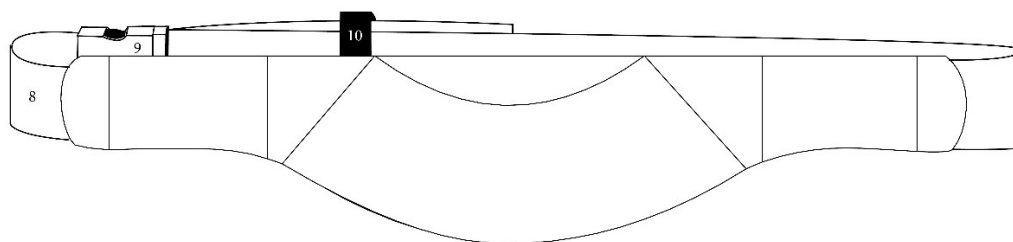


Figure 39 Carrier with additional parts

11 Discussion and Conclusion

This chapter discusses and investigates whether the purpose has been accomplished and opportunities for further development.

11.1 Discussion

When looking at the results in Table 21, the vast majority of needs are considered to be met and the developed design is fulfilling its purpose. The design is made simple with few components and features which makes it user-friendly and easy to understand. The final waist bag also fulfills the two most central needs of the project, adjustability to different phone sizes, see Figure 40, and adjustability to different body sizes, see figure 41 and 42.



Figure 40 Illustration of the waist bag carrying a small-sized phone (left pictures, iPhone 5), a middle-sized phone (middle picture, iPhone 6), and a large-sized phone (right picture, iPhone Plus).



Figure 41 Men size M/L



Figure 42 Women size S

The needs that are concerning the price of the carrier is left undefined, because a clear price picture cannot be made before all the different production aspects are taken into consideration. Where a product is produced can have a big impact on the cost, as well as the impact on humane and environmental sustainability. Nevertheless, by minimizing complex design, the number of components and by choosing a material not too expensive the cost can be kept down so that it meets both Medotemics' and the customers' needs.

Whether the design is discreet or not can be discussed. The carrier is large compared to the ideal value set at the beginning of the project. This to create stability and comfort around the waist. It has a height of 105 mm which exceeds the ideal value in the target specification of 40 mm, see Table 6. Nonetheless, it is kept within the marginal value and is not perceived as too large. However, the bag is designed with not that startling colors, with the possibility to place it under clothes, to hide if the user is not comfortable to show it, even though it is made larger than originally thought.

After the physical testing, the test people considered the carrier to be easy to attach. In comparison to the attachment solution consisting of a clamp presented early in the process, see Chapter 5. The concepts consisting of a clamp were all removed, when we age, we develop reduced mobility which makes it very hard to apply a product behind the back without increasing the risk of falling, see Section 4 *Reduced Mobility in Older Adults*. Using a clamp as an attachment solution would force a multi-joint movement that would be hard for the elderly and could expose them to a high risk of falling and conclusively hurting themselves. This constituted a big reason why these concepts were removed already in the concept screening, Chapter 6. There is also a high risk of imbalance when placing a clamp on the trousers, because of the weight from the mobile phone the trousers can be weighted down and cause irritation when used. The carrier seemed like the best solution for an easy and balanced attachment and is considered as fulfilling the primary need of usability

in all ages. Of course, there are elderly that are not able to move the way necessary to attach the waist bag. If they are in such a situation, they often have access to home care or some type of help to support them getting dressed. At the same time, they can help the older person to attach the waist bag. Therefore, the waist bag is considered a good solution for older as well as for younger users.

The design of the mobile phone pocket not only creates adaptability to different phones but also high reachability of the phone, it does not matter if the user is left or right-handed, the mobile can be reached in both directions. The fact that the pocket cannot be closed may seem uncertain, it was something that the test persons reacted to when testing the physical prototypes. The open pocket has not changed but only changed shape and depth so that the phone does not have an opportunity to fall out, it is considered sufficient measures for users to feel more secure with the product.

Experts in both the running and physiotherapists area got interviewed. From these people, valuable information could be collected. Everyday runners where a majority had been through rehab also got questioned which contributed to an understanding of a user who is willing to use the product when running and when going through rehabilitation. To develop an even broader knowledge it would have been advantageous to interview patients that need rehab today and see if their answers would differ from the ones collected from the questionnaire, it would also have been interesting to interview an elderly person to see his or her objections to the product. Nevertheless, this was not possible due to the current pandemic. However, the information received from the physiotherapists contributed to a wider understanding of older people's certain needs.

An improvement for the future would be to do more customer research. It would have been helpful to visit a rehabilitation center and meet patients and see what kind of movement difficulties they can have. It would also be necessary to observe the movements of the elderly to understand the difficulties they can meet with certain movements.

The target specifications for the product are based on benchmarking and customer needs. A source of error regarding the methodology was that there was no possibility to test the other products and therefore get a clear picture of metrics such as *Easy to use*, *Comfortable*, or *Does not affect the user's actions*. This concerned for example material choice and size of the bag, how did a waist bag with an elastic material differ from a static material, was it more comfortable with a larger waist bag or did it not matter. Questions like this had to be examined as the process continued and was at the beginning done instead as assumptions based on the answers collected from the survey, i.e., the test subjects' opinions of their current product. Maybe, the target specifications would have looked different if it had been possible to test more existing products on the market and different ideas may have been produced that did not at all include smaller waist bags. Nevertheless, the target specifications were considered guidelines and not a required value. Therefore, in the case where it was

deemed necessary, for example when deciding the size of the waist bag, the ideal values were not followed.

The marginal and ideal values regarding weight and size are also based on the answers by the test persons where the needs that could affect these values are carefully taken into consideration. One need that was mainly affected was need number 17, *The product does not interfere with the user's movements*. It is a need that can be affected by other measurements for example the shape of the product. It does not necessarily mean that a lighter or a smaller carrier does not interfere with the user's movements. If the bag has an unpleasant shape that scrapes or distributes the weight strangely, the weight and size are not something that can solve the problem. Therefore, it is important to look at where the real reason for interference of the movements arise, and not only stare blind on the ideal values decided in the target specification, since these are not tested just assumed from the answers received from the questionnaire.

Another important aspect that must be taken into consideration during the process is that the weighted values used in the concept scoring have not been discussed with future customers but are entirely based on the interviews, the surveys, and the Medotemic's wishes given in an early stage of the process. There is a risk that the relative importance of the criteria is not entirely correct, and it would have been good to receive a second opinion on them. For example, let a few people that could be considered future customers weigh the different values and create an average weighted value based on their results. It would also be good to let Medotemic weigh the values through their perspective to get a deeper understanding of what they consider more important when the needs are put about each other. If the weighted values are wrongly assumed, it could affect the final concept and the concepts that were chosen to be further developed. For example, maybe the concepts consisting of a clamp would have received the highest score because reaching and attaching the phone to the holder was considered more important and would have increased the score of the concept, while moisture resistance did not seem as important and would simultaneously decrease the other concepts scores. A change in the weighted values could affect the entire outcome of the concepts scoring that was the basis for the final concepts.

An error that could have affected the results of the physical test, see Chapter 7, was that the test persons got to choose which mobile phone to use when performing the tasks. He or she did not do every task with the three different sizes of mobile phones just one size. The way this could affect the test result is if the mobile phones fit more or less well in different prototypes and affect the bag in different ways. For example, a small phone may jump around more and cause imbalance while a medium-sized phone might have the perfect size to be placed comfortably around the user's waist. However, the test persons chose different phone sizes so that all the mobile phones were tested in all the tasks, therefore did this issue not seem predominant for an errored result. Instead, comments and observations were taken to catch the issues that might occur with the different sizes of mobile phones.

11.2 Conclusion

The purpose and the goal of the master thesis are considered to be fulfilled. All the needs that were established early in the process are met. The needs concerning cost; cheap production and a price that meets the customers' expectations are hard to establish, the cost will vary depending on where the waist bags are produced and which material Medotemic at the end chooses. But, with its simple design and low use of components the manufacturing cost of the bag will be pushed down. The design is unique and has the properties useful for a broad range of customers which is necessary for it to be useful for both the customer groups, runners, and rehabilitation patients. With its tight character and neutral coloring, the waist bag is not too eye-catching which increases the likelihood of use among people who are pickier in that area. Despite the limitations that were brought to this project by the pandemic a complete solution could be presented. Of course, there is always room for improvement. But I hope this solution can be a good start for Medotemic AB and help them develop their concept.

12 Bibliography

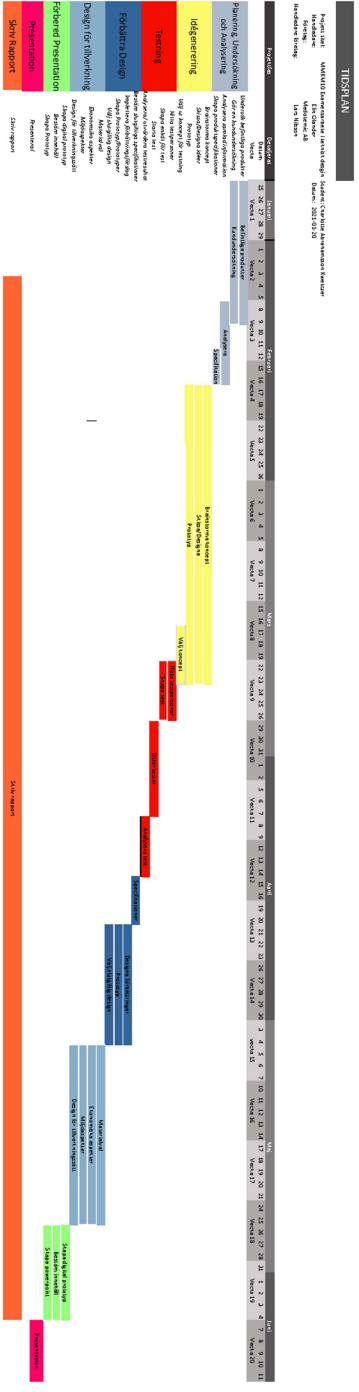
- [1] Ulrich, K. & Eppinger, S. D., 2012. *Product Design and Development*. 5 ed. New York: McGraw-Hill Companies, Inc.
- [2] Wikberg-Nilsson, Å., Törlind, P. & Ericson, Å., 2015. *Design: process och metod*. 1 ed. Lund: Studentlitteratur.
- [3] Kättström, D., 2014. *forskning.se*. [Online] Available at: <https://www.forskning.se/2014/09/09/aldrandet-borjar-vid-30/> [Accessed 23 02 2021].
- [4] Hälsosupporten, n.d. *Det här händer i kroppen då vi åldras*. [Online] Available at: <https://www.healthyageinginitiative.com/post/det-här-händer-i-kroppen-då-vi-åldras> [Accessed 24 02 2021].
- [5] Seidler, R. D. et al., 2009. *Motor Control and Aging: Links to Age-Related Brain Structural, Functional, and Biochemical Effects*, s.l.: s.n.
- [6] Generations Healthcare, n.d. *5 Ways Your Hands May Change with Age*. [Online] Available at: <https://www.lifegen.net/blog/5-ways-your-hands-may-change-with-age/index.html> [Accessed 24 02 2021].
- [7] Britannica, 2019. *Neoprene*. [Online] Available at: <https://www.britannica.com/science/neoprene> [Accessed 28 4 2021].
- [8] Sewport, 2021. *What is Neoprene Fabric: Properties, How its Made and Where*. [Online] Available at: <https://sewport.com/fabrics-directory/neoprene-fabric> [Accessed 28 04 2021].
- [9] Patagonia, 2016. *Yulex Natural Rubber*. [Online] Available at: <https://eu.patagonia.com/se/en/our-footprint/yulex.html> [Accessed 29 04 2021].
- [10] RunawaySport, 2021. *Recyclable Neoprene*. [Online] Available at: runawaysport.com [Använd 10 05 2021].

- [11] Sewport, 2021. *What is Polyamide Fabric: Properties, How its Made and Where.* [Online]
Available at: <https://sewport.com/fabrics-directory/polyamide-fabric>
[Accessed 28 04 2021].
- [12] Henningsson, M. & Westbom, j., 2009. *Vattentäta och "andande" textilier*, Borås: Textilhögskolan.
- [13] Zafar, S., 2021. *BioEnergy Consult.* [Online]
Available at: <https://www.bioenergyconsult.com/how-polyurethane-is-better-for-environment/>
[Accessed 29 04 2021].
- [14] CROW, n.d. *Biopolyamides.* [Online]
Available at: <http://polymerdatabase.com/Polymer%20Brands/Biopolyamides.html>
[Accessed 29 04 2021].
- [15] Textile Exchange, 2019. *How companies can source nylon more sustainably.* [Online]
Available at: <https://mci.textileexchange.org/discover/nylon/>
[Accessed 29 04 2021].
- [16] Econyl, 2020. *Some see trash. Others see treasure..* [Online]
Available at: <https://www.econyl.com/the-process/>
[Accessed 30 04 2021].
- [17] Hodakel, B., 2021. *What is Econyl Fabric: Properties, How its Made and Where.* [Online]
Available at: <https://sewport.com/fabrics-directory/econyl-fabric>
[Accessed 30 04 2021].
- [18] Hodakel, B., 2021. *What is Elastane Fabric: Properties, How its Made and Where.* [Online]
Available at: <https://sewport.com/fabrics-directory/elastane-fabric>
[Accessed 30 04 2021].
- [19] Casual Geographical, 2020. *Polyamide (Nylon) vs Polyester: Differences and Comparison.* [Online]
Available at: <https://casualgeographical.com/polyamide-nylon-vs-polyester/>
[Accessed 27 04 2021].
- [20] Kh, R., 2020. *The Terrifying Effects of Polyester on the Environment and Our Health.* [Online]
Available at: <https://blueandgreentomorrow.com/environment/terrifying-effects-of-polyester-on-environment-health/>
[Accessed 28 04 2021].

- [21] Textile Exchange, 2018. *Quick Guide to Biosynthetics*, Lamesa, Texas: Textile Exchange.
- [22] Nguyen, A., 2021. *How Sustainable Is Recycled Polyester?*. [Online] Available at: <https://compareethics.com/how-sustainable-is-recycled-polyester/> [Accessed 25 04 2021].
- [23] Friluftstyger.se, *Klickspänne Plus*. [Picture] <https://www.friluftstyger.se/sv/material/spannen/spannen-for-band/spanne-cb-10.html> [Accessed 24 05 2021]
- [24] Friluftstyger.se, *Platt klickspänne för band*. [Picture] <https://www.friluftstyger.se/sv/material/spannen/spannen-for-band/klickspanne-cb-46.html> [Accessed 24 05 2021]

Appendix A Gantt-Chart

A.1 Adopted Schedule



Appendix B Interview Questions

B.1 Interview Questions for Runners

- How often do you run?
- Would you consider using this type of solution to improve your running technique or your customers' running technique?
- If so, how would a workout with this product look like?
- Do you use any kind of mobile holder today when you run?
- If so, for what purpose do you use it and what do you think is good / less good about that product?
- Which feature (s) would you say is most important to you if you were to buy a mobile holder? Put a number next to the statements between 1-5 where 5 is very important and 1 less important.
 - the appearance of the product
 - that it is comfortable to use
 - that it does not interfere with training
 - that it is easy to use
 - that it is made of an environmentally friendly material
 - that it is easy to clean
 - how it is attached
 - that the mobile phone is protected from external stresses (eg rain)
 - Other alternative ...

- Are there any characteristics that can be decisive for you to buy products or not, such as appearance, price, comfort?
- How much do you think you would be willing to pay for this type of product?
- Are there any other characteristics / criteria that you are thinking of that could be important in the use of such a product?
- How would you have preferred to attach the mobile to your back at waist height? Via a waist bag, on the trousers, directly on the skin or with the help of some other solution?
- As the mobile phone is one of our main aids today, it is obviously important that it is easily accessible even though it is in the mobile holder and is placed on the back. How do you think you could make the mobile easily accessible when it is in the mobile holder?

B.2 Interview Questions for Physiotherapists

- Do you currently use any form of measuring instrument to measure the result and analyze the patient's progress?
 - Could you describe how it works?
- What types of injuries do you mainly work with? Have you worked with patients who have had a stroke or bone fracture, for example, where it is necessary to practice walking technique?
- What ages do you usually work with?
- Is this a solution that you think could facilitate your work and that you could consider using?
- If no, what would be required for you to want to use this type of solution (application with associated mobile holder)?
- Is there an age group that you think would have a hard time agreeing to use this type of product?
- In what way do you think it would be easiest for the patient to attach the mobile to the back?
- Do you think there may be any specific problems for the elderly to attach products?
- If so, how do you think it would be possible to facilitate the usage for older people?

- How important do you think the visual appearance of the mobile holder is for the user and can it play a role in how much he / she decides to use the product?
- What do you think is important to keep in mind when designing a product that is simple and functional to handle for the elderly.
- As the mobile phone is one of our main aids today, it is important that it is easily accessible even though it is in the mobile holder. Would it be most advantageous to be able to use the mobile phone when it is in the holder or do you think it is easier if there was an easy way to quickly disconnect the mobile phone from the holder?
- Are there any criteria that you think are important to keep in mind when designing the product?

B.3 Customer Data from Physiotherapists

Table 22 Statements and Need from Physiotherapist Eeva

| | | | |
|----------------------|-----------------|---------------------|-------------------------------|
| Interviewee: | Eeva | Interviewer: | Charlotte Abrahamsson Kwetcze |
| Type of user: | Physiotherapeut | | |

| Question/Prompt | Customer Statement | Interpreted Need |
|---------------------------|---|---|
| Important characteristics | I believe the easiest way to attach the carrier is around the waist, like a waist | The carrier is designed as a waist bag. |
| | I believe it would be good if it is possible to release the holder from the carrier. | The holder can be released from the carrier. |
| Problems for elderly | Some people can't reach behind their back and will not be able to attach the carrier on the body. | It is possible to attach the product centered on the front of your body if necessary. |
| Importance of design | It is important that the product has a timeless design with discrete colors. | The design is timeless |
| | | The design has neutral colors |

Table 23 Statements and Need from Physiotherapist Camilla

| Customer data | | | |
|---------------------------|---|--|-------------------------------|
| Interviewee: | Camilla | Interviewer: | Charlotte Abrahamsson Kwetzer |
| Type of user: | Physiotherapeut | | |
| Question/Prompt | Customer Statement | Interpreted Need | |
| Achieve Usage | Discreet design, adaptable for children so that they could decorate it. | The product is discreet but adaptable for younger persons. | |
| | Discreet design for the older generation, preferable to place it under your clothes. | The product design is discreet. | |
| | The easier it is to use a product the more willing you are to use it, simplicity is very important. | The product is simple to use. | |
| | Older people can get help from others, such as home care staff. | The product can be applied by others on you. | |
| Important characteristics | If you are older it is important to be able to take it off at the stomach. | The product is removable at the stomach. | |
| | The easiest things are hard to handle for older people. Small features are too hard to handle. | The product design is made easy with only a few features. | |

B.4 Customer Data from Athletes

Table 24 Statements and Needs from Running Coach Kenth

| Interviewee: | Kenth | Interviewer: | Charlotte Abrahamsson Kwetzer |
|----------------------------------|--|---|-------------------------------|
| Type of user: | Löpccoach | | |
| Question/Prompt | Customer Statement | Interpreted Need | |
| Current mobile holder - dislikes | Flipbelt - uncomfortable because it slides up to the waist instead of remaining at the waist. | The product is comfortable to use and is fixed at supposed place. | |
| Current mobile holder - likes | Flipbelt - easy to use and works good when you have a lot of stuff to bring. | The product can carry more than the mobile phone. | |
| Profitable characteristics | Easy to release the mobilephone from the holder if you need fast access to it. | The mobile phone can easily be released from the product. | |
| | Preferable to fix the mobile holder on the pants if possible in order to avoid an extra garment. | The product can be placed directly on already existing garments. | |

Table 25 Statements and Needs from Running Specialist Fredrik Zillén

Interviewee: Fredrik **Interviewer:** Charlotte Abrahamsson Kwetzer
Type of user: Löpspecialist

| Question/Prompt | Customer Statement | Interpreted Need |
|----------------------------------|---|--|
| Current mobile holder - dislikes | Arm holder - the mobile holder is in the way, it is placed at a moving part which affects the weight. | The product is placed centered on the body. |
| Current mobile holder - likes | Salamon, pulse belt - centered at the back, is placed very still and comfortable. | The product is still when used. |
| | A sidelong zipper is a good solution to avoid sliding of the waist bag. | The product is comfortable when in use. |
| | A tassel that makes it easy to open your pocket even when you have gloves. | The product is designed in a way which prohibit it from moving when used. |
| Profitable characteristics | To be able to bring more stuff in the holder, for example car keys, house keys and kredit cards. | The mobilephone can be reached when using outerwear. |
| | | The product has the ability to store all the necessary stuff than the mobilephone. |

Table 26 Statements and Needs from Orienteer Josefine

Interviewee: Josefine **Interviewer:** Charlotte Abrahamsson Kwetzer
Type of user: Orienteers

| Question/Prompt | Customer Statement | Interpreted Need |
|----------------------------------|--|--|
| Current mobile holder - dislikes | Arm holder - heavy and creates imbalance when running. | The Product is placed in a balanced way. |
| Current mobile holder - likes | Smooth to rotate a waist bag to get the mobilephone quickly. | The Product is rotateable which makes the mobeile easy to reach. |
| Profitable characteristics | The price is important. If I am going to buy an expencive product it has to be the best. | The Product price fits well the costumer expectations. |
| | If I am going to bring the phone it is important to quickly be able to release it from the holder and place it back in the holder. | The Product provides an easy way to release and place the mobilephone in the holder. |
| | You should be able to use the mobilephone with headphones and to bring keys. | The Product can easily be combined with headphones. |
| | | The Product has several pockets for |
| | You have to be able to use it in the winter when wearing alot of clothes and in the summer when using less. | The Product is usable in all climats. |
| | The holder must be placed in a stable way. | The product is stably attached on the body. |
| | It must be easy to attach and be placed well. | The product is easy to attach. |

Appendix C Questionnaire

This appendix presents the questionnaire used during the customer research.

C.1 Questionnaire Questions

Anpassningsbar mobilhållare

Under detta examensarbete ska en mobilhållare som ska fästas på ländryggen designas. Med hjälp av en app ska mobilen mäta rörelsemönster i syfte att förbättra gångteknik under rehabiliteringsprocessen hos en patient men också hjälpa till att förbättra en idrottares löpteknik. Den data som mobilen fångar upp från användaren kan sjukgymnaster få tillgång till och på så sätt utnyttja i sitt rehabiliteringsarbete. Används produkten istället i ett löptekniskt syfte kan användaren och dess tränare direkt få resultat och feedback i appen. Då mobiltelefonen är så pass vanlig i dagens samhälle är tanken att just den ska kunna användas även till dessa syften. På detta sätt slipper kunder också investera i nya former av teknik.

Hur produkten ska fästas är ännu inte bestämt mer än att den på något sätt ska placeras på ländryggen.

Användning i ett tränings syfte

Med hjälp av en app ska mobilen mäta rörelsemönster i syfte att följa och förbättra löpteknik. Den data som mobilen fångar upp från patienter kan patienten och dess coacher få tillgång till och på så sätt utnyttja för att förbättra sin löpteknik.

Hur gammal är du?

- <18
- 18-25
- 25-45
- 45-60
- 60-75
- 75+

Hur ofta löptränar du?

- Mer än 5 ggr i veckan
- 3-5 ggr i veckan
- 1-2 ggr i veckan
- ca 2 ggr i månaden
- nästan aldrig

Skulle du kunna tänka dig att använda denna typ av lösning för att förbättra din löpteknik?

- Ja
- Nej
- Övrigt:

Finns det några egenskaper som kan vara avgörande för att du skulle köpa och vilja använda produkten eller inte? Beskriv gärna kort.

Ditt svar

Om du skulle använda produkten, hur hade du föredragit att fästa mobilen på ryggen? (ex. via midjeväska, på byxan, direkt på huden eller med hjälp av någon annan lösning?)

Ditt svar

Brukar du använda dig av någon typ av mobilhållare idag när du springer?



Ja

Nej

Din mobilhållare

Vad använder du dig idag av för typ av mobilhållare? (skriv gärna vilket märke)

Ditt svar

I vilket syfte använder du den och vad tycker du är bra/ mindre bra med den produkten?

Ditt svar

Utseendet på produkten

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att produkten är komfortabel att använda

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att produkten inte stör träningen

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att den är enkel att använda

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att den är tillverkad med ett miljövänligt material

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att den är enkel att rengöra

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att produkten är enkel att applicera på kroppen

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att mobilen är enkel att få loss från hållaren

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att mobilen är enkel att fästa i hållaren

| | | | | | | |
|--|---|---|---|---|---|--|
| | 1 | 2 | 3 | 4 | 5 | |
|--|---|---|---|---|---|--|

Att mobilen skyddas från yttre påfrestningar

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att produkten är billig

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Eget alternativ som du tycker bör tas med...

Ditt svar

Användning i ett rehabiliteringssyfte

Har du varit i behov av någon typ av rehabilitering? Om inte, försök sätta dig in i vad du skulle tycka vara viktigt ifall du någon dag skulle vara i behov av rehab.

Har du varit i behov av rehabilitering?

- Ja
- Nej

Om ja, har du eller din sjukgymnast använt sig av något mätinstrument för att se resultat och framsteg under rehabiliteringsprocessen?

- Ja
- Nej

Skulle du vara villig att använda denna produkt om din sjukgymnast rekommenderade den?

- Ja
- Nej
- Övrigt:

Hur stor vikt skulle du lägga på utseendet av mobilhållaren och kan utseendet ha betydelse för hur mycket du i slutändan väljer att använda produkten? (Tänk på att produkten ska användas i vardagligt bruk)

Ditt svar

Hur skulle du vilja fästa mobilen på ryggen?

Ditt svar

Utseendet på produkten

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att den är komfortabel att använda

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att den inte stör i vardagen

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att produkten är enkel att applicera på kroppen

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att mobilen är enkel att få loss från hållaren

| | | | | | | |
|--|---|---|---|---|---|--|
| | 1 | 2 | 3 | 4 | 5 | |
|--|---|---|---|---|---|--|

Att mobilen är enkel att fästa i hållaren

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att den är tillverkad med ett miljövänligt material

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att den är enkel att rengöra

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Att mobilen skyddas från yttre påfrestningar (ex. regn)

| | | | | | | |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Mindre viktigt | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Mycket viktigt |

Skulle du kunna tänka dig att använda samma produkt som du använder i löpning även till rehabiliteringen och då alltså i en mer vardaglig situation.

- Ja
- Nej
- Övrigt:

Hur skulle du vilja att produkten var utformad så att du skulle kunna tänka dig att använda den i både ett rehabiliteringssyfte och vid löpträning?

Ditt svar

Då mobilen är ett av vårt främsta hjälpmedel idag är det självklart viktigt att den är lättillgängligt trots att den sitter i mobilhållaren och är placerad på ryggen. Hur tror du man skulle kunna göra mobilen lättillgänglig när den sitter i mobilhållaren?

Ditt svar

C.2 Statements and Interpreted Needs from Questionnaire

Questionair: Based on 85 answers Created by: Charlotte Abrahamsson Kwetze
 Type of user: Mostly Runners, some in need of Rehabilitation

| Question/Prompt | Customer Statement | Interpreted Need |
|-------------------------------------|---|--|
| Important characteristics for usage | It is important that the phone does not shake while running. | The phone is steady in the product while moving. |
| | It can't be placed so that it causes abraisions on the body after a while running. | The product is comfortable without causing irritation. |
| | Good if it is easy to take on and off and that it is possible to navigate on the phone while it is placed on the product. | The phone can be used while placed in the product. The product is easy to put on and off. |
| | Water and dirt resistant | The Product is water and dirt resistant. |
| | Unnoticeable during running. | The product is comfortable to use. |
| | Good price and high comfort. | The Product is priceworthy. |
| | Easy to use and good price | The Product is easy to use. |
| | Good looking and dry fast after use. | The Product dries fast after use. |
| | It must be placed tightly on the body. | The product is placed tight on the body. |
| | Should not notice it when wearing it. It must be comfortable and not in the way. | The product is not noticable while used. |
| | Moisture resistant | The product is resistant to moisture. |
| | Easy to place on and off both on the body but also the phone to the product. | The product has an easy on/off mechanism alsop when attaching the phone to it. |
| | Easy to use | The product is easy to use. |
| | Must be usable with other products such as rugbag and running vest. | The Product is combinable with other running accessories. |
| | It protects the mobilephone from sweat, rain and water. | The mobilephone is protected from moisture while attached in the product. |
| | Easy to understand how to use. | The product is simple to use. |
| | Sustainable desgin | The Product is designed to last over time. |
| | Easy to adapt to different body sizes so that it can be shared between family members. | The Product is adjustable to different body sizes. |
| | Safe that the phone can't loosen while running. | The Phone is securely attached to the product. |
| | It must be tough and scratch resistant. | The product is toguh and scratch resistant. |
| Design | Be able to put more things in it while using it, such as car keys, etc. | The product has a few compartments where it can carry smaller items. |
| | Discreet design, must be able to hide it under your ordinary clothes. | It is possible to carry the product under your clothes while using it. |
| | Easy to reach the phone. | The phone is reachable in the product |
| | Smooth and not too big. | The design is not too big. |
| | Simplicity is important | The product is easy to use. |

Appendix D Needs

Appendix E presents the full list of needs interpreted from the interviews and questionnaire.

D.1 List of Needs

Table 27 Full list of Needs

| Needs | |
|----------------|---|
| Need no | The Product is usable in all climates |
| 1 | The product is resistant to moisture. |
| 2 | The Product is designed to last over time. |
| 3 | The Product dries fast after use. |
| 4 | The Phone is securely attached to the product. |
| 5 | The Product is rain and dirt resistant. |
| 6 | The product is tough and scratch resistant. |
| | The Product has several pockets for storage. |
| 7 | The product has the ability to store all the necessary stuff. |
| 8 | The Product can easily be combined with headphones. |
| | The design is discreet. |
| 9 | Stylish design for both everyday and sporty use. |
| 10 | It is possible to carry the product under your clothes while using it. |
| 11 | The product is discreet but adaptable for younger persons. |
| 12 | The design is not too big. |
| 13 | The product design is made easy with only a few features. |
| | The Product is combinable with other products. |
| 14 | The product can be placed directly on already existing garments. |
| 15 | The Product is combinable with other running accessories. |
| | The Product is comfortable to use. |
| 16 | The product is comfortable without causing irritation. |
| 17 | The product is not noticeable while used. |
| | The Product is balancedly placed on the body. |
| 18 | The product is placed tight on the body. |
| 19 | The product is still when used. |
| 20 | The product is centered on the body. |
| | The Mobilephone is reachable in the Product. |
| 21 | The Product has an easy way to release/place the mobilephone in the holder. |
| 22 | The mobilephone can be reached when using outerwear. |
| 23 | The phone can be used while placed in the product. |
| 24 | The Product is rotateable which makes the mobile easy to reach. |
| 25 | The product is priceworthy |
| | The Product price fits well the customer expectations. |
| 32 | The product is cheap to produce |
| | The Product is easy to use for all ages. |
| 26 | The Product is easy to attach and release. |
| 27 | The product can be applied by others on you. |
| 28 | The product is attached centered on the back. |
| | The Product fits different types of mobiles with different shapes and sizes. |
| 29 | The holder is adjustable to different phone sizes. |
| | Useful for all body constellations |
| 30 | The Product is adjustable to different body sizes. |
| | The mobile phone must not be shielded by the material. (Metal wires or |
| 31 | Keys and kreditcards is placed on the side of the phone. |
| 33 | The material does not contain metal |

D.2 Importance Rating of the Needs

Table 28 Importance Rating of the Needs

| Rating | Organizing Needs |
|---------------|---|
| | The Product is usable in all climates |
| ** | The product is resistant to moisture. |
| ** | The Product is designed to last over time. |
| ** | The Product dries fast after use. |
| *** | The Phone is securely attached to the product. |
| ** | The Product is water and dirt resistant. |
| * | The product is tough and scratch resistant. |
| | The Product has several pockets for storage. |
| ** | The product has the ability to store all the necessary stuff. |
| ** | The Product can easily be combined with headphones. |
| | The design is discreet. |
| ! | Stylish design for both everyday and sporty use. |
| * | It is possible to carry the product under your clothes while using it. |
| * | The product is discreet but adaptable for younger persons. |
| * | The design is not too big. |
| ** | The product design is made easy with only a few features. |
| | The Product is combinable with other products. |
| * | It is possible to carry the product under your clothes while using it. |
| * | The product can be placed directly on already existing garments. |
| * | The Product is combinable with other running accessories. |
| | The Product is comfortable to use. |
| ** | The product is comfortable without causing irritation. |
| ** | The product is not noticeable while used. |
| | The Product is balancedly placed on the body. |
| ** | The product is placed tight on the body. |
| *** | The product is still when used. |
| *** | The product is centered on the body. |
| | The Mobilephone is reachable in the Product. |
| ** | The Product has an easy way to release/place the mobilephone in the holder. |
| ** | The mobilephone can be reached when using outerwear. |
| * | The phone can be used while placed in the product. |
| ** | The Product is rotateable which makes the mobile easy to reach. |
| ** | The holder can be released from the product. |
| | The product is priceworthy |
| ** | The Product price fits well the costumer expectations. |
| | The Product is easy to use. |
| *** | The Product is easy to attach and release. |
| *! | The product can be applied by others on you. |
| ** | The product is easy to attach on the back at waist height. |
| | The Product fits different types of mobiles with different shapes and sizes. |
| *** | The holder is adjustable. |
| | Useful for all body constellations |
| *** | The Product is adjustable to different body sizes. |
| | The mobile phone must not be shielded by the material. (Metal wires or similar that screen GPS signals picked up by the cell phone). |
| *** | Keys and kreditcards should be placed on the side not above the phone. |
| *** | The material does not contain metal |

D.3 Relative Importance of the Needs

Table 29 List of the Relative Importance of the Needs

| Rating/Importance | | Organizing Needs into a Hierarchy |
|-------------------|---------|---|
| | Need no | |
| | | The Product is usable in all climates |
| 5 | 1 | The product is resistant to moisture. |
| 3 | 2 | The Product is designed to last over time. |
| 3 | 3 | The Product dries fast after use. |
| 5 | 4 | The Phone is securely attached to the product. |
| 4 | 5 | The Product is water and dirt resistant. |
| 4 | 6 | The product is tough and scratch resistant. |
| | | The Product has several pockets for storage. |
| 4 | 7 | The product has the ability to store all the necessary stuff. |
| 3 | 8 | The Product can easily be combined with headphones. |
| | | The design is discreet. |
| 2 | 9 | Stylish design for both everyday and sporty use. |
| 2 | 10 | It is possible to carry the product under your clothes while using it. |
| 2 | 11 | The product is discreet but adaptable for younger persons. |
| 3 | 12 | The design is not too big. |
| 5 | 13 | The product design is made easy with only a few features. |
| | | The Product is combinable with other products. |
| 2 | | |
| 2 | 14 | The product can be placed directly on already existing garments. |
| 2 | 15 | The Product is combinable with other running accessories. |
| | | The Product is comfortable to use. |
| 5 | 16 | The product is comfortable without causing irritation. |
| 5 | 17 | The product does not interfere with with the user's movements |
| | | The Product is balancedly placed on the body. |
| 4 | 18 | The product is placed tight on the body. |
| 5 | 19 | The product is still when used. |
| 5 | 20 | The product is centered on the body. |
| | | The Mobilephone is reachable in the Product. |
| 5 | 21 | The Product has an easy way to release/place the mobilephone in the holder. |
| 3 | 22 | The mobilephone can be reached when using outerwear. |
| 3 | 23 | The phone can be used while placed in the product. |
| 4 | 24 | The Product is rotateable which makes the mobile easy to reach. |
| 2 | 32 | The holder can be released from the product. |
| | | The product is priceworthy |
| 4 | 25 | The Product price fits well the costumer expectations. |
| | | The Product is easy to use. |
| 5 | 26 | The Product is easy to attach and release. |
| 3 | 27 | The product can be applied by others on you. |
| 5 | 28 | The product is easy to attach on the back at waist height. |
| | | The Product fits different types of mobiles with different shapes and sizes. |
| 5 | 29 | The holder is adjustable. |
| | | Useful for all body constellations |
| 5 | 30 | The Product is adjustable to different body sizes. |
| | | The mobile phone must not be shielded by the material. (Metal wires or similar that screen GPS signals picked up by the cell phone). |
| 5 | 31 | Keys and kreditcards should be placed on the side not above the phone. |
| 5 | 33 | The material does not contain metal |

Appendix E Benchmarked products from questionnaire

E.1 Table with properties for benchmarked products

| Benchmarking | | | | |
|------------------------------------|---------------------------|--|---|---|
| Metric | Flipbelt | Salomon Pulse Belt | Energy Belt | Agile 250 Set Belt |
| Visual appearance | Discreet/Simple | Discreet/big | Big black | Thin and thick |
| Easy to use | Yes | Yes | Yes | Yes |
| Adjustable phone holder size | No | No | No | No |
| Steady attachment | Yes | Yes | Yes | Yes |
| Material | 92% polyester, 8% spandex | 89% Polyamid, 11%Elastan - rryg; 84% Polyamid, 16% Elastan | Elastic Power mesh, 3D mesh, 70D Nylkon Ripstop, Vattentät 500mm, | PVC fri, 3D mesh, 70D Mini Ripstop, Waterproof 500mm, Elastisk Jersey |
| Volume | ? | 0,79 L | 0>5 L | 0,25 L |
| Weight | 200 g | 62 g | 220 g | 74 g |
| Comfortable | Yes | Yes | Yes | Yes |
| Moisture resistant | no | no | Yes | Yes |
| Compartments | 1 | 1 | 1 | 1 |
| Does not affect the users actions | True | True | True | True |
| The phone is secure in the product | Yes | Yes | Yes | Yes |
| Price | 349 kr | 345 kr | 495 kr | 495 kr |

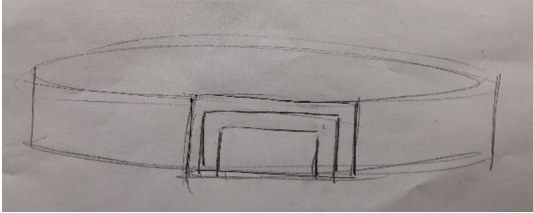
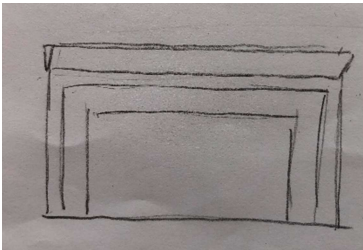
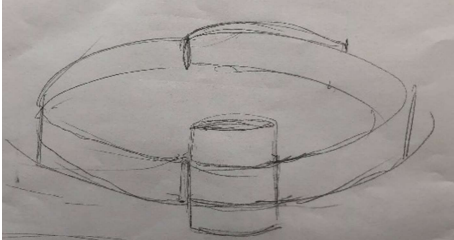
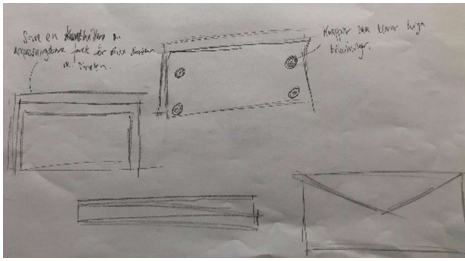
Figure 41 Properties for benchmarked products

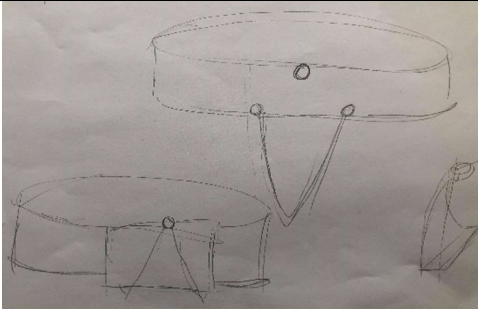
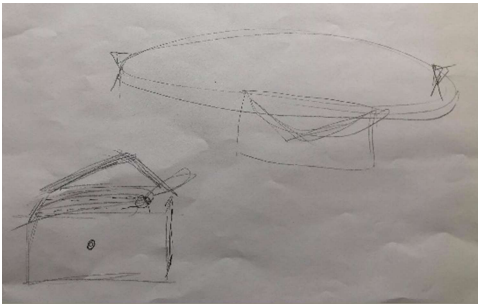
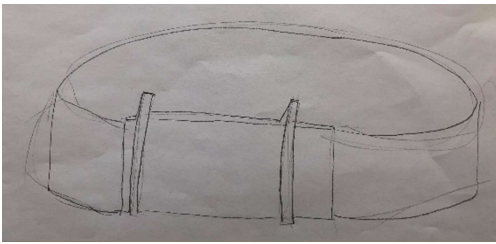

Appendix F Sketches and Prototypes

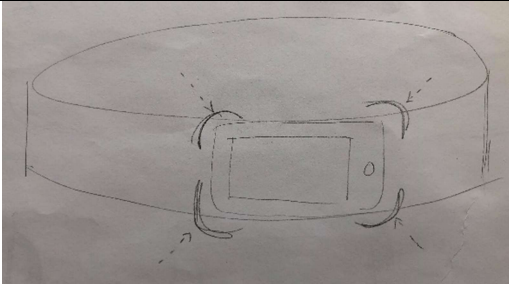
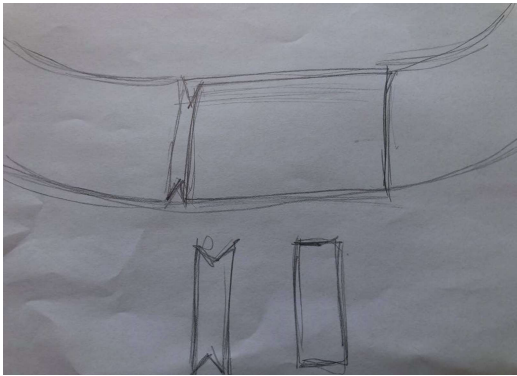
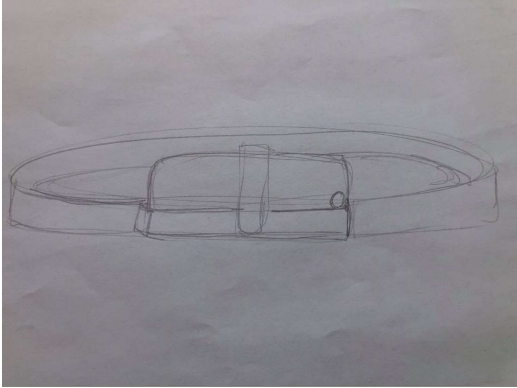
F.1 Table with Sketches

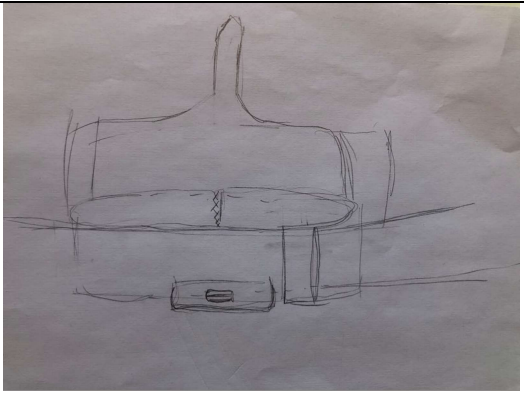
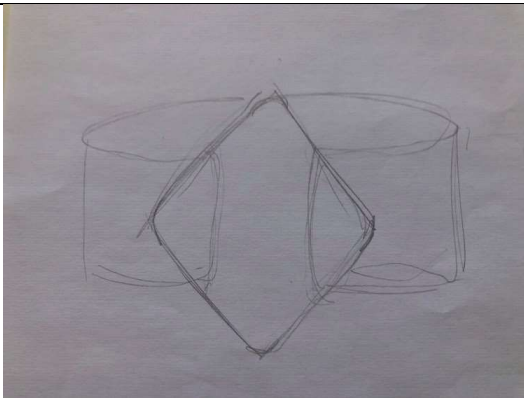
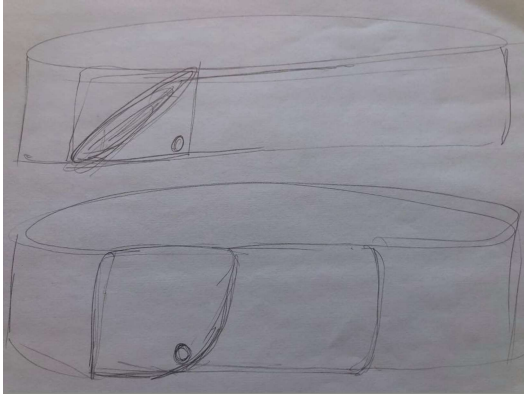
Table 30 Sketches of the first ideas

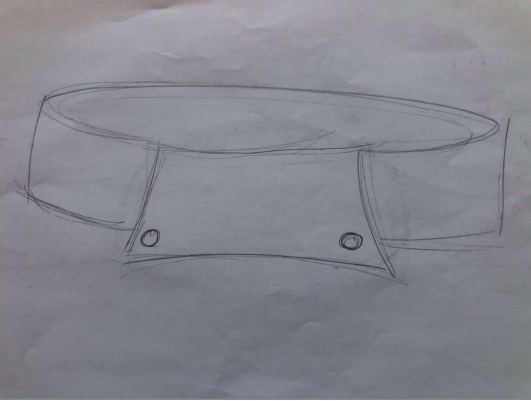

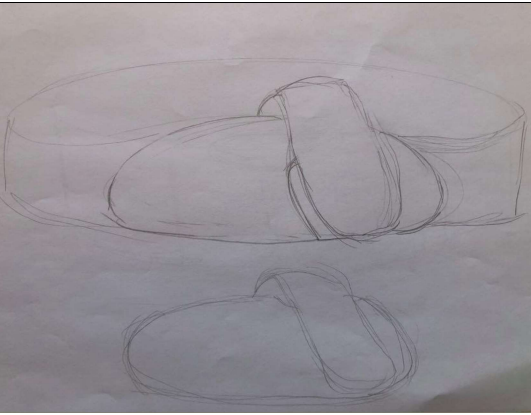
| | |
|--|--|
| 1. Waist bag with different sizes of pockets fitting | |
|--|--|

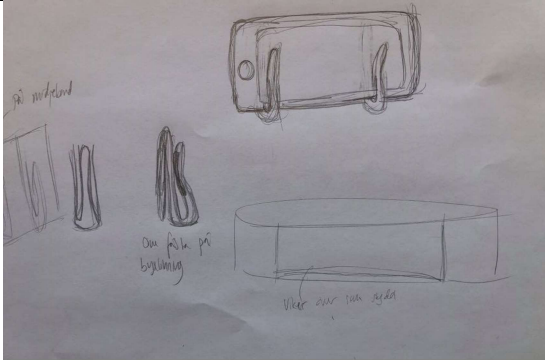

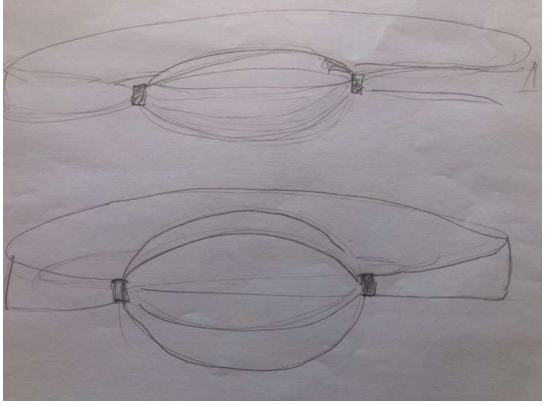
| | |
|---|--|
| <p>different models of mobile phones.</p> |  |
| <p>2. A Clamp placed on the trousers with different sizes of pockets fitting different models of mobile phones.</p> |  |
| <p>3. A waist bag that when it is tightened the holder for the phone also gets tightened by the same band that are placed around the waist and therefore adjusted for your phone size.</p> |  |
| <p>4. A clamp with a purse consisting of pockets in different sizes to fit the different models of phones. The clamp and purse are equipped with push buttons which makes it easy to detach from the product.</p> |  |

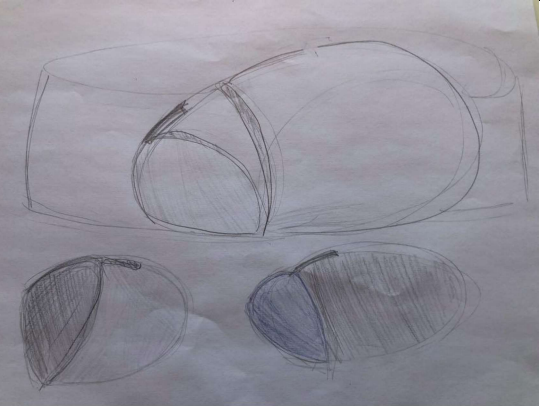
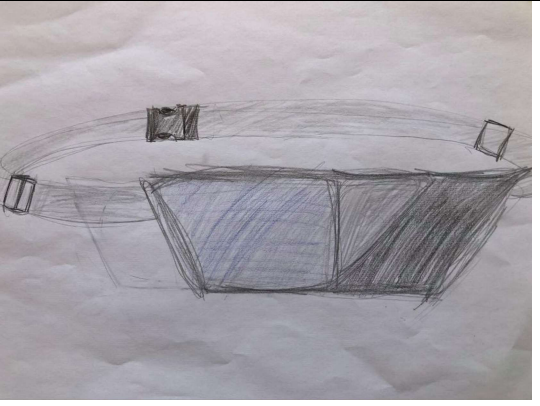
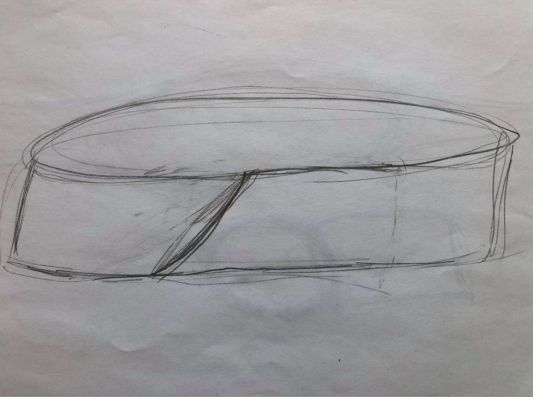
| | |
|---|--|
| <p>5. A waist band equipped with a rubber band that can be stretched to fit different sizes of mobile phones.</p> |  |
| <p>6. A waist bag with clamps on the sides to hold it still while moving. A holder for the phone designed like a purse with a bag in it that can be adjusted by cord stops.</p> |  |
| <p>7. A waist bag with a large pocket that can be adjusted with clamps to the size needed for the user's phone.</p> |  |
| <p>8. A waist bag with a holder with a mechanical tightening function.</p> |  |

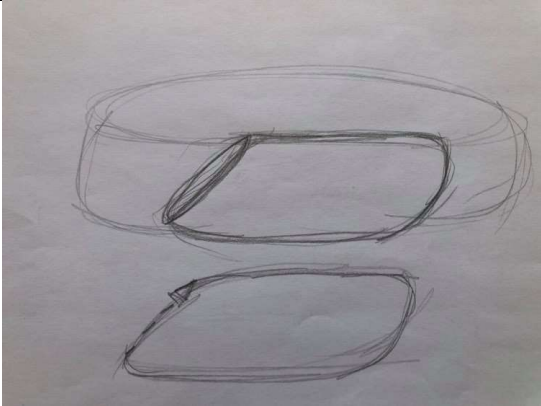
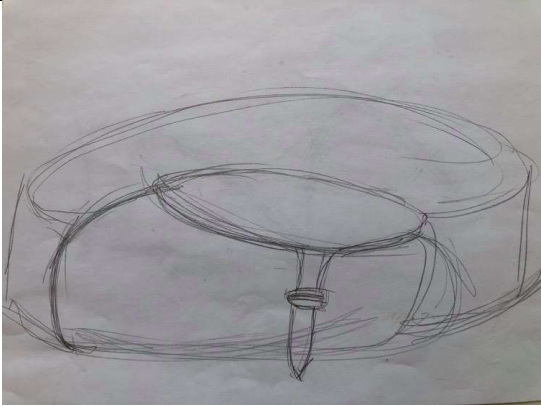

| | |
|---|--|
| |  |
| <p>9. A waist bag with a unfoldable pocket that can fit different sizes of mobile phones.</p> |  |
| <p>10. A waist bag with a static holder and a tensionable band keeping it safe and still.</p> |  |

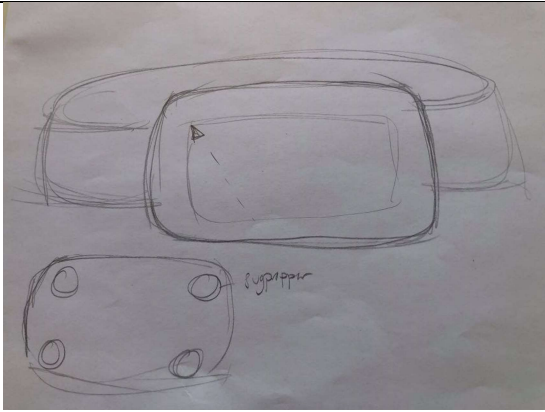
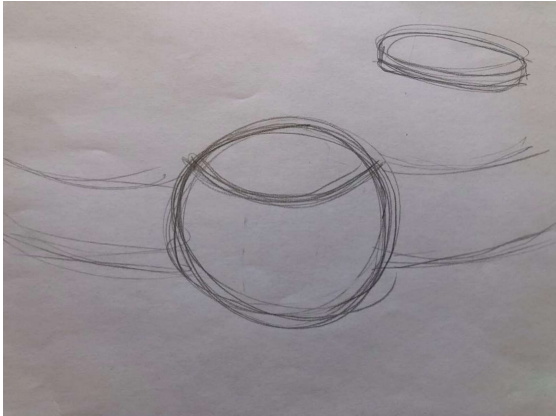
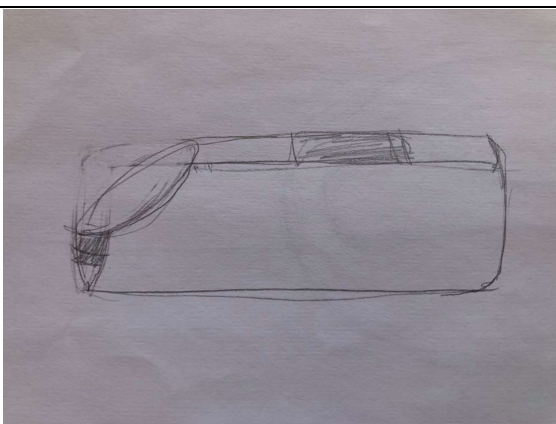
| | |
|--|--|
| <p>11. A waist bag with a static bottom and bands that tightens the mobile phone when it is tensed around the waist.</p> |  |
| <p>12. A diamond-shaped waist bag allowing extra storage on the sides of the bag.</p> |  |
| <p>13. A waist bag with different sizes of pockets with a cover to protect the mobile phone.</p> |  |

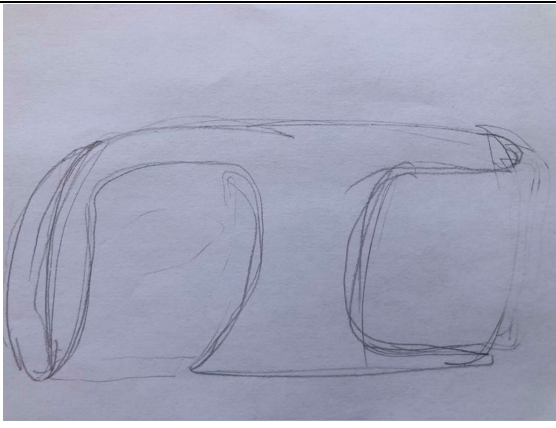
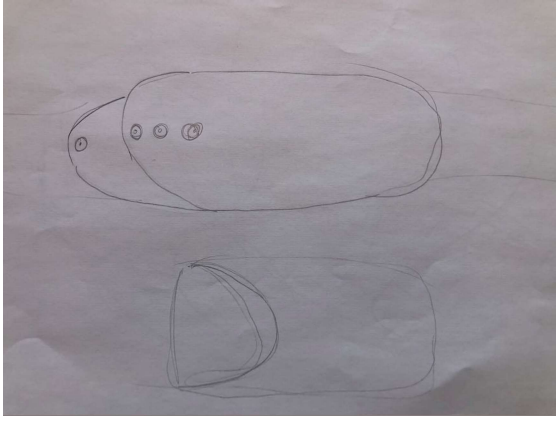
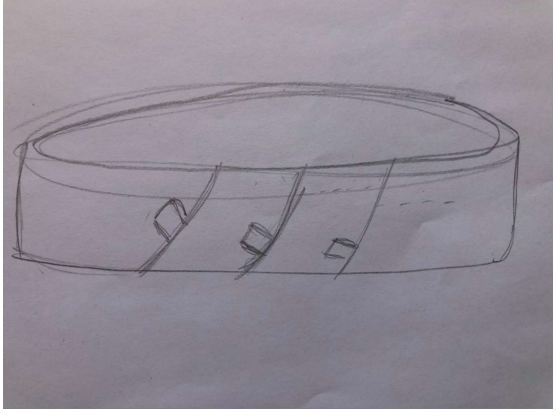
| | |
|---|--|
| <p>14. A waist bag with pockets that are covered with a sharply formed cover.</p> |  |
| <p>15. A waist bag with sides that are expandable to match the size of the mobile phone</p> |  |
| <p>16. A waist bag fastened with a larger flap.</p> |  |

| | |
|---|---|
| <p>17. A waist bag with hooks made of plastic and a cover that can protect the phone from external stress.</p> |  <p>The sketches show a mobile phone with two hooks on its sides, a separate hook component, and a rectangular protective cover. Handwritten notes in a non-Latin script are present: 'pi midland' near the phone, 'Dua fole pi byuhing' near the hook, and 'Wier sur pan apda' near the cover.</p> |
| <p>18. A waist bag with a round shape and opening in the middle. The mobile phone is tightened with the bands that are attached around the waist.</p> |  <p>The sketch depicts a horizontal waist bag with a rounded, bulbous center and a narrow opening in the middle. A mobile phone is shown inserted into the opening, held in place by two vertical bands.</p> |
| <p>19. A waist bag with a rounded shape that are tightened with round plastic clamps to fit the size of the mobile phone.</p> |  <p>Two sketches show a rounded waist bag. The top sketch shows the bag with two round plastic clamps on the sides, which are used to tighten the bag around a mobile phone. The bottom sketch shows the bag without the clamps.</p> |



| | |
|--|--|
| <p>20. A waist bag that can be tightened and adaptable to different mobile phone sizes through different buttons on the top.</p> |  |
| <p>21. A waist bag with an edgy form and pocket for storage.</p> |  |
| <p>22. A waist band with a slanted and elastic pocket for an easy reach of the mobile phone.</p> |  |





| | |
|---|---|
| <p>23. A waist bag with a slanted pocket for an easy reach of the mobile phone.</p> |  A hand-drawn sketch of a waist bag. It features a wide, flat band around the waist. Attached to the band is a rectangular pocket that is slanted downwards. The drawing uses multiple overlapping lines to create a sense of depth and texture. |
| <p>24. A larger sized waist bag with a cover attached on the front.</p> |  A hand-drawn sketch of a larger waist bag. It has a wide band and a large, rounded front cover. A small, circular detail, possibly a button or a fastener, is visible at the bottom center of the front cover. The sketch is composed of several overlapping lines. |
| <p>25. A triangular-shaped waist bag.</p> |  A hand-drawn sketch of a triangular-shaped waist bag. The bag is triangular in form, with a dashed line indicating a fold or seam along one of its sides. A small triangle is drawn at the top vertex of the bag. The bag is attached to a wide band around the waist. |


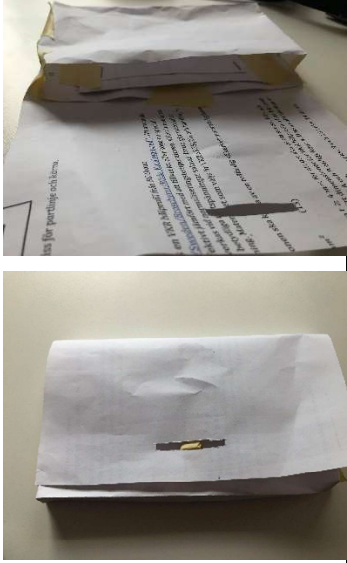
| | |
|--|--|
| <p>26. A flat waist bag with suction plugs keeping it close to the body.</p> |  |
| <p>27. A roundly shaped waist bag.</p> |  |
| <p>28. A mobile phone holder with stretchable sides adaptable to different sizes of mobile phones.</p> |  |




| | |
|---|--|
| <p>29. A mobile phone holder with stretchable sides and complementary clamps for stability.</p> |  |
| <p>30. A holder with a simple pocket that can be snapped in different sizes.</p> |  |
| <p>31. A waist band with different sizes of pockets fitting different sizes of mobile phones.</p> |  |





F.2 Table with Paper Prototypes and Description

| Concept | Illustrations | Description |
|---------|---|---|
| 1. |  | <p>The idea of this concept is that it is a waist bag consisting of several pockets in different sizes. The pockets are supposed to be made of an elastic material keeping the mobile phone close to the body in a fixed position. Depending on the size of the user's mobile phone they can choose either a smaller or a larger pocket. The product can be adjusted around the waist on both sides making it possible to fit different body sizes.</p> <p>An addition to the product is a bag around the pockets hiding the phone and protecting it from external stresses. In the bag it is possible to store keys and other necessities.</p> <p>The idea of the holder is that the phone should stick out a little so that it becomes easy to reach.</p> |
| 2. |  | <p>The idea of this design is a waist bag that when it is tightened the holder for the phone also gets tightened by the same band that are placed around the waist and therefore adjusted for your phone size. The holder is created as a bag which makes it easy to use. An addition to the bag could be an outer bag which makes the design more discreet and open ups for the opportunity to store other necessities.</p> |

| | | |
|----|---|--|
| 3. |  | <p>The idea of this design is to have a large pocket that can be adjusted with clamps to the size needed for the user's phone. The product is designed as a waist bag and can be adjusted to different body sizes.</p> |
| 4. |  | <p>This is the same design as the design presented in row number 2. But instead of making the holder horizontal making the phone lying down, it is placed vertical in a upright position. This because the average range between the width is smaller than the height this mean less garment will be folded over the phone when tightening it.</p> |
| 5. |  | <p>This idea of an adaptable holder is very simple with strings holding it which can be tightened fitting different phone sizes. The material of the stripes should not be elastic because the phone must be still when the product is in use.</p> |
| 6. |  | <p>This design is similar to the one above, instead of one pinch holding it together, there are one on each side of the phone keeping the phone steady.</p> |

| | | |
|-----------|---|--|
| <p>7.</p> |  | <p>This concept is based on the idea of a purse. The phone is centered between a large band which tightens the phone when closed.</p> |
| <p>8.</p> |  | <p>This idea is a combination of the first one presented and the one presented just above. it is designed with different sizes of pockets that fit different sizes of mobile phones. Within the bag other necessities can be stored. The plan is to place the bag on a waist band.</p> <p>Every pocket will be equipped with a flap making it easier to place the phone in the holder.</p> |

| | | |
|-----|---|---|
| 9. |  | <p>This prototype illustrated a waist bag that can be tightened and adaptable to different mobile phone sizes through different buttons on the top. The smaller the mobile phone the smaller the holder gets.</p> |
| 10. |  | <p>This concept describes a holder that consists of elastic material allowing it to expand with the mobile phone. It is combined with flaps that provides it with stability.</p> |
| 11. |  | <p>This concept is inspired by simplicity and consists only of a pocket. The pocket is elastic in one way and is closed and tightened on the side as the picture illustrates.</p> |

| | | |
|-----|---|--|
| 12. |  | <p>This concept consists of pockets in different sizes. The size of pocket that matches the user's mobile phone the best is the one used. It is combined with a smaller pocket where smaller products can be stored such as keys or credit cards. The pocket is protected with an outer pocket that works as a cover.</p> |
| 13. |  | <p>This prototype consists of three pockets, one where credit cards can be stored, one for the users' keys and the third for the mobile phone. The mobile phone pocket has a semicircular opening making it easier to place the mobile phone in the holder. The pocket is either equipped with anti-slip material on the inside keeping it in place, or with different sizes of pockets.</p> |
| 14. |  | <p>This concept describes a round bag that are tightened by clamps on the sides to fit the mobile phone.</p> |
| 15. |  | <p>This concept provides a holder existing of plastic clamps that keeps the mobile phone tightly placed. The clamps are placed with a distance from each other that works for all mobile phone lengths and is therefore easy feasible for all mobile phones.</p> |

Appendix G Benchmarked Waist Bags

In this appendix Benchmarking of current waist bags are presented. The waist bags have similar properties as the one that will be produced.

G.1 Benchmarked Waist Bags

MIIBELT NEW AND IMPROVED



PROPERTIES

- 2 pockets with zippers
- Adaptable to different phone sizes
- Water and moisture repellent material
- Reflective tape
- Headphone jack
- Adaptable size (60 - 120)
- Available in different colors
- Weight 65 gram

Figure 42 Miibelt New and Improved with Properties

FLIPBELT



PROPERTIES

- High comfort, no clasps
- Multiple pockets around the belt
- 92% Polyester and 8% Spandex
- Not adaptable to different body sizes
- Works for different phone sizes.
- Available in different colors
- Tight design
- Price: 349 kr

Figure 43 FlipBelt with Properties

SALOMON PULSE BELT



PROPERTIES

- No clasps
- Multiple expandable pockets
- Weight 62g
- Not adaptable to different body sizes
- Works for different phone sizes.
- Angled zipper for the pocket to minimize risk of movement
- Tight design
- Fourway stretch for high comfort
- Polyamid, Elastan
- Price: 350 kr

Figure 44 Salomon Pulse Belt with Properties

AGILE 250 SET BELT



PROPERTIES

- No clasps
- 1 expandable pocket in the front and 1 bigger at the back
- Weight 74g
- Adaptable to different phone sizes
- Tight design
- Adaptable to different body sizes
- Moisture resistant
- Polyamid, Elastan and Polyester
- Price: 495 kr

Figure 45 Agile 250 Belt with Properties

NIKE EXPANDABLE WAISTPACK



PROPERTIES

- 1 expandable pocket
- Adaptable to different phone sizes
- Tight design
- Adaptable to different body sizes
- Available in different colors
- Polyester, Spandex
- Price: 220 kr

Figure 46 Nike Expandable Waistpack with Properties

SLIM 2.0 WAISTPACK



PROPERTIES

- 1 expandable pocket
- Adaptable to different phone sizes
- Tight design
- Adaptable to different body sizes
- Nylon
- Available in different colors
- Price: 279 kr

Figure 47 Slim 2.0 Waistpack with Properties

Appendix H Mood Boards

Appendix K presents and describes the Mood Boards used as inspiration for the bag.

H.1 The Mood Boards with Description

The mood boards are created to achieve the right feeling so that the product ends up with the features that are bewished. The Discreet mood board below are inspired by transparency, discreet colors, movements, and soft shaped products. A keyword for discretion is to not stand out of the crowd which has influenced the mood board.



Figure 48 Discreet Mood Board

The second mood board created is based on the word simplicity and what we experience as simple. It is inspired by simplicity in nature, in life, in actions and in shapes.

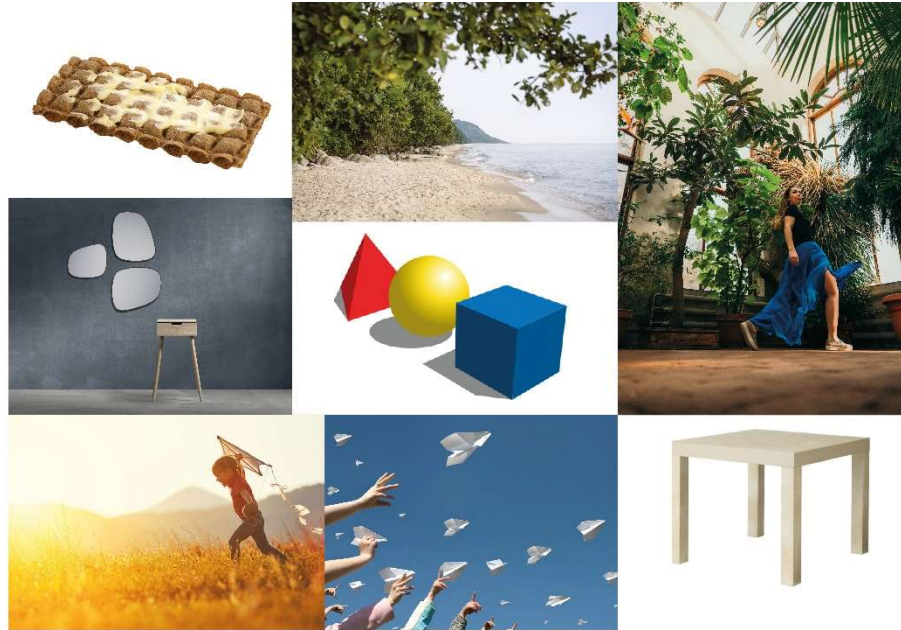


Figure 49 Simplicity Mood Board

One of the needs requires the mobile phone to be still when the user is moving therefore a mood board was created with collected products that has a still installation or prevents movements.

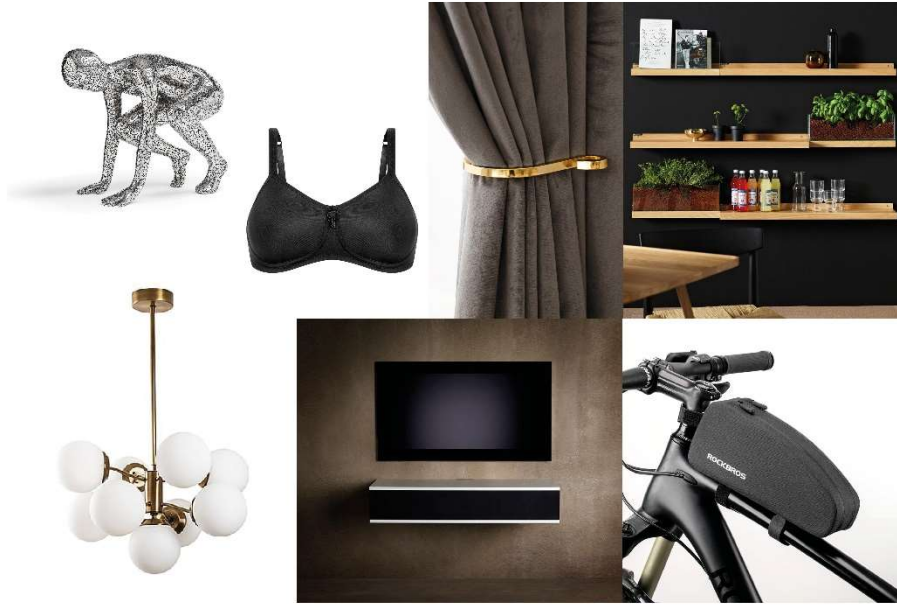


Figure 50 Still Placement Mood Board

The final product should be placed tight on the body and a mood board was created with products that are tightly placed on the body or has a tightening function.



Figure 51 Tight Fitting Mood Board

The product should not be too advanced and only be based on a few features therefore a mood board inspired by products consisting of only a few or a pair of parts was created.



Figure 52 Few Features Mood Board

The product should be cheap to produce but should not look cheap. A mood board was created with products that are cheap but also look cheap. It was made to get a guideline of how the product should not look like.



Figure 53 Cheap Design Mood Board

Appendix I Concept A-E

CONCEPT A

DUAL-FUNCTION TENSIONING MECHANISM

This concept is based on the ones described in paper prototype 2 and 4. The waist band is spun around a bag where the mobile phone is placed. When the strap is tightened around the waist, it is simultaneously tightened around the mobile phone and holds it in place. To make it more visually pleasing a outer bag can be applied around the phone holder.

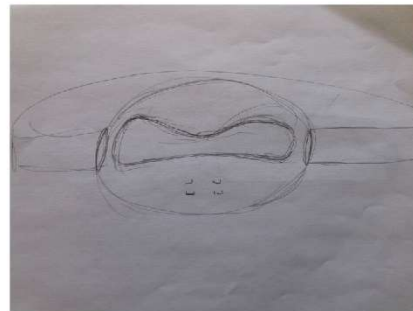
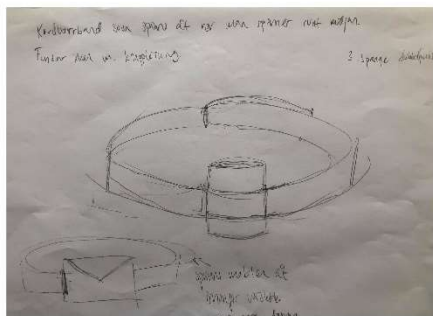
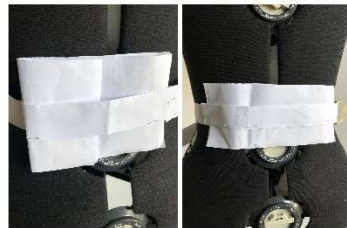


Figure 54 Concept A

CONCEPT B

POCKET BASED DESIGN

This concept is based on the idea of having different sizes of pockets that fits different sizes of mobile phones. The user choses the pocket that fits best their size of mobile phone. The concept can be designed in many different visual apperances and combined with other pockets for necessary storage.



Figure 55 Concept B

CONCEPT C

ELASTIC POCKET

This concept is based on the product material. With an elastic pocket any size of mobile phone can fit the pocket and it is allowed to take up smaller space. The pocket can be closed with various methods such as zippers, push button or Velcro.

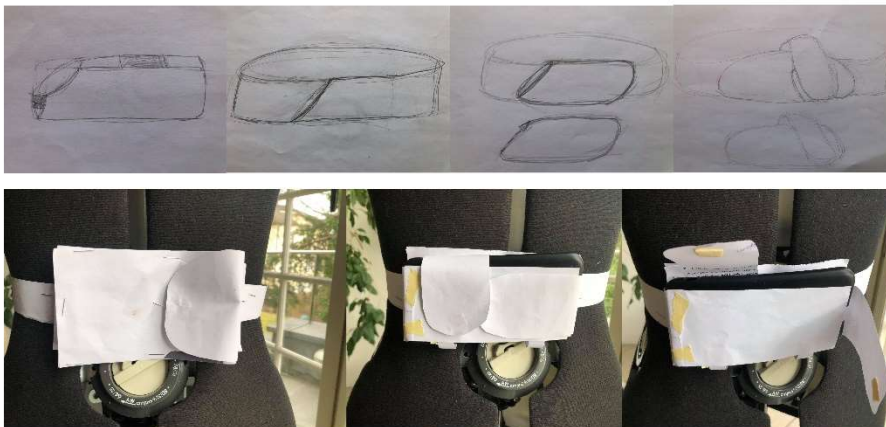


Figure 56 Concept C

CONCEPT D

WAISTBAND WITH CLAMPS

In this concept the idea is that clamps made of plastic material or similar is placed with a certain distance between each other so that all mobile phone sizes can be placed between the clamps. The concept can be further developed with a cover to protect it from outer stresses.

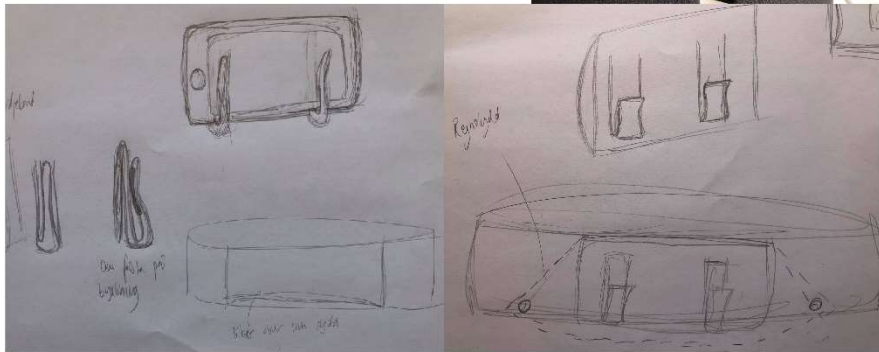


Figure 57 Concept D

CONCEPT E

ADJUSTABLE CLAMPS

The idea behind concept E is to adjust the mobile phone holder to the right size by placing clamps to determine the size of the mobile phone holder. The outlook of the concept can vary in shape and design but works similarly.

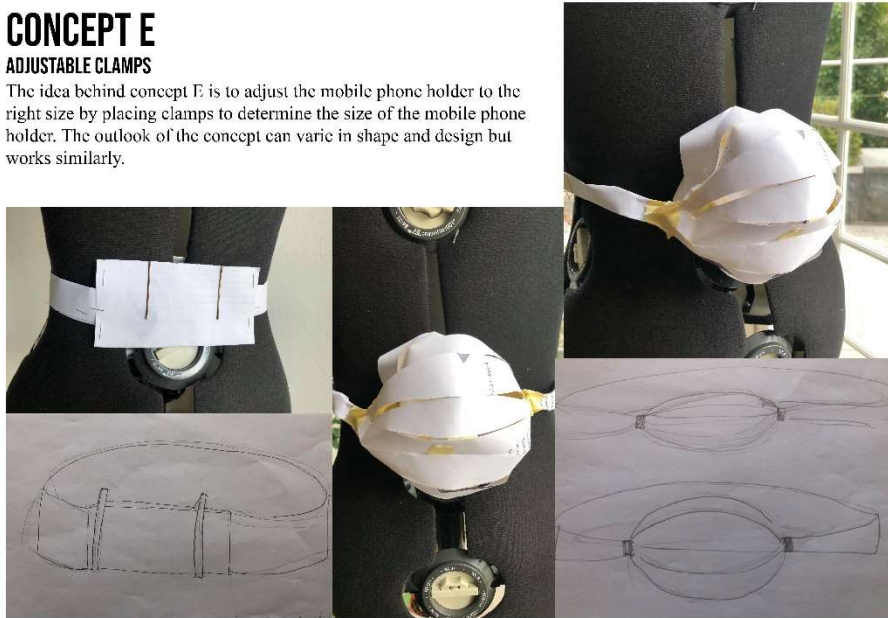


Figure 58 Concept E

Appendix J Questionnaire Testing

J.1 Questionnaire during the test

Concept Testing

1. How old are you?

2. Which potential customer are you?

Markera alla som gäller.

Rehabilitation patient

Runner

Tasks (Prototype 1)

Place the smartphones in the holder

3. How did you experience the difficulty of placing the mobile phone in the holder?
(The small one)

Markera endast en oval.

| | | | | | | |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| Very hard | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very easy |

4. How did you experience the difficulty of placing the mobile phone in the holder?
(The middle one)

Markera endast en oval.

| | | | | | | |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------|
| | 1 | 2 | 3 | 4 | 5 | |
| Very hard | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very easy |

5. How did you experience the difficulty of placing the mobile phone in the holder?
(The large one)

Markera endast en oval.

| | 1 | 2 | 3 | 4 | 5 | |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------|
| Very hard | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very easy |

Place the waist bag around your waist so that the holder is centered on the back.

6. Did you experience any difficulties attaching the waist bag on your body?

Walk around with the waist bag

7. How did you experience the mobile phone when walking?

Markera endast en oval.

| | 1 | 2 | 3 | 4 | 5 | |
|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------|
| Very uncomfortable | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very comfortable |

8. Did you experience anything disturbing when you were moving?

9. How balanced did you experience the waist bag to be when you were moving?

Markera endast en oval.

1 2 3 4 5

Very unstable Very stable

10. Did you feel calm having the mobile phone in the holder or were you ever concerned it would fall out?

Markera endast en oval.

1 2 3 4 5

Very concerned Very calm

Someone is calling you, try to reach the mobile phone!

11. How did you choose to reach the phone when it was in the holder?

12. How hard was it to reach the phone?

Markera endast en oval.

| | 1 | 2 | 3 | 4 | 5 | |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------|
| Very hard | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very easy |

Place the phone in the holder again

13. How did you place the mobile phone in the holder?

14. How hard was it to place the phone back in the holder?

Markera endast en oval.

| | 1 | 2 | 3 | 4 | 5 | |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------|
| Very hard | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very Easy |

Run with the waist bag

15. Was there something that annoyed you when running with the bag?

16. How well attached did you experience the holder to be when running with the bag?

Markera endast en oval.

| | 1 | 2 | 3 | 4 | 5 | |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------|
| Very shaky | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very still |

17. Was the holder still centered on the body after you had run?

Markera endast en oval.

Yes

No

Questions after the test (bag number 1)

18. What did you think was good with the bag?

19. What was less good with the bag?

20. Was there something missing on the bag that would have made you more prone to use it/buy it?

21. How did you experience the user-friendliness of the bag?

Markera endast en oval.

| | | | | | | |
|------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Very hard to use | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very easy to use |

22. Based on your previous answer, what made it hard/easy to use?

23. Was there any part of the tasks that were extra hard to manage?

J.2 Questionnaire After the Testing

108. Do you believe it is necessary to be able to place the phone in the holder without having to loosen the entire waist bag?

109. How important is it to be able to place the waist bag under your clothes when using it?

Markera endast en oval.

| | | | | | | |
|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Not that important | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very important |

110. Which waist bag did you prefer?

Markera alla som gäller.

- Prototype 1
- Prototype 2
- Prototype 3
- Prototype 4
- Prototype 5
- I would like a combination of the bags

111. Why did you prefer this bag?

112. Is there any property that you would like to add to this bag?

113. Is there any property that you found on another bag that you liked and would like to add to this bag?

114. Is there anything specific you would like to change with the design of the waist bag?

115. What is the probability that you would buy this bag for running or rehabilitation purposes?

Markera endast en oval.

| | | | | | | |
|---------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Very unlikely | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | Very likely |