Group B: Smart Gadget to foster a healthier Lifestyle

February 7, 2020

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Course Work: User Interface Engineering

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Winter Term 2019/20

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Part I
Introduction

As part of the coursework *User Interface Engineering*, a concept for a smart gadget to support people in adopting a healthier lifestyle is developed. The project group is composed of five students with background in either Computer Science or Psychology.

The goal of the project is to implement a prototype to test and present the outcome. The workflow encompasses an analysis phase, a design phase and a prototype and evaluation phase. In the following subsections, the progress is documented structured according to the different phases.

1 Brainstorming

The goal of the first group meeting is to get an overview which aspects characterize a healthy lifestyle and break down the topic. Furthermore, first visions and ideas are proposed.

1.1 Healthy Lifestyle

A healthy lifestyle compromises many different facets like e.g. nutrition or physical activities. To gain an overview, brainstorming on what a healthy lifestyle means to each team member is done. The results are collected in form of a mind map (see figure 1).

The mind map shows different ways on how to accomplish a healthier lifestyle.

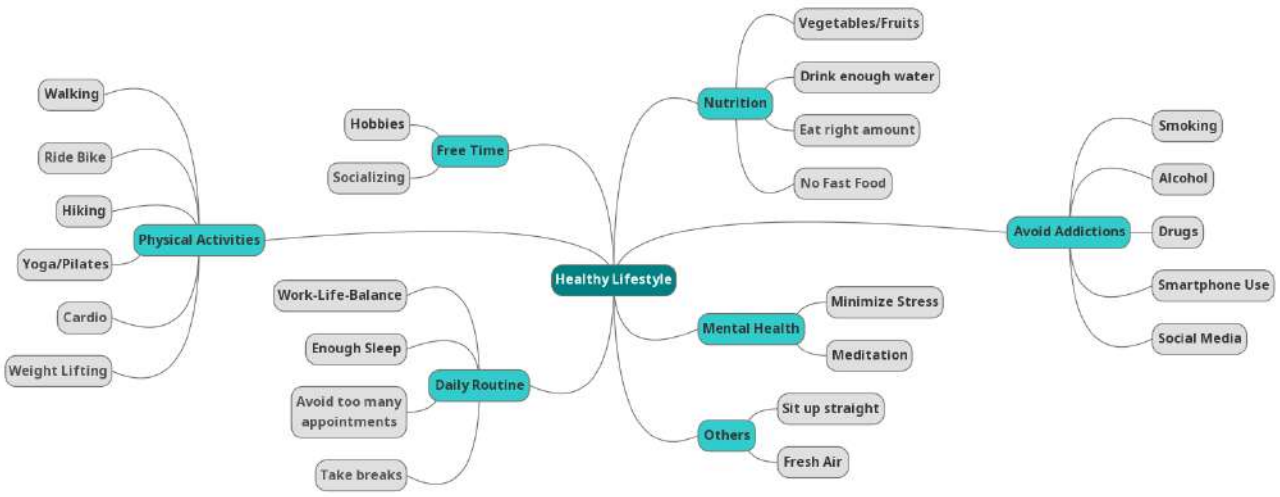
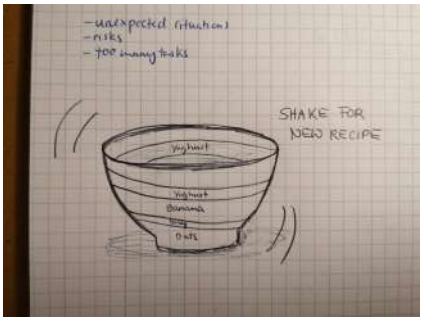


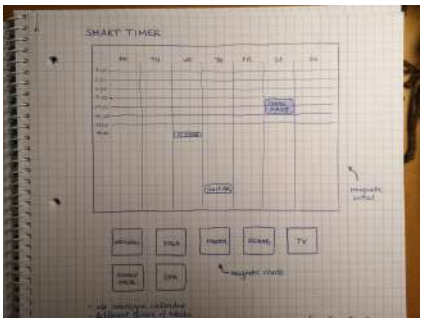
Figure 1: Mind Map "Healthy Lifestyle"

1.2 First Visions and Ideas

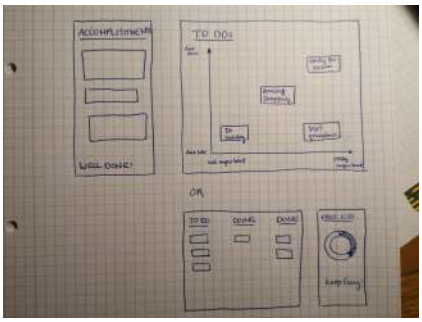


(a) Smart Muesli Bowl

(b) Smart Yoga Mat



(c) Smart Schedule



(d) Smart To Do List

Figure 2: First Visions and Ideas

2 Decision

As can be seen in figure 1, the subject of a healthy lifestyle could be addressed in many different ways. However, it turns out there are already many existing solutions like smart yoga mats and bottles which remind you to drink water - only to mention two of them. Based on this fact and the motivation stated in section 2.1, the focus of this project is laid on stress. The following subsections deal with motivation, goal and further definition of the subject outline.

2.1 Motivation

While there are many gadgets to support you in your fitness and eating habits there is only little support when it comes to app's and gadgets in the field of stress reduction. Nevertheless, stress is an important factor in our society and leads to an alarming raise in break-downs. Nowadays, people are faced with a much faster living pace compared to a couple of years ago. In this trend, the internet and social media play a major role: they confront us with a flood of information in realtime. Furthermore, stress affects everyone from kid to elderly and appears in many situations like at school, at work, on the streets, at the doctor's and in supermarkets.

2.2 Characteristics of Stress

In this section, specific characteristics of stress are worked out. Below, possible stakeholders - people who are affected by stress in some way - are listed. Furthermore, an overview of situations and places in which stress might appear is given. They differ between different personalities. Since time pressure seems to be an important aspect when it comes to stress, reasons for being under time pressure are collected. Finally, some ideas on how stress could be reduced are stated.

Groups of persons who are affected by stress

- students
- pupils
- workers
- adults

Situations in which we are stressed

- time pressure / bad time management
- unexpected situations / external influences
- high goals bad self-assessment
- too many tasks too complex tasks
- media / society social situations
- high expectations
- meeting strangers

Places at which stress appears

- streets / traffic
- office / workplace
- supermarket
- social environment / family
- public transport

Reasons for being under time pressure

- no time for breaks
- external unexpected factors
- long travel time / forgotten to allow travel time
- bad task / time management
- missing motivation

Methods to reduce stress

- visualize accomplished tasks -> motivation
- time manager, smart schedule -> time management, breaks
- shopping aid -> reduce stress in supermarket

2.3 Goal

The main goal of this project is to support people in reducing stress and achieving a healthier lifestyle. Therefore, a stressful situation which affects a large user group is going to be detected, analyzed and addressed. Then, a smart gadget is to be developed which reduces the stress and / or supports users in mastering the stress.

Part II
Analysis Phase

After some first brainstorming is done, the actual analysis phase takes place. Below, possible scenarios in which stress appears and corresponding stakeholders are presented. Since grocery shopping is a situation which is perceived stressful by all team members, field studies and interviews are undertaken in order to reinforce or disprove the assumption.

3 Possible Scenarios

In this section, possible scenarios in which stress appears are analyzed. Stakeholder diagrams give an overview of stakeholders and their relations. Additionally, stakeholders and their respective background, expectations and preferences are listed.

3.1 University

Stakeholder Diagram

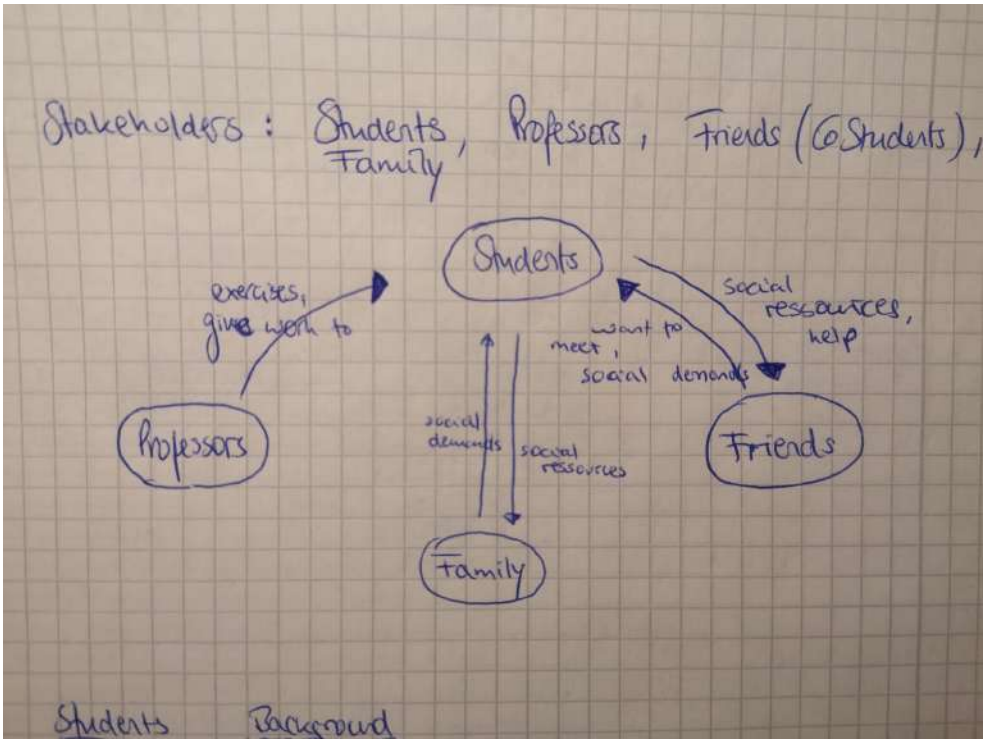


Figure 3: Stakeholder Diagram - university scenario

Stakeholders overview

Stakeholder	General Group Characteristics
Student	**Background** familiar with smartphone, PC and so on; used to waking up late; bad with time management; overwhelmed by social media; need to reconcile lectures; projects and work; annoyed of their high smartphone use **Expectations** want to have time for their friends **Preferences** smartphone app or analog gadget for a change
Professor	**Background** know how to operate smartphone, PC etc. **Expectations** expects students to recap what they have learnt **Preferences** computer, e-mail
Friends	**Background** same as listed under "student" **Expectations** expect you to have time for them **Preferences** smartphone app

Table 1: Stakeholders and respective background, expectations and preferences - university scenario

3.2 Home

Stakeholder Diagram

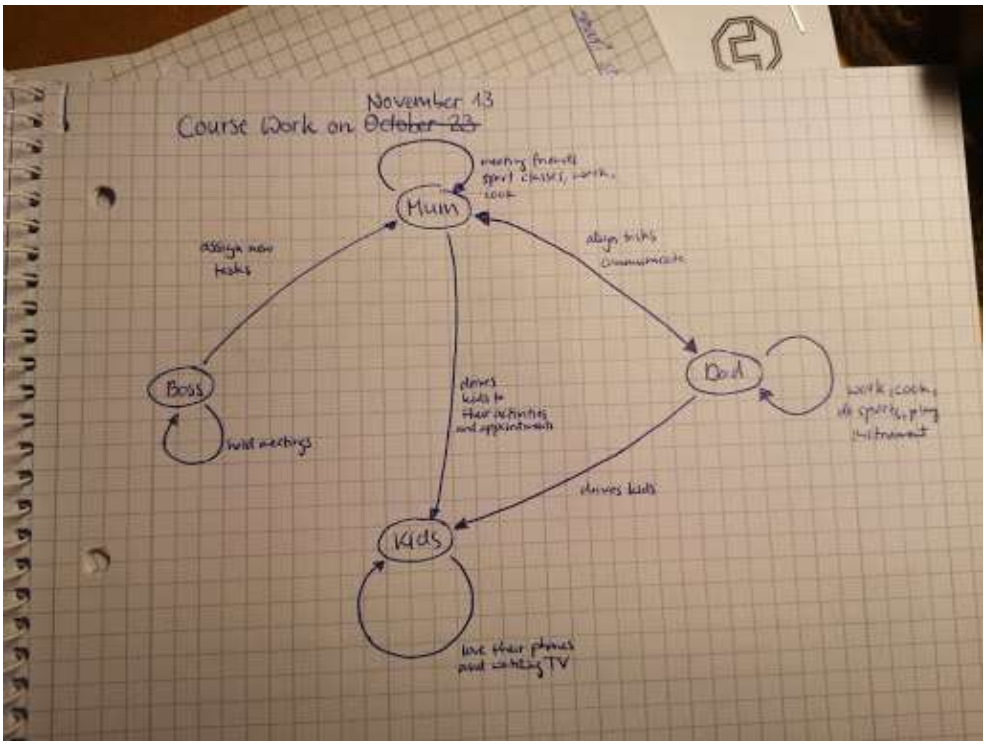


Figure 4: Stakeholder Diagram - home scenario

Stakeholders overview

Stakeholder	General Group Characteristics
Parents	**Background** need to care for their kids; go to work every day; meal prep; grocery shopping; social activities; do sports; drive their kids around; know how to use smartphone and PC at a low level; struggle in managing their daily tasks; hard to balance / reconcile multiple schedules; stressed from work **Expectations** want their kids to take on responsibility; expect their boss not to overwhelm them with tasks; want to be role models for their kids; meet their friends regularly; have time for their social activities; appreciation **Preferences** easy communication; analog gadget
Kids	**Background** know how to operate smartphone, PC etc. **Expectations** rely on their parents; have free time; not too many homeworks / household tasks; have hobbies **Preferences** smartphone app

Table 2: Stakeholders and respective background, expectations and preferences - home scenario

3.3 Supermarket

Stakeholder Diagram

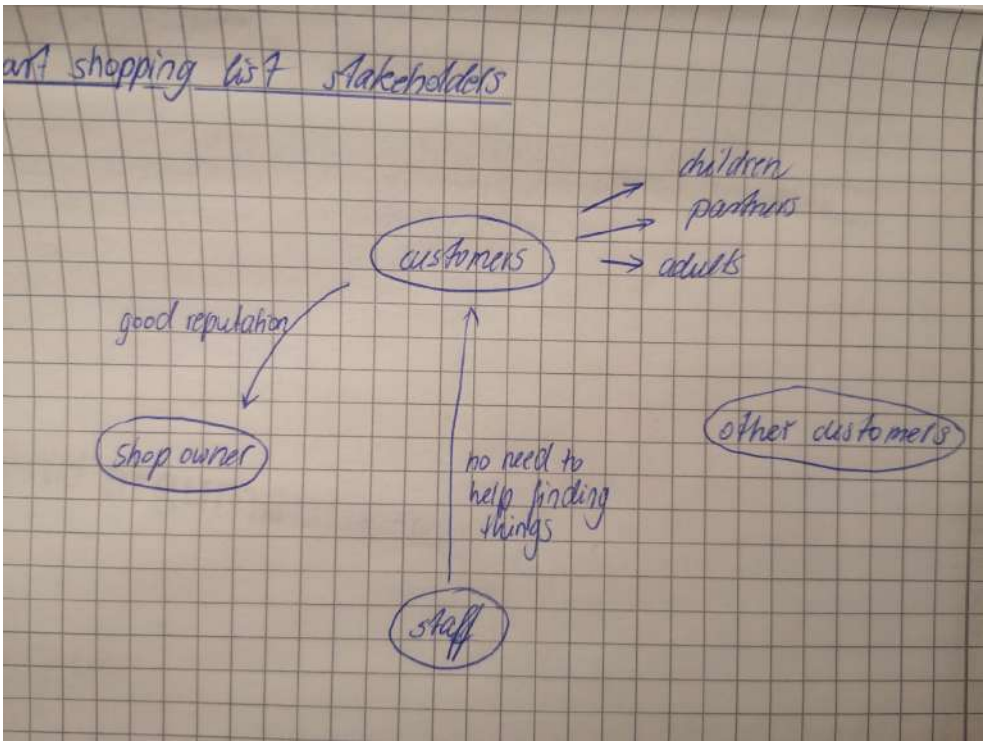


Figure 5: Stakeholder Diagram - supermarket scenario

Stakeholders overview

Stakeholder	General Group Characteristics
Customer	**Background** need to do grocery shopping for themselves and/or family **Expectations** well sorted supermarket; easy to find products; not too many other customers; fast handling at checkout; available staff to ask questions **Preferences** get grocery shopping done as fast as possible; don't walk back and forth
Supermarket staff	**Background** knows where products are placed **Expectations** friendly and polite customers; don't be interrupted too often **Preferences** customers who find products themselves
Cashier	**Background** knows how to operate the cash register **Expectations** polite communication with customers **Preferences** fast paying process
Supermarket owner	**Background** owns the supermarket; responsible to keep staff and customers happy; pays salaries **Expectations** high sales and profit; staff should fulfill their tasks **Preferences** no theft; happy customers and staff; high profit

Table 3: Stakeholders and respective background, expectations and preferences - supermarket scenario

4 Field Studies

Field studies are undertaken to get a better understanding of supermarket environments. The results are presented below.

4.1 Observations

- Grocery shopping is part of nearly everybody's life
- shops for groceries differ e.g. in large, in offer, in quality of products etc.
- we classify three kinds of shops: small markets, medium sized markets, hypermarkets
- in medium sized stores and hypermarkets people seem to be more stressed

4.2 Shop Types

Supermarkets differ in size, product range, price class. Table table 4 gives an overview of shop types and their characteristics.

Small markets	**Medium sized markets**	**Hypermarkets**
• no chain stores • products are limited e.g. regional, organic	• discounters • chain stores • cheap products • attract customers through offers	• products in huge amounts • large assortment • large variety

Table 4: Shop Types

5 Interviews

Interviews are held in order to get a better picture of different user groups. To make the interviews comparable, a questionnaire is set up in advance.

The following questions are asked:

1. If you go shopping, do you feel stressed? (never, sometimes, often, almost always)
2. What triggers/causes the stress?
3. Think about solutions that would reduce the stress, what could that be?
4. Regarding to these solutions, what do you do already? What do you not do?
5. Independent of stress-regulation - is there anything that you miss when you go shopping? Other Problems? Is there something that could enrich your shopping experience?

5.1 Interview 1

The interviewee is a person with family and goes shopping for a handful of family members.

Answers:

1. sometimes feels stressed because of shopping
2. Stress factors:
   - time management (before shopping)
   - lack of motivation, because to shop alone is exhausting
3. Possible Solutions:
   - better planning regarding times - when are best shopping times?
   - To have someone with you while shopping - is more motivating
4. I do:
   - ask my daughter to come with me
5. other problems:
   - music too loud/advertisement - lack of concentration that causes forgetting to buy something

- difficulties to find things, because of rearrangements of products, new places for products - too much time to find new position of products
- too much stuff on shelves -> too much time to find the one thing you needed although you know that it is in the reached shelf

5.2 Interview 2

The interviewee is a women who does shopping for two people.

Answers:

1. Feels sometimes stressed
2. Stress factors:
   - loud music
   - too many people
   - too many possibilities
3. Possible Solutions:
   - reduce the stimuli
   - always carry a shopping list with me
4. I do:
   - shorten the shopping experience as much as I can
   - very goal oriented - no "extra-ways"
   - But: I cannot change the music, the stimuli
5. Other problems:
   - waiting in queue
   - interactions of mums and kids are often stressful even for strangers

   Other things that could enrich my shopping experience:
   - less advertisement of products for kids -> less discussions between family and kids

5.3 Interview 3

The interviewee is a female person who does shopping for herself.

Answers:

1. Never feels stressed while shopping
2. Stress Factors: -
3. Possible Solutions: -
4. I do:
   - I mostly go in stores, that are less noisy and that have well structured products
   - usually I listen to my own music while shopping - don't have to listen to the noisy environment
5. Things that could enrich my shopping experience:
   - bright stores
   - less waiting in queues

5.4 Interview 4

The interviewee is a male student who does grocery shopping for 1 or sometimes 2 persons. He often takes a digital shopping list on his smartphone.

Answers:

1. sometimes feels stressed
2. Stress Factors:
   - stores I don't know
   - don't know where products are
   - when I need to buy things for someone else & don't know how they look like & where to find them
   - too many people, people blocking aisles/ways with their shopping carts
3. Possible Solutions:
   - to know where products I need are without asking the staff (don't want to set down headphones)
   - less people
4. I do:
   - almost always listens to own music on headphones while shopping
   - go to supermarkets I already know
   - google unknown articles before ahead to know how they look like → easier to find them

   I do not:
   - ask staff where to find products I'm looking for
   - ask people to move their shopping carts, so I could pass
5. Other ideas:
   - would like to find things faster
   - ideas for a recipe (because sometimes I go shopping without knowing before want I could cook)
   - likes shopping (online shopping wouldn't be an alternative) but less people would enrich shopping experience

5.5 Interview 5

The interviewee is a woman who does grocery shopping for two persons. She always has a shopping list on paper or in her diary.

Answers:

1. feels often stressed
2. Stress Factors:
   - too many people
   - feels like there is not enough time to select products carefully & unhurriedly
   - billboard adverts are sometimes in the way
   - hard to pass with shopping cart
   - when products are rearranged, not where they used to be

- searching for a car park close to the entrance of the shop
- walk with shopping cart through parking area to get to car
- music too loud
- things other than groceries make supermarkets even more confusing

3. Possible Solutions:
   - relaxed music
   - less people
   - no billboard adverts
   - organic products separate from others
4. I do:
   - go at times when there are less people shopping (disadvantage: sometimes choice of fresh products is limited
   - ask staff when I can't find products
5. Other ideas:
   - everything that would save time would be better
   - less people

5.6 Interview 6

The interviewee is male, works and mostly does grocery shopping for one or two persons. He rarely takes a shopping list.

Answers:

1. feels sometimes stressed
2. Stress Factors:
   - when I forget a product & have to go back through the whole store
   - when product I want is not available/ I can't find it
   - differences of temperature (wearing a warm jacket & very warm in the supermarket due to heating)
   - cashier is very fast but I need more time to pack stuff before paying
3. Possible Solutions:
   - something (box) where I could put my jacket while shopping
   - people who pack stuff at the cash desk
   - separated areas to pack stuff
4. I do:
   - pay by card because it's faster
   - go to supermarkets I already know
   - make notes about things I need sort products depending on what should go into basket first & last
5. Other ideas:
   - shelves should have better labeling
   - searching for products on display that shows the correct shelf
   - shopping help but still want to collect fresh products by myself

5.7 Interview 7

The interviewee is male, works full-time and usually shops for two persons.

Answers:

1. sometimes feels stressed when shopping
2. Stress Factors:
   - many people
   - running forth and back because he forgot/missed sth.
3. Possible Solutions:
   - less people
4. I do:
   - sometimes writes down shopping list
5. Other ideas:
   - support in finding products
   - better structured shopping cart to better place sensitive/less sensitive products

5.8 Summary

The interviews are held with only a small group of users and might therefore not be representative for the overall societs. However, the interviews pointed out that most of the subjects have a high stresslevel during shopping (see figure 6a). Factors that are mentioned noticeably often are crowded supermarkets and forgotten products (see figure 6b). Consequently, as factors to enrich the shopping experience less crowded supermarkets and a shopping help are stated (see figure 6c).

(a) Overall stresslevel during shopping

(b) Causes, stressors, problems during shopping

(c) Factors to enrich shopping experience

Figure 6: Interview outcome

Factors that possibly influence the overall shopping experience can be classified by *individual* and *store specific factors*. Table 2 lists factors based on these two facets. The list is not exhaustive.

Individual factors	Store factors
• motivation • age • coping-style • values and attitude • personality • creativity • socio economic status	• crowding • music • staff • temperature • product quality • location • product assortment

Table 5: Stress factors classified by individual and store specific factors

6 Domain literature

An exploratory study of grocery shopping stressors was done by Aylott and Mitchell in 1998[1]. Although the study was conducted over 20 years ago, it seems still valid to our today's shopping behavior. It was found out that 50% of the study subjects being from dual-earner families and 35% of the subjects being from single-earner families feel that shopping adds stress to their lives. The diagram in figure 7 shows the loading of stressors in the 1990's on stress experience while shopping. Popular stressors are social components like crowding and badly behaved children. Also time related components like queuing and time pressure play a role. Furthermore, product related components like poor signage and product relocation contribute to the stresslevel. These factors coincide with the outcoming of the interviews presented in section §5.

[1]TODO: [Aylott & Mitchell, 1998}

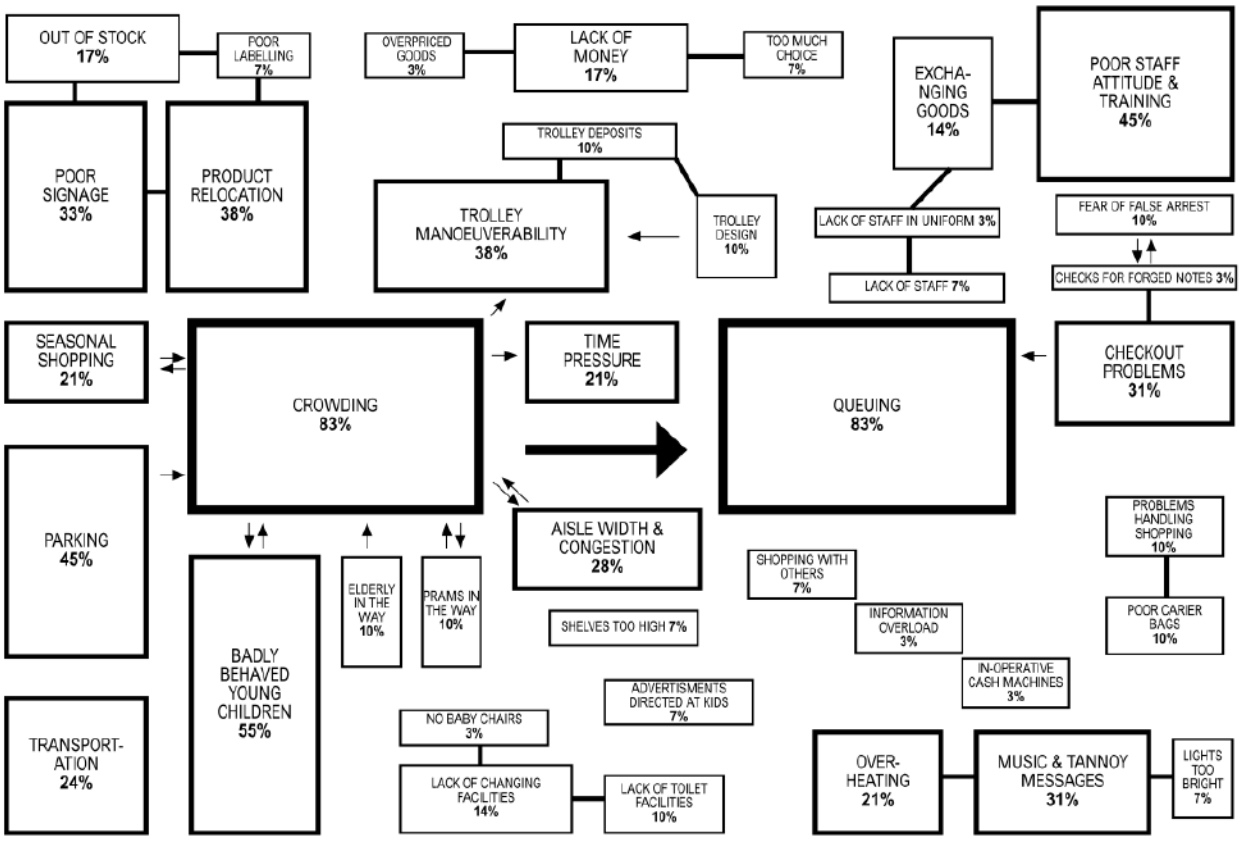


Figure 7: Grocery store stressors and their relations footnote (1)

7 Stakeholders

7.1 Revised Stakeholderdiagram

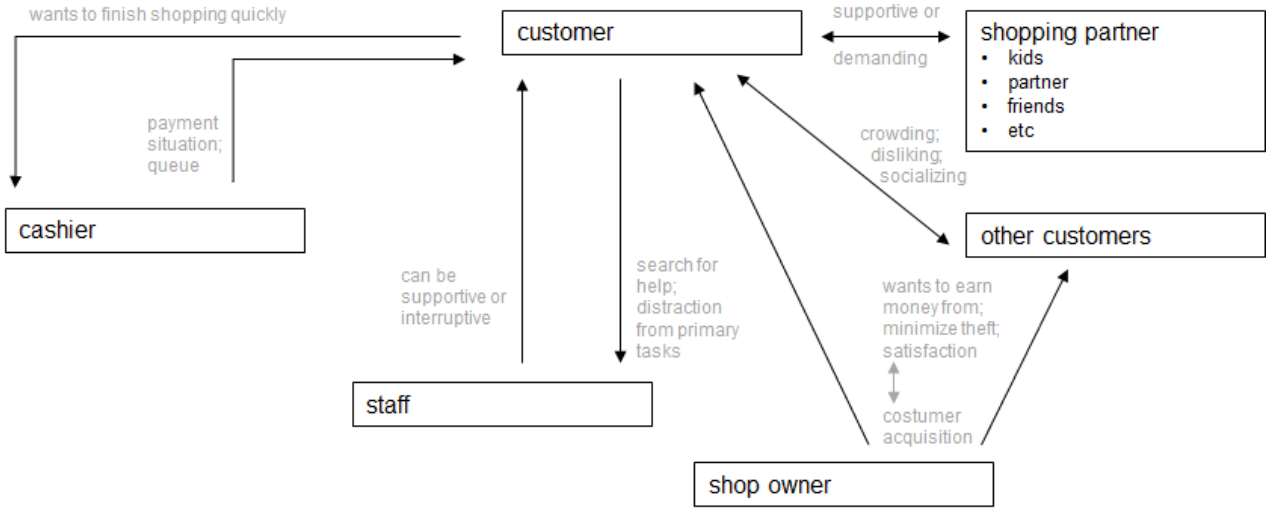


Figure 8: Stakeholderdiagram Shopping Experience

7.2 Revised Stakeholder Overview

Stakeholder	Characteristics
customer	**background** need to do grocery shopping for themselves and/or family, different values regarding groceries/food-quality, variance in motivation, shop alone or with "shopping partner", mostly go in same stores **expectations** well sorted supermarket, easy to find products, finding specific products, shopping is more motivating **preferences** no crowding, not waiting in queue, get groceries done as fast as possible, don't walk back and forth
shopping partner	**background** kids, family/partner, friends who accompany customer, variance in motivation, can be supportive or demanding for customer **expectations** enriched shopping experience, being supportive **preferences** not to interrupt customer in shopping
other customers	**background** need to do grocery shopping for themselves and/or family, different values regarding groceries/food-quality, variance in motivation, shop alone or with "shopping partner", mostly go in same stores **expectations** less crowding, no blocking **preferences** have good smalltalk with other customers or no contact
staff	**background** have different tasks: satisfy customer, care about products, responsibility for cleaned and well organized store **expectations** fulfill tasks well and conscientiously, don‘t be interrupted too often **preferences** satisfied customers finding products themselves
cashier	**background** are responsible for payment situation, need to handle different customers (ages, payment methods) **expectations** payment situation should be as fast as possible, need to work quickly and exactly **preferences** polite contact with customers
shop owner	**background** owns the supermarket, responsible to keep staff and customers happy, pay salaries, high sales and profit, customer acquisition **expectations** smooth work-flow, satisfied customers **preferences** no intervention in daily work of staff and customers

Table 6: Stakeholders Overview

7.3 General User Groups

It is thought of user groups which are possible customers in any kind of supermarket. Respective background, expectations and preferences are listed.

7.3.1 Students

Background:

- very familiar with electronic devices
- moderate to extensive use of smartphone apps
- often buys only a few things, is quite quick
- prices often matter

Expectations:

- shopping experience should be quick
- still having the possibility to choose between products is important

Preferences:

- system that sorts products beforehand
- navigating in the shop to be faster

7.3.2 Family Member

Background:

- quality & origin of products matter
- moderately familiar with electronic devices/smartphones
- often accompanied by children that ask about products/want to get products/need attention

Expectations:

- origin & ingredients of products should be labeled
- even children should learn something while grocery shopping (e.g. where food comes from)

Preferences:

- ideas for recipes for the family would enrich shopping
- possibility to keep children busy while shopping

7.4 Personas

The personas are chosen to best represent the usergroups which are affected by stress during shopping.

(a) Emma – Student (b) Emma – Student (c) Emma – Student

Figure 9: Personas

7.4.1 Emma (student)

Emma is a 22 years old **student** at the Technical University Dresden. She lives in her own little flat and usually goes shopping to buy **groceries only for herself**. She **doesn't really plan** in advance what she's going to shop. She rather goes to the supermarket and buys whatever she thinks she could need. While doing so, she looks out for **small prices and offers**. That's why she often **forgets** to buy something and has to go shopping **multiple times** a week. In addition, Emma has no car and needs to **carry home** her groceries in her **brought bags** and therefore can't buy too many things at once. Her shopping trips are rather short and she quickly **rushes** through the supermarket. She **avoids buying plastic bags** at the cash desk, but sometimes just **forgets to bring her own** reusable bags.

7.4.2 Susan (mum)

Susan is a **working mom**. She is married to Fred and they have two kids aged 3 and 7. When grocery shopping, she prefers to go to **local little shops**. But since she usually does the **shopping for the week** in one shopping trip, she has no other choice than going to a large supermarket. There they have a **huge product variety** and she can get all at once. In exchange, she pays attention to buying **organic products** and **doesn't care for the price** of a product too much. For Susanne a **well-balanced nutrition** of her family is really important which reflects in her shopping behavior. Shopping for her would be a huge chaos without her **shopping list**, that she prepares in advance on a small sheet of paper (which she unfortunately forgets at home from time to time). Susanne usually goes shopping after work on a weekday when it can be **pretty crowded**. Since she has no one to look after her **kids** at that time, she takes them with her. This can make shopping even more strenuous when they have a bad day or **ask her for toys and candies** the whole time. Therefore, she always tries to get grocery shopping done as **fast** as possible. Good for her she already has kind of a **routine and favorite products** she usually gets and knows where to find them.

7.4.3 Roger (pensioner)

Roger is **retired** for almost ten years and needs a **walking frame**. He is always **accompanied by his wife** when grocery shopping. When it's grocery shopping day, which is usually a certain day of the week, Roger is taking a **big shopping basket** for the groceries. The elderly couple **plans** their shopping in advance. For that, Roger's wife writes a **shopping list** with all the products they need to buy. As they both like to have a routine, they visit the **same store** nearby once a week. Roger is used to push the shopping cart and read the list aloud while his wife is selecting the products. Sometimes when **groceries cannot be found** where they used to be but have been moved to different shelves, they both get confused quite easily. In this case, shopping is very **time-consuming** for

the couple. They also **prefer to buy the same things** all the time rather than trying new products as they are **worried about hidden ingredients** that might not be good for them.

8 Hierarchical Task Analysis (HTA)

To analyse specific tasks, the main task *grocery shopping* is divided into three subparts: planning the shopping trip, selecting products while in the supermarket and conclude shopping. An hierarchical listing of the specified tasks can be found in the HTA in figure 10.

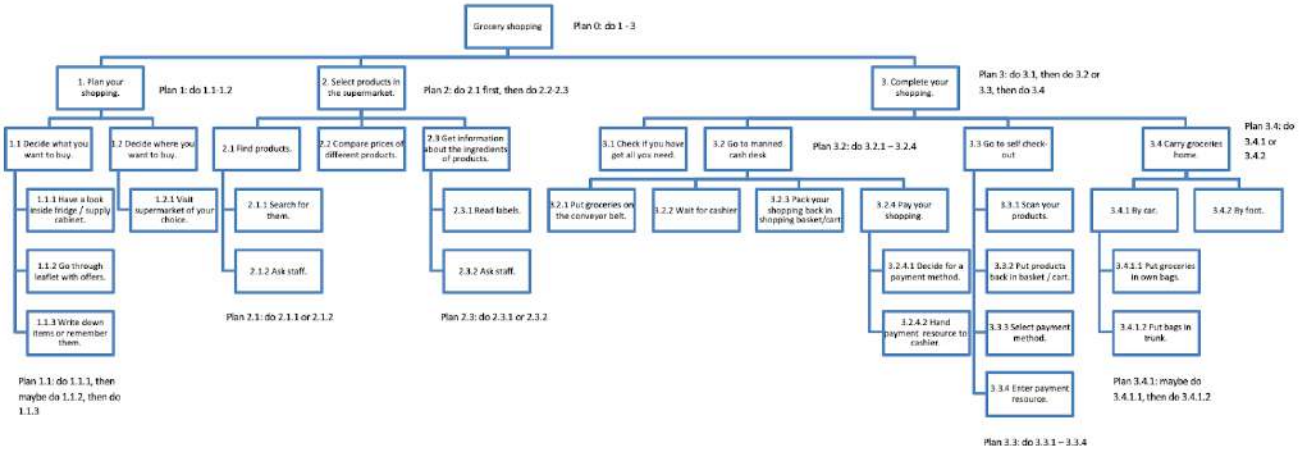


Figure 10: Hierarchical Task Analysis

Part III
Design Phase

9 Project Visions

Based on the outcome of Part II two visions are developed. They are similar to each other regarding their main functionality. However, the vision under section 9.1 focusses on creating a fast and efficient shopping experience. While the vision presented in section 9.2 provides the user with additional information and tries to turn the crowd into a positive aspect .

9.1 Vision 1: Mobile gadget for an efficient shopping trip

The gadget is a small ring with a touch display which can be clipped onto the handle of the shopping cart. The gadget is available to everyone from a stand in the entry area of the supermarket. A pre-condition in order to use the app is a prepared shopping list using either a smartphone or a website or a specific magnet board.

Firstly, the user attaches the gadget onto the shopping cart. The handle functions as display and extends the small display of the gadget. The shopping list can then be synchronized by holding the smartphone close to the gadget or inserting a smart shopping coin which contains the shopping list. After synchronizing the shopping list, it is automatically reordered based on the placement of products in the specific supermarket. The ordered list is the basis for an efficient navigation through the aisles. Furthermore, the gadget provides information on products like price, origin, carbon footprint and nutritional facts when approaching them. To support the user in making a fast decision on a product out of a large variety, a pre-defined user profile containing user preferences (e. g. cheapest / organic / local) is used.

When putting an item in the shopping cart, the gadget automatically recognizes the product using image recognition and weight. The product is then checked off the shopping list and added to a digital receipt. In addition, the total amount of products in the cart is summed up and presented on the screen. Moreover, the gadget analyzes the content of the shopping cart. A graphic illustrates the proportion of protein, carbs, dairy etc. which supports people taking care of a well-balanced nutrition.

As soon as the user is done shopping and reaches the cash desk, the gadget switches into payment-mode. The digital receipt allows a fast payment process: Instead of having to put all items on the conveyor belt, a QR-Code can be scanned.

Feature	**Pros**	**Cons**
gadget available in the entry area of the supermarket	+ cannot be forgotten at home + available to everyone	- users are not as careful as with own property - prone to be stolen/get lost - acquisition cost for the supermarket
synchronization and reordering of prepared shopping list	+ avoids smashing/melting of products + not forgetting any products + no double ways + more time-efficient	- potential users need to have a smartphone or internet access - preparing in advance
navigation through the store	+ no double ways + more time-efficient	- less inspiration - customers might buy less products
automatic item recognition	+ no need to put products on the conveyor + no waiting in a queue at check-out + payment can be done very fast + displayed total price helps to keep track of money that will be spend	- only for shopping with the shopping cart
screen in handle	+ more space for information + space for advertisement + no bulky screen	- can only be used when gadget clipped onto cart - new shopping carts needed
user profile with preferences	+ easier to fulfill specific needs (vegan, vegetarian, gluten-free, tight budget)	
overview about dietary composition	+ helps to keep on track with a balanced nutrition	- not everybody might be interested

Table 7: Vision 1: Features with respective pros and cons

9.2 Vision 2: Combination mobile + stationary for an extended shopping experience

The gadget is a small magnetic slice that can be attached to own shopping basket or walking frame. The shopping list can be prepared at home by typing it on the gadget. When entering a certain store, the gadget is automatically arranging products in the right order. It is navigating the customer through the supermarket by displaying arrows and giving haptic feedback (vibration) when the user reached the wanted product. We assume that in the supermarkets, there are stations where the users can put the gadget on. By doing so, users can view their shopping list on a display and tap on the items for further information about it. In addition, with these stations the “crowding

factor" is used by offering interaction between customers. For example, users can share recipes or get inspirations. Furthermore, the gadget has a scanner included, which customers can use to scan different products while standing in front of the shelves and get more information like nutritional components and carbon footprints. There is also the possibility to put headphones in and listen to the information via audio when scanning the product. If parents are going to shop with their children, the gadget offers a function of getting a child-friendly explanation of where the product comes from and why it is healthy or rather not healthy.

Feature	**Pros**	**Cons**
function to type in shopping list	+ can be prepared at home	- gadget must be carried around for the preparation in advance
navigation through the store	+ more time-efficient + not forgetting any products + no double ways	- less inspiration - customers might buy less products
stations in the supermarket	+ possibility to share ideas + more inspiration	- time-consuming because people might need to queue up at stations
audio option	+ informative for customers + more motivation	- people standing in the aisles while listening
audio option for children	+ kids learn about nutrition + kids are less bored, so their parents are less stressed	- shopping trip might take longer
haptic feedback	+ helps to orientate in the store when labeling of shelves is bad	- constant vibrations could cause stress
additional **display**	+ get further information + get inspired by recipes + learn more about the product (origin, ingredients)	- might be unstable - unhandy/bulky

Table 8: Vision 2: Features with respective pros and cons

10 Activity Design

10.1 Activity Design Scenarios

Susan (mom)

In the afternoon, the supermarkets are really crowded and it's difficult to maneuver her own shopping cart around parked shopping carts of other customers. Taking her kids shopping makes it even more strenuous for her. They are usually bored and ask for candy and toys when they pass those shelves. The items on her shopping list are in a different order than in the supermarket. This is why she often passes shelves, forgets to grab the item and has to come back at a later point of time. Comparing products regarding origin and ingredients can be really time-consuming and difficult because all packages and cartons look different and sometimes even don't offer detailed information. In addition to her whining kids, the loud background music and other noises can be really distracting and often cause her a headache. Because of all these challenges, Susan often has little motivation to go shopping.

Activity Scenario: Susan uses her new physical shopping list tool to prepare a shopping list. It is attached to the fridge in the kitchen and can therefore be updated by the whole family. When going shopping, she synchronizes the tool with the shopping cart in the supermarket which then supports her in finding products and decides on one product out of many based on her personal preferences. Additionally, when synchronizing the shopping list products are reordered based on an algorithm which considers the shortest route and the sensitivity of items (frozen, softness etc.). Next, Susan collects her groceries in the most efficient way. Susan can use the gadget in different situations: First, when there is less time, it can support her in finding the products in the most efficient way, that will strengthen her motivation. Second, when she has more time, she can use the gadget to compare products, get

more information about a specific product, also her kids can interact in a playful way with it, these features are motivating and informative. The the surface and if the possibilities of interaction of the shopping system make it fun for her kids to support her instead of whining during the shopping trip. Moreover, the shopping cart can suggest items based on a well-balanced nutrition to complement her shopping list. So Susan doesn't have to worry if she forgot to put anything on the shopping list.

Problem Scenario	Transformed into Activity Design Scenario
Susan writes a paper shopping list which is not accessible to her husband and kids	Susan creates a synchronizable and shareable shopping list
bored kids	make technology accessible to little kids
order of shopping list, Susan has to manually order the shopping list without detailed knowledge about products' location in the supermarket	automatic reordering of the shopping list and synchronization for specific supermarket -> displays next item to pick up
deciding on a specific product from a large variety is time-consuming	possible suggestion of products based on the user profile, set and switch overall preferences
less motivation	with a navigation system it is possible to do the shopping as fast as possible or/and if there is more time, possibility of interaction to get more information about products
obstacles by parked shopping carts	Susan (as all the other customers) follows suggested routes through the aisles -> less parked carts

Table 9: Susan's Problem Scenario transformed into Activity Design Scenario

Emma (student)

After university it's often crowded in the supermarket which causes long waiting times at the cash desk. Since Emma doesn't prepare a shopping list, she often forgets something and won't notice until she's already at home. Moreover, she often has no idea what to cook, as a result, she often just has pasta and tomato sauce for dinner. Comparing prices takes quite some time, but because Emma always only buys a little amount of products she's still faster than many others. When carrying home her goods, fruits and vegetables get often smashed on the bottom of the shopping bag.

Activity Scenario: Emma prepares a shopping list on the app in her smartphone during a break between her classes. She chooses a supermarket and the app reorders the products in an efficient way. Because Emma is unsure what to cook for dinner, the app suggests recipes based on her preferences and her created shopping list. After all her classes ended, Emma heads to the desired supermarket and grabs a shopping cart. She puts her smartphone on the display in the cart to synchronize her shopping list. While shopping, the display shows products in the same price range so Emma knows exactly which products to pick without losing any time. At the checkout, she realizes that she forgot to bring her reusable bag and buys a new one. The app suggests which items to pack first so soft items won't get squashed on the bottom of the bag.

Problem Scenario	Transformed into Activity Design Scenario
Queuing	smart scanning system → not packing twice → less queuing
Crowding (cannot really be changed)	customers can "use" the crowd → sharing recipes, rating by users
Emma doesn't prepare a shopping list and therefore forgets certain products	She can prepare a shopping list on the smartphone on the go that automatically and effectively reorders the products
Emma often doesn't know what to cook	The app suggests recipes based on her preferences or what she has put in the shopping cart. Those can be viewed in the app or on the display in the shopping cart. Additionally, she can be inspired for recipes by other customers (internal recipe cloud)
Products get squashed on the bottom of the bag	Emma organizes her groceries in the shopping cart; an algorithm provides a clever order to pick up items and to organize them in cart/bag
Emma looks out for cheap prices and offers	The app suggests products based on her user profile and calculates the total amount of the cart

Table 10: Emma's Problem Scenario transformed into Activity Design Scenario

Roger (pensioner)

When products were rearranged in the shop, Roger has problems to find them because shelves are badly labeled. In addition, there are too many products that distract him from finding the one he always buys. He does not like to buy new products as gathering information about ingredients is hard because of the small font size of the product labels. Furthermore, Roger has difficulties to reach products on upper shelves. Sometimes it's a problem for him to pass through the supermarket because of the narrow aisles. When shopping, a sensory overload is influencing Roger's experience. For him, loud music is distracting him as well as advertisement and sales. When he is wearing a jacket it's often too hot for him in the store. Moreover, Roger feels overwhelmed when he is paying for his shopping and at the same time has to and pack it at the cash desk. He would prefer just leaving the groceries in the basket when completing his shopping.

Activity Scenario: Roger can use his physical shopping list to the supermarket, which is able to synchronize with the shopping cart. The app will suggest the intelligent and optimized order of the products in the shopping list and it navigates towards the best possible way to pick up items quickly. To generate an overview of the information about the product, in particular ingredients, a classification of those will be represented through colors and symbols. With the built-in scanner, check-out will be hassle-free as it calculates the overall sum of the picked-up products.

Problem Scenario	Transformed into Activity Design Scenario
does not have a smartphone, is writing a paper-based shopping list	works with a physical shopping list which is able to synchronize with the gadget
rearrangement of products makes it difficult to find them	the app suggests the order of picking the items and navigates Roger
gathering information about ingredients is difficult because of small font size	a classification of ingredients through colors and symbols makes it easier for Roger to gather information about the product
difficulties to reach items on upper shelves	Roger can use a service button to call staff for help
Roger is overwhelmed at the cash desk when he has to pack and pay at the same time	there is a scanner which already sums the total amount of the products up by putting them into the shopping cart -> at the cash desks all products can be scanned at once instead of each product individually

Table 11: Roger's Problem Scenario transformed into Activity Design Scenario

10.2 Claims

Activity Design Feature	Pros	Cons
synchronizable and shareable shopping list	+ needed products can be recalled anywhere and on any device + more than one person can access the list	- preparing in advance - needs an internet connection - probably requires knowledge with current technology (smartphone etc.)
technology accessible to children	+ fosters a more conscious consumer behavior at younger ages + easier to understand by everyone + amuse and entertain kids	
automatic reordering of the shopping list based on arrangement of products in specific supermarket	+ faster shopping trip	- different for each supermarket -> requires maintenance by the supermarket
including user profile with overall preferences	+ suggestions based on customers preferences are possible	- needs to be maintained - what if user wants to choose product based on different preferences?
navigation through aisles	+ avoids routes that are crowded + goal-oriented finding of products	- less inspiration - customers might buy less
suggestions of recipes	+ inspiration	- might distract from shopping - might make shopping slower
algorithm that provides a clever order to pick up items and helps to organize them in cart	+ soft items do not get smashed in bottom of bag / cart + no running back and forth	- prioritization of either an efficient route or sensitivity of products
calculation of total amount of shopping	+ having an overview of the price to pay	- customers might buy less - user has to scan each product or new technology is needed (recognition of products, amount/weight)
suggestions of the cheap deals	+ aid to save money + attract customer to buy more products (interest of the supermarket)	- some people might not be concerned about the price but quality
classification of ingredients	+ getting a fast overview of ingredients	- might be too much information at once
service button to get help from staff	+ when having other questions/needing help to reach upper shelves	- people could take advantage of it (e.g. only to have a chat) -> staff cannot fulfill their regular tasks
digital receipt of products in cart	+ no need to unpack items again at the cash desk + paying situation is less stressful	
videos and speech	+ gives additional information + additional form of interaction	- additional noises to ambient noise

Table 12: Claims analyzing the key features of the activity design

11 Information Design

11.1 Scenarios

Susan (mom)

When Susan enters the supermarket, the smart gadget synchronizes the shopping list items with the arrangement of the products which is signalized by the screen lighting up. Susan then recognizes her shopping list has appeared in the middle of the round display. In the upper part of the screen, a navigation system with an arrow and the labelling of the shelf helps Susan to find products that she is looking for. After collecting some items, Susan notices that below her shopping list the total amount of products she has already put in the shopping is displayed. Which helps her to not lose track of the sum of money she has to pay. Today, Susan is not in a hurry. That means she has more time to look at the ingredients. When she approaches a product the navigation system will automatically show her the exact product (that she selected during the shopping list creation) with the name, price and the amount to buy. If she didn't specify which product (of which brand) to get, a product she has previously purchased will pop up. There is also the possibility to compare products of different brands. In order to do this, the extended screen needs to be rolled out. The items are sorted after her preferences set in her user profile. But she is also able to resort them after labels like organic, regional, vegan, vegetarian, gluten-free, dairy, allergies, and more. These filters can be added or removed in the user profile. After she has selected one item by pushing the gadget to the right, she is able to see the price, origin, nutritional facts and other information. She is able to return to the overview by pushing the gadget to the left or to the home screen (which is the shopping list) by pushing it down. When her kids ask how long the shopping will take, Susan shows them the colored led light circle on the outer side of the gadget which demonstrates their progress. A pie chart of the nutritional facts of the whole cart can be viewed as well by pushing the gadget up. The components of the chart are proteins, carbs, fat, sugar, dairy, etc, which can be customized as well. By extending the display Susan is able to get a more accurate insight into the nutritional facts of her grocery shopping. Suggestions for a more balanced diet are also provided.

Activity Design Scenario	**Transformed into Information Design Scenario**
Susan creates a synchronizable and shareable shopping list	the shopping list can be created on a website or on an app that synchronizes with the gadget in the supermarket
make technology accessible to little kids	color-codes that show the shopping progress, educational information is visualized by colors and icons/symbols
automatic reordering of the shopping list and synchronization for specific supermarket -> displays next item to pick up	an algorithm automatically reorders the shopping list according to the attended supermarket on the website, app and on the gadget (an internet connection is needed for updates)
possible suggestion of products based on the user profile, set and switch overall preferences	an algorithm suggests products based on the user profile; remembers last bought products and amount
with a navigation system it is possible to do the shopping as fast as possible or/and if there is more time, possibility of interaction to get more information about products	the gadget navigates customer with an arrow and the exact position description of products to the shelf for fast shopping; if the customer has more time there is a possibility to extend the display where further information of the products, recipes etc. are shown
the gadget should not make any additional sounds	the gadget doesn't have any audio but visual output, illustrated by icons/symbols, charts, recipes, the colored progress bar
Susan (as all the other customers) follows suggested routes through the aisles -> less parked carts	an algorithm guides customers through the supermarket with a suggested route

Table 13: Susan's Activity Design Scenario transformed into Information Design Scenario

Emma (student)

Emma has created her shopping list on her smartphone because that was the only thing she had with her when she was thinking of what she needs. Synchronization makes it possible to transfer these information to the display of the gadget. Emma does not like queueing after only buying a few items in the supermarket. Therefore a smart scanning system at the back of the gadget which already sums up the total amount of all products helps to prevent long queues at the checkout. When Emma has no idea what to cook for dinner, she can use the option given by the gadget to get inspired by other people that shared their recipe ideas via the app. The recipe ideas are shown in an order that matches Emma's preferences.

Activity Design Scenario	**Transformed into Information Design Scenario**
smart scanning system → not packing twice → less queuing	a smart scanning system in the cart and basket scans the products in order to prevent long queues at the checkout
customers can "use" the crowd → sharing recipes, rating by users	customers are able to share their recipes with other customers in the supermarket which they approve of sharing beforehand; depending on the product, recipes are suggested
She can prepare a shopping list on the smartphone on the go that automatically and effectively reorders the products.	a shopping list can be created on a website or on the smartphone; an algorithm effectively reorders the products depending on the selected supermarket
The app suggests recipes based on her preferences or what she has put in the shopping cart. Those can be viewed in the app or on the display in the shopping cart. Additionally, she can be inspired for recipes by other customers (internal recipe cloud)	an algorithm suggests recipes based on her preferences when creating the shopping list and ingredients can be added to it; on the extended screen recipes from other customers can be viewed as well
Emma organizes her groceries in the shopping cart; the application provides a clever order to pick up items and to organize them in cart/bag	an algorithm suggests ways to organize the products in a smart way in order to prevent soft items getting squashed
The app suggests products based on her user profile and calculates the total amount of the cart.	Emma sets preference for low-priced products in her user profile; an algorithm suggests products based on that preference; the gadget displays the total amount of the cart which is always fixed on the screen for a better overlook

Table 14: Emmas's Activity Design Scenario transformed into Information Design Scenario

Roger (pensioner)

Today, Roger goes shopping alone since his wife is not able to go with him. He goes to the supermarket nearby but has limited mobile internet which he has already depleted. The supermarket he visits offers free WiFi for their customers, so Roger is able to synchronize his shopping list with the gadget. He attaches it to his walking frame which leads him to the closest products. Since Roger is short-sighted, he extends the display to have everything at a glance. Roger knows which items to buy because he and his wife go to the same supermarket every week, so he knows which route to take. He barely looks at the navigation, but as he approaches a shelf where the product usually is positioned isn't there, he is confused and lost. Besides, the service button is far away, too. So he looks at the gadget which leads him to the right aisle and shelf. He scans his products while collecting them and pays them at the checkout.

Activity Design Scenario	**Transformed into Information Design Scenario**
works with a physical shopping list which is able to synchronize with the supermarket	needs at least a mobile gadget that is able to download the app to create the shopping list; if he hasn't mobile Internet, he is able to connect with the supermarket's WiFi
the app suggests the order of picking the items based on the user profile	an algorithm suggests a smart way to pick up items; the order varies depending on the chosen supermarket
a classification of ingredients through colors and symbols makes it easier for Roger to gather information about the product	the extended screen offers more place to display more products with a bigger font than on the actual screen; icons/symbols facilitate the most important information (vegan, vegetarian, dairy, gluten-free, allergies, ...)
there is a scanner which already sums the total amount of the products -> at the cash desks all products can be scanned at once instead of each product individually	an integrated scanner in the gadget is able to scan the products

Table 15: Rogers's Activity Design Scenario transformed into Information Design Scenario

11.2 Claims

Information Design Feature	Pros	Cons
round button	+ can be used as display and button	- some wasted space (round design)
display on button shows always: ˜the progress of the shopping process (round bar chart; colored LED) ˜the next item in shopping list (in shortened form; in the middle of display) ˜total price of products in shopping cart (in the lower part of the display) ˜navigation system (map of the store, shelf numbers; in the upper display part)	+ important information are always shown, even the extractable display is not needed (e.g. if only few products will be needed, if customer is in a hurry) + colored LED will be salient → recognizing of progress could be motivative	- might be too much information/letters too small for people who can't see well (e.g. older people)
extractable display for further information	+ more space for information if they are needed	- sensitive display - bulky
extractable display shows shopping list	+ more information for a product (weight, quantity, further personal notes, etc.) + could be in larger letters (more readable)	
extractable display shows automatically acomparison of specific products belonging to a category (on shopping list); presorted by user profile or sorted by clicking on filter	+ user can find easily prefered products from a large product range + user can compare products by personal preferences (e.g. price, organic, ingredients)	
extractable display shows recipes to get ideas from other customers or upload own recipes	+ sharing ideas between customers → effect on rating others as less annoying? + users can get more recipe ideas	
split button - one half: turnable; other half: display can be extracted	+ fast scrolling through lists without changing display position	
fixed base (and scanning system) on shopping cart/basket/etc	+ fixed scanning system; a product that was put in cart/basket/etc. is automatically scanned - possibility of theft decreases + products automatically are deleted from total amount when they are taken out of the cart + synchronizing base at cash point → user only needs to pay the total amount → less queuing	
adaptable base to different calibers of basket/cart/etc.	+ different users (carts, baskets, walking frames)	- no permanent fixation on carts → users could fail to put it back in a good way
haptic feedback (vibration) for navigation (e.g. if there is a change of direction); possibility of switching it off	+ no need to always look on the display, additional information + optional → not annoying	- optional feature: must be understood and additional expenses for the production
color codings, icons, possibility of some animations on display	+ gadget is accessible for kids → less bored kids	

Table 16: Claims analyzing Information Design aspects

12 Interaction Design

12.1 Scenarios

Susan

After work, Susan is picking up her children from kindergarten and school. Close to the school a new supermarket has just opened. She decides to go there for grocery shopping today. In front of the supermarket, Susan gets a shopping cart and attaches the smart shopping device to its handle. By entering the supermarket, the gadget synchronizes the shopping list that she and her husband created last night in a smartphone app. The display of the gadget shows the first products to collect; "pepper", "tortellini", "peach juice". As Susan would like to know if her husband added some more things this morning, she pushes the middle knob to see the whole shopping list. By doing so, an extractable display extends from the knob. By turning the knob, Susan can scroll down the list, stopping by "potatoes". She notices that her husband added potatoes to the list. As she knows that her dad will come to visit this week and always brings some of his own cropped potatoes, she deletes the item by going to her shopping list, choosing the item and then selecting the delete button. After checking the list, Susan and her kids continue shopping. First, the display navigates the family to the shelf where herbs are placed. When reaching the shelf, it displays more information about the item written on the shopping list which is "whole peppercorns black from Mantra Organic". She grabs the corresponding product and puts it in the shopping cart. The included scanner at the back of the device scans the item. After that, the family is getting navigated to the next item "tortellini". As Susan prefers to eat vegetarian tortellini, she selects the vegetarian symbol by turning the knob to the icon and pushes it to the right. This way, available products get arranged according to her preference. She is interested in the origin and ingredients of one product. She selects one product by scrolling through the list and selecting it by pushing the knob to the right. The display shows the wanted information displayed on the extractable screen. As her kids seem to be really enthusiastic about having tortellini for dinner tonight, Susan needs an idea of how to combine these. She turns the knob (to scroll) and selects the option "recipes" und pushes it to the right again to confirm her action. Now recipe ideas are shown on the extractable screen. By turning the knob, Susan can scroll through the different recipes. She decides for tortellini with fried vegetables and pushes the knob again to the right to confirm that she wants to add the other products needed for this recipe to her shopping list. After that, Susan is pushing the knob down to the home symbol to return to the shopping list. The family continues collecting products written on the list. As it's important for Susan to offer her family a balanced diet, she likes to have an overview of the nutritional values of her collected products. By pushing the knob to the top, the round display shows a circular chart of the nutritional components current products in the shopping cart.

Emma

Emma decides to take a basket rather than a shopping cart for her shopping trip today. She is attaching the smart shopping list to the handle of her basket. When Emma is in the supermarket, she wants to compare the prices and ingredients of couscous and bulgur. For that, she takes off the device and scans the corresponding items from the shelf to get the relevant information. As she also would like to get some inspirations about what she could cook with couscous or bulgur, Emma turns the knob to the field "recipes" and pushes it to the right to confirm her action. By reading some suggestions of other persons, Emma favors the "couscous salad" which is shown at the top of her display. In her smartphone app Emma had indicated that she is vegetarian and likes salads. Therefore, couscous salad has been the most suitable recipe idea for Emma. By pushing the knob to the right, there is the option to read the whole recipe and by pushing it again, Emma confirms to add the required ingredients for this recipe to her shopping list. After that, she pushes the knob down to return to her shopping list and easily attaches the gadget to her basket again.

Roger

Roger was shopping with his walking frame today with the smart shopping list attached to it. Every item he has put in his walking frame basket was automatically scanned by the gadget. When he is unable to reach a certain product, Roger calls the staff to help him. After collecting everything he needs, Roger is heading to the cash desk. There is only a very short queue. When it's his turn, the cashier scans the back of the device and the total amount

of the whole content of Rogers walking frame basket shows up. Because Roger didn't have to clear the basket and place all items in again, he can take his time for the payment.

12.2 Claims

Scenario Feature	Pros	Cons
Pushing the display (which also functions as a button) to unroll additional display to see an overview of the different kinds of products that are available/see whole shopping list	+ builds on people's familiarity with desktop applications by clicking on name of product + simple discrete input	- might not be intuitive on first use
Turning the display (like a knob) to scroll down in the list of products	+ builds on people's familiarity with other round buttons/knobs that are used to adjust sth. (e.g. button to dim the light, magnetic slice to turn on the induction stove)	- only one-dimensional
Pushing the knob to the left to go back to your last screen	+ gives possibility to return to the previous displayed screen + back buttons usually point to the left	- might not be intuitive on first use
Pushing the knob to the right (to select or confirm) to get further information like recipes shown	+ gives possibility to get recipes idea and add new products to the user's list + direction to the right is usually used to visualize depth of navigation hierarchy	- might not be intuitive on first use
Pushing the knob up to get stats about the nutritional values of the current content of the shopping cart	+ encourages customers to be aware of a nutritional balance + suggestions for a more balanced nutrition	- might not be intuitive on first use
Pushing the knob down to get back to your shopping list (home)	+ builds on people's familiarity with home buttons of tablets and smartphones	- might not be intuitive on first use
Taking off the device to scan products from the shelf	+ user can get information about any product in the shelf and does not necessarily have to find it by scrolling on the device	- not hands free - might be socially unacceptable - error prone (good image recognition algorithm needed)

Table 17: Claims analyzing important features of shopping list interaction

13 Storyboard

The storyboard in figure 11 shows how the gadget is used throughout shopping. The detailed steps are as follows:

Step 1: Grab a knob from a wall in the entry area of the supermarket. (figure 11a)

Step 2: Attach the magnetic knob onto the base on the hand- le of the shooping cart. The shopping list is synchro- nized by holding a smartphone which is running the shopping list app close to the knob. Or by inserting a smart coin. At the first use, a tutorial is shown. (figure 11b)

Step 3: The gadget navigates you through the supermarket. It further states upcomimg items and you current total amount. (figure 11c)

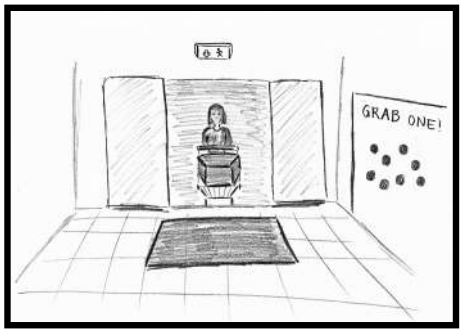
Step 4: When you approach an item, the gadget automatical- ly display various options which you can filter by „ve- gan“, „vegetarian“, „local“ and „organic“ and sort by the price. (figure 11d)

Step 5: If you want to get further information on a product in the shelf, you can simply deattach the knob and scan the item. (figure 11e)

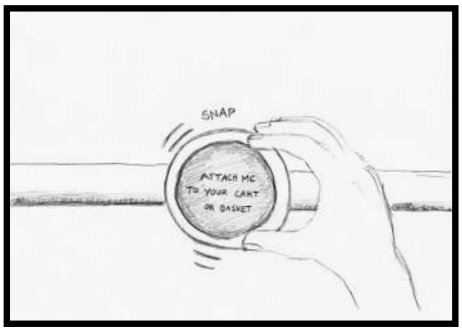
Step 6: The gadget automatically recognizes if you add so- mething to you cart, checks it off your list and adds its price to your total. (figure 11f)

Step 7: When you‘re done shopping and get to the check- out area, the knob displays a QR-Code which you scan to get an overview of the content of your cart. You can then pay without having to scan each item individually. (figure 11g)

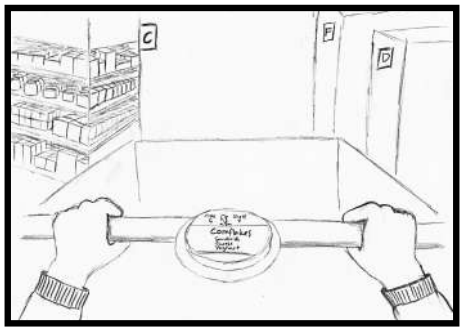
Step 8: Shopping is completed and the knob has to be put back on the wall in the entry area. (figure 11h)



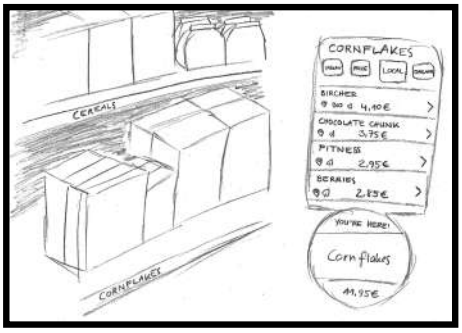
(a) Step 1 – Grabbing a gadget



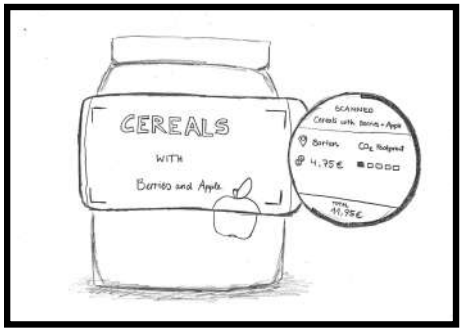
(b) Step 2 – Attaching the gadget to the cart or basket



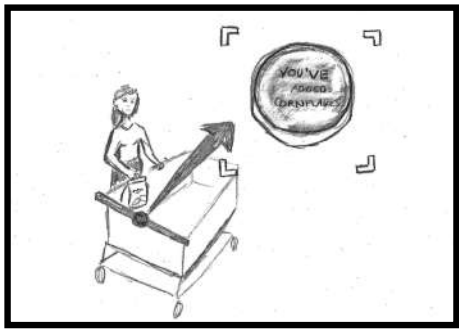
(c) Step 3 – Navigation through the supermarket



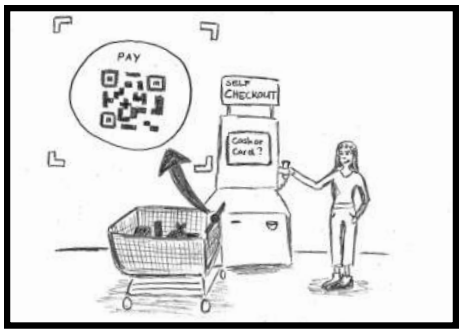
(d) Step 4 – Comparing items



(e) Step 5 – Scanning item



(f) Step 6 – Adding item to the cart



(g) Step 7 – Paying

THE END

(h) Step 8 – Shopping completed

Figure 11: The shopping process using the gadget

14 First Paper Prototype

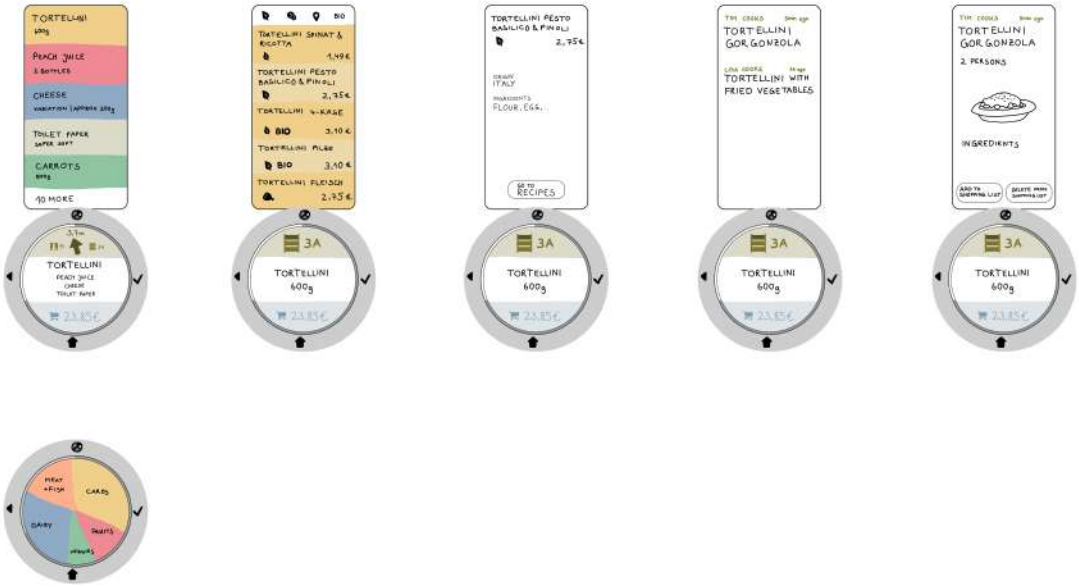


Figure 12: Paper Prototype

Part IV
Prototype and Evaluation Phase

15 Prototype

15.1 Design idea & construction of the prototype

We created our prototype with a lasered boxboard. It could be attached to different objects with a hook-and-loop fastener. A fixed base with the main icons (simulating a smart scanning system) was attached to the knob via magnets. The knob consists out of two parts: A fixed part, where a transparent sheet of plastic could be attached (incl. different paper-displays) and a movable part to simulate scrolling.

(a) The knob in compact mode

(b) The gadget in extended mode

(c) Nutritional facts in form of a cake chart

(d) Payment

Figure 13: Basic prototype

15.2 Screen Design

The screens can be found under section §J in the appendix.

16 Heuristic Evaluation

1. Meet expectations

1.1. Match between system and the real world

Icons are commonly used. Scrolling is used by turning the knob as like a volume control knob.

1.2. Consistency and standards

Product suggestions based on user's activities and choices to support internal consistency. Users will be used to follow a similar workflow in the current grocery shopping experience with some advanced assistance with this gadget.

1.3. Help and documentation

There is a demonstration video for the interaction and usability of the gadget, but the user guide or built-in help is not included in this phase of the gadget.

2. User is the boss

2.1. User control and freedom

Removing items from cart and adjust the total amount Always can go back to the homepage User can choose their own item or following the suggestions from the system There is no zooming or panning feature in the gadget, but those do not make a bad impact as there is a feature of extended display.

2.2. Visibility of system status

Shows shopping progress ring Total amount of gathered amount Users can have a quick look at the statistics of the nutritional components from the gathered products (i.e. dairy, meat + fish, vegetables, carbs, fruits percentage) with a pie chart.

2.3. Flexibility and efficiency of use

Users can use the two different modes of the gadget as per their need. If they need detailed information they can use the extended display mode or they can use only the knob for faster shopping experience.

3. Errors

3.1. Error prevention

We do not have the error prevention techniques as the gadget is in a very preliminary stage.

3.2. Recognition rather than recall

The gadget has a scrolling feature as the volume knob that is easy to recognize. Commonly used icons and color codes are used in the gadget, hence the user can easily recognize the features. Maximum features of this gadget are new and the users are not used to having those. Users have to recall the getting started guide to get the maximum benefit from the gadget.

3.3. Help users recognize, diagnose, and recover from errors

There is no option to recognize and diagnose errors from the User.

4. Keep it simple (and nice)

4.1. Aesthetic and minimalist design

The design of the gadget is simple and that is flexible to use in two different modes. The gadget is small and fits well into the shopping cart, basket, walking frame (for elderly people).

17 Usability Tests

17.1 Method

For the usability evaluation, we choose "Think-Aloud" as formative empirical method. The user tests are conducted in a laboratory setup. To present the information flows to the user, we follow "Controlled Experiments". In addition, we used usability inspections to find problems evolving by the usage. The usability tests were conducted by providing the test persons with a basic prototype of the gadget (see figure 13). Since it is just a basic prototype and does not allow proper interaction the collected data is qualitative.

17.2 Participants

Due to time constraints only a small amount of user tests were conducted. However, when choosing test persons it was considered to select from a variety of age groups and fields.

For our user study we recruited six participants (2 male, 4 female) aged from 22 to 49 (M = 31.17; SD = 10.9). Four of them were students, the other two employees already working for some years.

17.3 Procedure

Procedure Firstly, subjects were given Part I (see section §A) of the questionnaire which asks for personal information about their current shopping behavior. After completing the form, subjects were given the prototype and introduced to the basic functions of the gadget by the examiner. The complete instruction can be seen in the appendix under section §C. They had to complete the following tasks:

Task 1: Find the cheapest tortellini option.

Task 2: Where do the 4-Cheese Tortellini come from?

Task 3: Find a recipe for 4-Cheese Tortellini and add some of the recipe ingredients to your shopping list.

Task 4: Go back to the home screen.

After finishing the tasks, participants were given Part II (see section §A) of the questionnaire which evaluates the usability of the gadget. While the participants were working on the tasks and thought out loud, the examiner completed the form for observations (appendix section §B).

17.4 Results

To get an overview about how familiar our participants with interfaces are we asked them which functions of their smartphone they usually use. The chart in figure 14a shows that all of our participants at least have a smartphone and most of them are familiar with using app's or the internet. Moreover, we collected personal data about the usage of a shopping aid participants currently use when grocery shopping (see figure 14b). In addition, we asked the participants how much time they usually spend grocery shopping. Figure 14c shows that the majority states to rather have a fast shopping trip. Nevertheless, two out of six participants at least mostly spend a lot of time shopping. Another question included in our user study asks about the simplicity of using the gadget. As shown in graph x all six participants have found it neutral to very easy. The mean rating of this item is 3.8 which has a lot to commend that using the gadget is not too hard for people that have a smartphone.

To get an overview about what was rather hard or easy when using the gadget, we included free text questions regarding difficulties experienced when fulfilling the tasks, as well as features participants liked most or least. The results are summarized in table 18.

Finally, we wanted to know how satisfied the users were by using the gadget. Table 19 shows the means of the satisfaction rating. According to that, all six participants indicated to be satisfied with the usage of the gadget.

Participant	**Task 1**	**Task 2**	**Task 3**	**Task 4**
1	Comments: "What is the difference between these two icons?" (point on vegan/vegetarian) Observed errors or problems (e.g. assistance offered): no problems Other relevant observations: no problems with fulfilling the task, clear and direct way of interaction	Other relevant observations: gives correct answer	Comments: "Can I also add all ingredients at once? Cause I do need everything for cooking the meal - I do not have something in my fridge at home!", "the plus is for adding one ingredient, I guess" Other relevant observations: slightly hesitates with adding an ingredient	Comments: "This was the home button, right?" Other relevant observations: posed the question as counterinsurance, but found the home list without problems

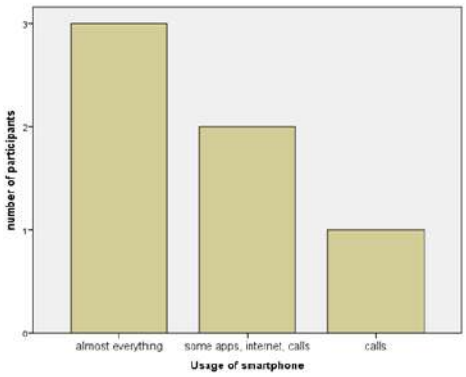
2	Other relevant observations: hesitates/unsure how to extract the expanded display, recognizes the filter symbols to rearrange the products accordingly → finds the cheapest on top of the list	Comments: "Do I have to pick "item options" to get further information?" Observed errors or problems: was unsure of term "item options" Other relevant observations: scrolls down to the wanted product & selects it by pushing to the right, likes the clear structure of the information on the display	Comments: "What if I would like to add a product that is not included in the recipe?" Other relevant observations: while still on the "information" page, he tries to scroll down to find recipes but realizes that he has to go back	Other relevant observations: does it without any complications
3	Comments: deleting items is quite complicated, filter option would be good Observed errors or problems: tries to use knob as touchscreen, has problems tackling the first task (told her that she needs to extract the extended display), has problems to extract the additional display, scrolls through the whole product list without using the filter option	Comments: adding new items is not possible Other relevant observations: finds origin of product easily	Comments: "I have seen that there were recipes listed but how do I get there?", asks how to add some ingredients for the recipe Observed errors or problems: needs some time to find the "back button" Other relevant observations: remembers that there was the option for recipes at the previous display	Other relevant observations: finds "home button" easily

4	Comments: “Was not intuitive for me to push to the right to confirm” Observed errors or problems: Tabs in the middle of the knob to confirm the item „tortellini“ instead of pushing knob to the right side to confirm Other relevant observations: needs some time but manages the rest of the steps, uses the filter and finds cheapest product	Other relevant observations: finds origin of product quite easily	Comments: “What is the meaning of the icons in the recipe list?”, “The “plus” probably adds the ingredients to the list, right?” Other relevant observations: scrolls on the information screen but then notices that she has to go back, takes a lot of time	Comments: “That’s an easy one - I know that symbol from my tablet.” Other relevant observations: easy to find home button
5	Comments: asks for touch interaction for selecting items from the display. Observed errors or problems: tries to select by touch interaction. Other relevant observations: does not like the knob to go over the menu items.	Comments: likes the concept of displaying product origin information. Other relevant observations: easily found the product origin information.	Other relevant observations: not much interested to find new recipes	Other relevant observations: easily found the icon for the Home and completed the task very fast.
6	Comments: prefers selection by pressing the knob and open the extended display by pushing the knob up Other relevant observations: ask assistance to explain one more time to the interaction of the system	Other relevant observations: delighted to have the information about carbon dioxide footprint	Comments: suggests to improve the item deletion from the list to a much easier option Observed errors or problems: confused about the delete in the item options	Other relevant observations: successfully did the task

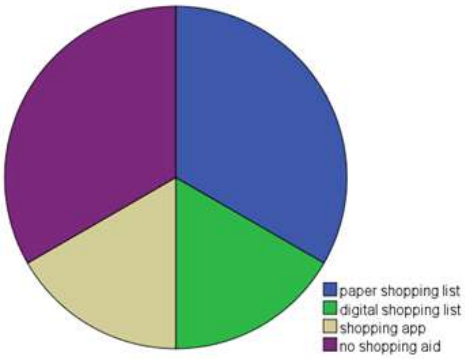
Table 20: Results from observing the participants

17.5 Summary of results

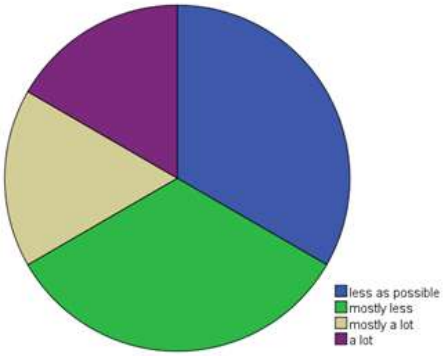
Although most of the participants use their smartphones for almost everything, only one third use a digital shopping aid. Most of them spend rather less time for grocery shopping, but there are also subjects who spend more time



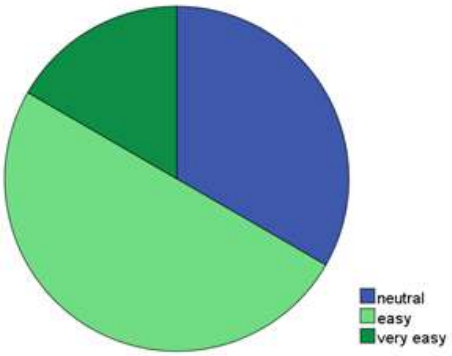
(a) Smartphone use of participants



(b) Usage of a shopping aid



(c) Time participants usually spend shopping



(d) Perceived difficulty when using the gadget

Figure 14: Results of questions

Participant	difficulties	likes	dislikes
1	- Remembering icons (what is reverse button, home button) - Distinction between icons “vegan” & “vegetarian” not clear	- Scrolling is easy to use - Confirm is intuitive - Size of gadget - Size of text - No touch - Intuitively usable - Option to view recipes - Option to get further information of products - Navigation system viewed as helpful	- Icons should be more unambiguous
2	- Expanding display - Distinction between back & home button not clear	- Navigation system - Scanning system for payment - Option to find products according to your preferences - Size of text and gadget - Progress bar	- Not always clear how to go back or forward in menus - Not usable without a shopping cart or basket
3	- Accessing additional screen - Using knob not intuitive	- Option to order items - Navigation system - Recipes - Information about products - Scanning products	- Finding recipes might be time-consuming - Scanning product in shelf might be uncomfortable in real supermarket environment
4	- Unsure about the meaning of some items - Recalling icons	- Option to order items - Navigation system - Recipes - Information about products - Scanning products - Turning knob - Extended display - Navigation & exact position of product - Efficiency	- Size of display (information squeezed into a small space - Deleting items too complicated
5	- Recalling the selection	- Viewing nutritional components - Navigation & position of product - Filter option - Detailed information about products - Scanning feature - Size of gadget - Flexible way of using the gadget	- no touch interaction - scanning system needs to be good
6	- confusion about a few items - confusion about display extension & item selection	- information display - handy sized gadget	- position of buttons - deleting items

Table 18: Summary of free text comments regarding difficulties, likes and dislikes by using the gadget

Likert item	Mean rating	Standard deviation
How satisfied are you with the usage of the gadget?	4.0	0.0

Table 19: Satisfaction ratings for using the gadget (across 6 participants) very unsatisfied = 1; unsatisfied = 2; neither nor = 3; satisfied = 4; very satisfied = 5

for grocery shopping. Participants rated the gadget as rather easy and are on average satisfied with the usage.

There were some difficulties arising from the free text data as well. The main difficulties were applying the recalling of the icons, as well as the extraction of the display. Some confusion about the meaning and usage of icons and buttons arose. The navigation system as well as the ordering function were mostly viewed as being very helpful and efficient. Most participants liked the further options of the gadget like getting recipes and information about, e.g., the origin of a product as well as having a smart scanning system. On top of that, many participants liked the handy size of the gadget. We could figure out discordances about the system input: There were participants who liked the input we designed, but some would prefer touch screens.

The examiners observations supported the subjective evaluation of participants. We could observe hesitation and comments that expressed uncertainty about the meaning of icons. Moving the knob to the right/left for confirmation/going back seemed to be in some cases not intuitive, people did tapping gestures like they would on a smartphone. But we also could observe that most participants managed the tasks without problems. Some positive comments on the options of the gadget were made; most people liked searching for recipes and, e.g., carbon footprint.

Some of the difficulties that are named are owed to the usage of our prototype itself: the extraction of the display or the imagination of scrolling through a product list. Another critique is about the study setting: to conclude if our gadget effectively can reduce stress for customers, the study should be repeated in a supermarket with an enhanced prototype, so that we can measure the stress experience with and without the gadget.

In conclusion, the data indicates that there are some difficulties arising when participants use the gadget. Nevertheless, generally participants appreciated a lot of the included features. Collected data will help to make further improvements in the future.

17.6 Outlook

Improvements that could be implemented in the next phases are more distinct and easily recognizable icons since a few participants had problems identifying symbols, as well as the possibility to add products spontaneously. We were asked how to add items if they forgot to add something to their shopping list and we realized that there is no option for it. Furthermore, we came to the conclusion that a more logical menu list (for the extended display) is needed. We tested the following process: `shopping list → select e.g. tortellini → list of tortellini products → select one specific tortellini product → menu: more information, recipes, delete`. But recognized that another order was more reasonable: `shopping list → select e.g. tortellini → tortellini menu: product comparison (list of tortellini products), recipes, delete → [...]`. In this way, "tortellini" generally is erased from the shopping list instead of one specific tortellini product. Lastly, a clear and simple tutorial before using the gadget is highly necessary to understand the features and to properly interact in order to experience a more enjoyable shopping trip.

18 Conclusion

We started an idea about fostering a healthy lifestyle with the support of a smart gadget. We set the focus on reducing stress in grocery shopping, because it is a daily topic and there we find a heterogeneous user group. We think that the gadget we developed can reduce stress in two ways: If people do not have much time for grocery shopping, the gadget can support in doing grocery shopping in a fast manner, so that there is no wasted time that

can lead to experience stress. If people do have more time for grocery shopping, the gadget can support motivation, creativity and learning by different functions, so that shopping is experienced in a positive way and not stressfully.

Till today we cannot find a comparable gadget as shopping aid, indeed there are some shopping apps, but shopping aids/gadgets are not implemented yet. This kind of shopping aid supports a targeted, time-saving and informative shopping experience, maybe this does not reflect the aim for shop owners. We do not include the holistic requirements of every shop owner, even though a satisfied customer is vital for a running business, the overall turnover is probably a man factor for shop owners. To which extent the gadget can really reduce strain through stress experience while grocery shopping should be analyzed in further studies.

Part V
Appendix

A Questionnaire for participants

Questionnaire for Participants

Personal Information

Date:_____ Age:_____ Gender:_____

Part I

For which functions do you use your smartphone?

☐ *almost everything (different apps, calls, etc.)*	☐ *1-2 apps, internet, phone calls*	☐ *phone calls*	☐ *I have no smartphone*

Do you use a shopping aid?

☐ *paper shopping list*	☐ *digital shopping list*	☐ *shopping app*	☐ *I do not use an aid*	☐ *other aids:* _____

How much time do you usually spend on your shopping?

☐ *as little as possible*	☐ *depends on the situation, but **mostly little***	☐ *depends on the situation, but **mostly a lot***	☐ *I like to spend a lot of time to get information, inspiration,etc*

Part II

How easy was it to use the gadget ?

☐ *very easy*	☐ *easy*	☐ *neutral*	☐ *hard*	☐ *very hard*

How satisfied are you with the usage of the gadget ?

☐ *very satisfied*	☐ *satisfied*	☐ *neither nor*	☐ *unsatisfied*	☐ *very unsatisfied*

Which difficulties did you have while using the gadget?

Which features did you like at least?

Which features did you like the most?

Figure 15: Questionnaire for participants

B Observer Form

Observer form:
Data collection form developed for usability testing of prototype

Date:_____ Participant:_____ Evaluator:_____

Task 1

Comments made by participant:

Errors or problems observed (e.g. assistance offered):

Other relevant observations:

Task 2

Comments made by participant:

Errors or problems observed (e.g. assistance offered):

Other relevant observations:

Task 3

Comments made by participant:

Errors or problems observed (e.g. assistance offered):

Other relevant observations:

Task 4

Comments made by participant:

Errors or problems observed (e.g. assistance offered):

Other relevant observations:

Figure 16: Questionnaire for participants

C Test Instructions

Imagine you are doing your grocery shopping in the supermarket „Kaufland“. You are in the entrance hall and on your left there is a board, where you can grab the gadget. This is the gadget (observer gives gadget to participant). In a real life situation you will see a tutorial, that will explain to you how to use the gadget. Now, in this simulation the main function of the gadget will be explained. You can attach the gadget to different objects: shopping cart, basket, etc. This is the handle of a shopping cart (observer gives participants the prototype of handle). The knob consists out of two parts: a fixed base with a scanner, here you can scan your products by putting them into the basket. The other part is detachable. There are two displays, one is fixed (observer shows the round display) and one is extractable (observer shows the larger display and adds it to the round one), you can extract the larger display by tapping in the middle (observer shows tapping). On the round display you can see your reordered shopping list (observer shows shopping list), an integrated navigation system (observer shows navigation system), your total shopping amount (observer shows total shopping amount) and the progress of your shopping with this coloured ring (observer shows shopping ring). On the larger display you can get further information and you can scan products. For scrolling you can turn the knob in both directions. On the base you can see four icons, you can push the knob towards the icons: Push it down to see the home screen - that is your shopping list. Push it to the right to select or confirm your selection. Push it to the left to go back to the previous screen. Push it up to see the statistics of your nutritional components.

Now I will give you 4 tasks, please solve the tasks. While solving it, please speak out loud, how you do it and if you have any problems:

Task 1: Find the cheapest tortellini option.

Task 2: Where do the 4-Cheese Tortellini come from?

Task 3: Find a recipe for 4-Cheese Tortellini and add some of the recipe ingredients to your shopping list.

Task 4: Go back to the home screen.

D Results Participant 1

Observer form 1:
Data collection form developed for usability testing of prototype

Date: 14/01/2020 Participant: 1 Evaluator:

Task 1

Comments made by participant:
- “What is the difference between these two icons?” (point on vegan/vegetarian)

Errors or problems observed (e.g. assistance offered):
- no problems

Other relevant observations:
- no problems with fulfilling the task
- clear and direct way of interaction

Task 2

Comments made by participant: -

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- gives correct answer

Task 3

Comments made by participant:

- “Can I also add all ingredients at once? Cause i do need everything for cooking the meal - i do not have something in my fridge at home!”
- “the plus is for adding one ingredient, I guess”

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- slightly hesitates with adding an ingredient

Task 4

Comments made by participant:

- “This was the home button, right?”

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:

- posed the question as counterinsurance, but found the home list without problems

Figure 17: Questionnaire for participants

E Results Participant 2

Observer form 2:
Data collection form developed for usability testing of prototype

Date: 14/01/2020 Participant: 2 Evaluator:_____

Task 1

Comments made by participant: -

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- hesitates / unsure how to extract the expanded display
- recognizes the filter symbols to rearrange the products accordingly → finds the cheapest on top of the list

Task 2

Comments made by participant:

- "Do I have to pick "item options" to get further information?"

Errors or problems observed (e.g. assistance offered):
- was unsure of term "item options"

Other relevant observations:
- scrolls down to the wanted product & selects it by pushing to the right
- likes the clear structure of the information on the display

Task 3

Comments made by participant:

- "What if I would like to add a product that is not included in the recipe?"

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- while still on the "information" page, he tries to scroll down to find recipes but realizes that he has to go back

Task 4

Comments made by participant: -

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:

- does it without any complications

Figure 18: Questionnaire for participants

F Results Participant 3

Observer form 3:
Data collection form developed for usability testing of prototype

Date: 16/01/2020 Participant: 3 Evaluator:

Task 1

Comments made by participant:

- deleting items is quite complicated
- filter option would be good

Errors or problems observed (e.g. assistance offered):

- tries to use knob as touchscreen
- has problems tackling the first task (told her that she needs to extract the extended display)
- has problems to extract the additional display
- scrolls through the whole product list without using the filter option

Other relevant observations: -

Task 2

Comments made by participant:

- adding new items is not possible

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- finds origin of product easily

Task 3

Comments made by participant:

- “I have seen that there were recipes listed but how do I get there?”
- asks how to add some ingredients for the recipe

Errors or problems observed (e.g. assistance offered):
- needs some time to find the “back button”

Other relevant observations:
- remembers that there was the option for recipes at the previous display

Task 4

Comments made by participant: -

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- finds “home button” easily

Figure 19: Questionnaire for participants

G Results Participant 4

Observer form 4:
Data collection form developed for usability testing of prototype

Date: 16/01/2020 Participant: 4 Evaluator:

Task 1

Comments made by participant:

- “Was not intuitive for me to push to the right to confirm”

Errors or problems observed (e.g. assistance offered):
- Tabs in the middle of the knob to confirm the item „tortellini“ instead of pushing knob to the right side to confirm

Other relevant observations:
- needs some time but manages the rest of the steps
- uses the filter and finds cheapest product

Task 2

Comments made by participant: -

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- finds origin of product quite easily

Task 3

Comments made by participant:

- “What is the meaning of the icons in the recipe list?”
- “The “plus” probably adds the ingredients to the list, right?”

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- scrolls on the information screen but then notices that she has to go back
- takes a lot of time

Task 4

Comments made by participant:

- “That’s an easy one - I know that symbol from my tablet.”

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- easy to find home button

Figure 20: Questionnaire for participants

H Results Participant 5

Observer form 5:
Data collection form developed for usability testing of prototype

Date: 18.01.2020 Participant: 5 Evaluator:_____

Task 1

Comments made by participant:

- asks for touch interaction for selecting items from the display.

Errors or problems observed (e.g. assistance offered):
- tries to select by touch interaction.

Other relevant observations:
- do not like the knob to go over the menu items.

Task 2

Comments made by participant:

- likes the concept of displaying product origin information.

Errors or problems observed (e.g. assistance offered):

Other relevant observations:
- easily found the product origin information.

Task 3

Comments made by participant:

-

Errors or problems observed (e.g. assistance offered):

Other relevant observations:
- not much interested to find new recipes

Task 4

Comments made by participant:

Errors or problems observed (e.g. assistance offered):

Other relevant observations:
- easily found the icon for the Home and completed the task very fast.

Figure 21: Questionnaire for participants

I Results Participant 6

Observer form 6:
Data collection form developed for usability testing of prototype

Date: 18.01.2020 Participant: 6 Evaluator:_____

Task 1

Comments made by participant:

- prefers selection by pressing the knob and open the extended display by pushing the knob up

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:
- ask assistance to explain one more time to the interaction of the system

Task 2

Comments made by participant: -

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:

- delighted to have the information about carbon dioxide footprint

Task 3

Comments made by participant: -

- suggests to improve the item deletion from the list to a much easier option

Errors or problems observed (e.g. assistance offered):
- confused about the delete in the item options

Other relevant observations: -

Task 4

Comments made by participant: -

Errors or problems observed (e.g. assistance offered): -

Other relevant observations:

- successfully done the task

Figure 22: Questionnaire for participants

J Prototype Screens

Figure 23: Screens 1

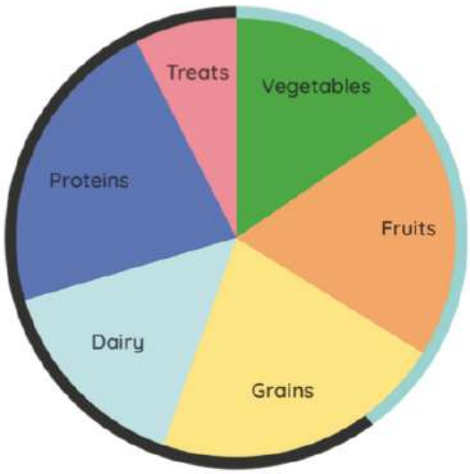


Figure 24: Screens 2

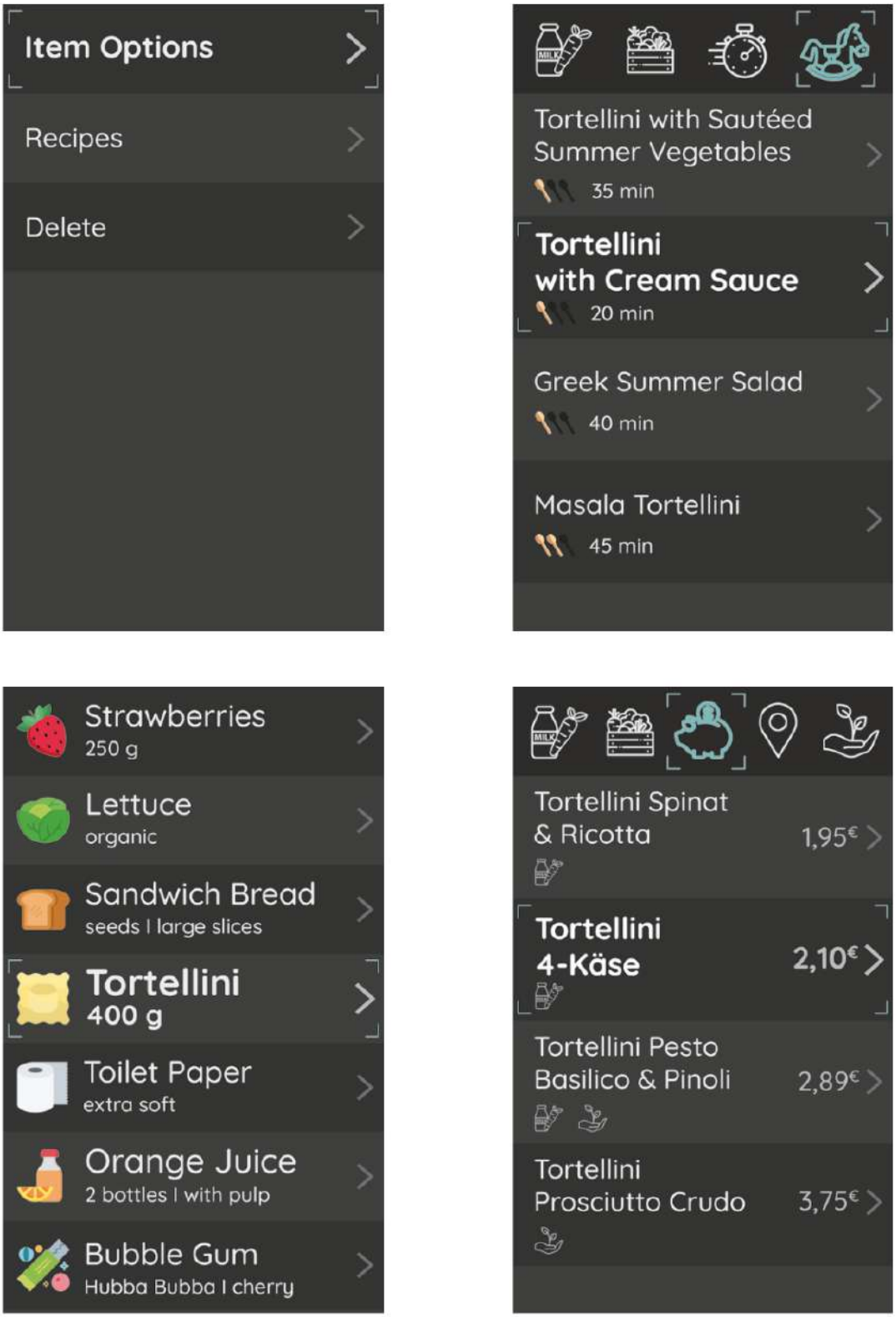


Figure 25: Screens 3