Creating sustainable washing behaviour within a pay-per-use business model

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Abstract

This report focuses on the start-up company HOMIE B.V. (hereinafter refered to as “HOMIE”).
HOMIE is a household appliance company, currently focused on washing machines, that provides its products through a pay-per-use model. Here the customer does not buy the product, but only pays a small fee for each time that the product is used.

Through this model, HOMIE aims to generate sustainable customer behaviour. The customer is motivated by the payment system to wash less often. Addtionally, HOMIE asks different prices for different washing temperatures, and the company provides customers with feedback mailings, all to motivate sustainable washing.

The aim of this project was to answer two main research questions:

- To what extent is HOMIE already creating sustainable customer behaviour through the currently implemented design interventions? How does the environmental impact compare to average washing machine use, and what level of change is reached through the current interventions?
- Which design solutions can provide the best results in terms of environmental impact, customer satisfaction and business viability? Which design and business model solutions can provide the best results for creating the sustainable customer behaviour interventions?

To answer the first question, a literature review was conducted to understand what sustainability entails in the case of washing machines, and which factors influence it.
Nationwide washing data was then collected, and compared through statistical analysis to the washing data of HOMIE customers. Although the monthly mailings did not have a statistically siginificant effect on the washing behaviour, there was still a statistically significant difference between certain washing behaviour aspects of HOMIE customers and the national averages.

Gaining the necessary insights for the second research question also started with a literature review, aimed at understanding the relevance of customer behaviour to the environmental impact of washing machine use. The literature review also explored existing research on the topic of how to change customer behaviour, as a foundation for developing new solutions.

An internal analysis of HOMIE as a company, and an external analysis of the competitive landscape were conducted to understand the strategic environment in which new concepts would have to be released. A series of interviews was used as additional research to understand users’ current washing behaviour.

New concepts were then developed in an idea generation process, and one of these was chosen to be explored further. Using questionnaires, the concept was evaluated in regard to some of the most important criteria that were established for this project. After this, the concept was improved using outcomes from the questionnaire, after which the concept was evaluated again.

All in all, the project provides an insight into the effects of the business model HOMIE uses to generate sustainable washing behaviour, and also delivers new solutions aimed at maximising value for creating environmental impact improvement, for delivering customer value and for creating business value.

Acknowledgements

I would like to thank Ruth Mugge, Vivian Tunn, Nancy Bocken and Colin Bom for coaching me throughout this project, providing clear and useful feedback at all the meetings. Also, additional thanks for always helping by thinking along with new ideas, all the input was very much appreciated!

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1 Introduction

The increase in global population and the increased pressure on natural resources are creating a growing need for sustainable development. Sustainable initiatives solely focused on the supply-side can be inadequate on their own, and excessive consumption patterns also need to be tackled in order to create effective sustainable development (Bocken & Short, 2016). Sustainable business models can play an important role in creating sustainable consumption patterns, because of their systemic approach, since they encompass how an organisation creates, delivers and captures value for the consumer (Bocken, 2017). One of the sustainable business model archetypes identified by Bocken et al. (2014), is delivering functionality without ownership, a category which also includes pay-per-use models.

1.1 HOMIE B.V.

HOMIE B.V. (hereinafter referred to as "HOMIE") is a Delft-based start-up company which focuses on the home appliance market. Their logo is shown in *Figure 1*. Starting with washing machines, HOMIE aims to reduce the environmental impact of home appliances by moving from an ownership model towards a pay-per-use model (HOMIE B.V., 2017). The company is centred around a circular economy model (MacArthur, 2013), where the maintenance, refurbishment and redistribution of the product are enabled by retaining the ownership of the product, and letting the user pay for the use of the product, rather than for the product itself. Furthermore, HOMIE aims to reduce the environmental impact of the use phase by creating behavioural change towards more sustainable customer behaviour.

These two aspects are in accordance with what Tukker (2004) identifies as the two main areas of potential environmental benefit of pay-per-use models. First of all, since the company is responsible for the lifecycle costs of the product, the company becomes motivated to optimise the product in terms of lifecycle performance, where elements of the product can be reused. Secondly, users will make more conscious use of the service, since they now pay per washing session.

HOMIE is currently already implementing some design interventions (further discussed in Chapter 3.1) to change customer behaviour to become more sustainable, beginning with the first of the following interventions: eco-information, eco-choice, eco-feedback, eco-spur, eco-steer, eco-technology and clever design. These envisioned steps are based on Tang's (2010) Design Behaviour Intervention Model which focuses on creating new sustainable user habits through design interventions on different levels, ranging from user-led to product/service-led interventions.

Figure 1. HOMIE's logo

1.2 Problem definition

This graduation project will focus on HOMIE's business model, in order to determine how sustainable washing behaviour can be created within a pay-per-use business model.

Since optimising the environmental impact is a central goal of HOMIE, an understanding has to be developed of to what extent HOMIE influences the environmental impact, and of which solutions in the design and business model can be developed to generate the optimal change in environmental impact.

For the first issue, there has to be an understanding of to what extent HOMIE is currently creating sustainable customer behaviour through the already implemented design interventions. How does the environmental impact compare to average washing machine use, and what level of change could be reached?

As to the second issue, with some of the design interventions already being implemented in HOMIE's business model, it is important to know which design solutions can provide the most results in terms of environmental impact, customer satisfaction and business viability in the envisioned intervention steps. Which design and business model solutions can provide the best results for creating the sustainable customer behaviour interventions?

1.3 Contents

The Literature Review (Chapter 2) presents an overview of existing research on the role of business models in reducing the environmental impact of products or services, and on the environmental impact of washing machine use in specific. The Internal Analysis (Chapter 3) then presents an overview of HOMIE's current business model and positioning, along with insight into the effect of currently implemented interventions on the consumers' washing behaviour. The External Analysis (Chapter 4) lists some of HOMIE's main competitors, as well as relevant trends in the current laundry market. The Customer Analysis (Chapter 5) then goes into the washing habits of both the average user as well as HOMIE's customers, and creates insight into the way the current laundry habits take place. The Requirements (Chapter 6) list the criteria that any new solution needs to meet, before the Idea Generation (Chapter 7) and Concepts (Chapter 8) chapters discuss which solutions were indeed developed. The Validation chapter (Chapter 9) discusses how the chosen concept was tested and improved, and the Conclusion chapter (Chapter 10) discusses the answers and solutions this project provides to the problem definition.

2 Literature review

This chapter serves to provide an overview of existing research literature that is relevant to this project.

In the first part (2.1), the role of business models (and pay-per-use business models in particular) in reducing the environmental impact of washing machine use will be discussed, to provide an understanding of why innovation of the business model is relevant in the field of sustainability in the first place.

Then the second part (2.2) will focus on existing insights into how designers can use product/service design to create sustainable consumer behaviour.

2.1 The role of business models – and specifically, pay-per-use models – in reducing the environmental impact of washing machine use

2.1.1 Business models and sustainable development

Design techniques like eco-design and eco-efficiency (saving energy and materials) aid in reducing energy and resource consumption, but not significantly enough to offset the increasing negative impact resulting from the constantly growing world population. To reach a sustainable economy, a long-term, integrated approach is instead necessary, focused on minimising consumption instead of on creating excessive consumption. The approach should also focus on creating societal/environmental benefit rather than economic growth, designing out waste by closing system loops, emphasising functionality and user experience rather than ownership and focusing on collaboration instead of aggressive competition (Bocken et al., 2014).

To reach such a system, there has to be a fundamental shift in the way business is conducted and value is created. Business model innovation presents potential for these required changes since it reassesses an organisation's purpose and way of creating value. A business model entails a firm's value proposition, the way a firm creates and delivers value, and the way a firm captures value, as visualised in *Figure 2*. (Bocken et al., 2014)

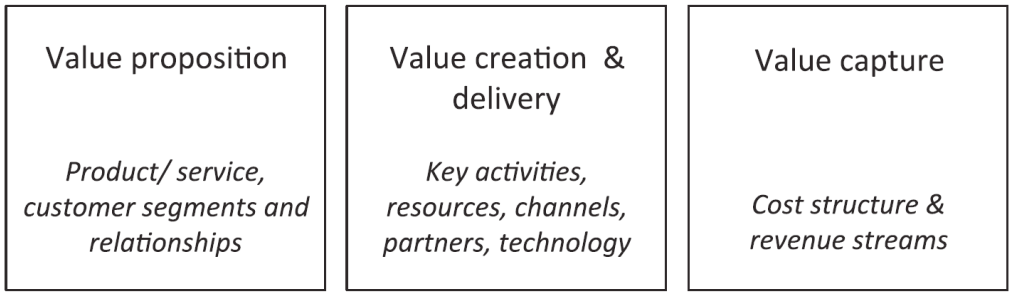


Figure 2. Business Model framework (Bocken et al., 2014)

Classic business models are a significant reason behind un-sustainable development in companies, since these classic business models are aimed at capturing economic value through excessive consumption, planned obsolescence, and a take-make-dispose model, requiring many resources and generating a lot of waste (Bocken, 2017). Design techniques like eco-efficiency focus on increasing efficiency from the supply-side, by focusing on reducing the necessary resources to deliver results to the consumer, but do not focus on these problems of excessive consumption patterns and the take-make-dispose model.

"Sufficiency" based business models however focus on the demand-side, by encouraging less excessive consumption patterns and reducing quick discarding and replacement of products. Sufficiency-based business models focus on new ways to capture economic value instead of excessive consumption, and as a result show promise in significantly reducing environmental impacts. (Bocken & Short, 2016)

"Pay-per-use" is one such sufficiency-based business model, where companies offer their customers functionality rather than the ownership of products (Bocken et al., 2014). With such an approach, the link between production volume and profit can be broken, since companies will not gain profit from number of products sold, but from the functionality that is delivered. This is in accordance with the first way that Tukker (2004) describes in which pay-per-use business models show environmental impact reduction potential. Consumers are more conscious of the way they make use of the functionality, since that is what they pay for rather than for product ownership. Apart from that, the service providers are incentivised to design products that are optimised in terms of costs over their entire lifecycle, and of which parts can be reused after the product's useful life, since they, as owners of the product, are responsible for the product's lifecycle costs.

2.1.2 Environmental impact of electrical consumer products

In the case of electrical consumer products, the consumption patterns of users have a large influence on the total lifecycle impact of the product.

In the lifecycle impact of washing machines specifically, the use phase accounts for the largest environmental impact. Koerner et al. (2011) assess that with washing machines, the use phase accounts for 92% of all water consumption, 60% of energy consumption, 73% of the global warming potential and 62% of fossil fuel depletion in the entire lifecycle impact. Bourrier et al. (2011) put the total impact of the use phase of washing machines a little over 80% of total lifecycle impact.

This impact during the use phase is largely influenced by the way consumers use the product. Energy use can differ up to a factor of two to three in identical homes populated by people of similar demographics (Froehlich, 2009), demonstrating that use habits of individuals can make a significant difference in overall energy consumption.

As a result, a pay-per-use model aimed at creating more sustainable consumer behaviour can create significant change in the environmental impact of washing machines.

2.1.3 Conclusion

All in all, the role of business models – and specifically, pay-per-use models – in reducing environmental impact of washing machine use, can be summarised as follows:

- Designing more efficient products helps to reduce environmental impact, but to actually counter the effect of the increasing population, excessive consumption patterns have to be tackled.
- Business model innovation provides a chance to tackle these consumption patterns, since classic business models are often aimed at gaining profit through excessive consumption.
- Sufficiency-based business models focus on gaining profit through different means, like "pay-per-use" models, where consumers pay for functionality rather than for ownership of products.

- As a result, pay-per-use models offer sustainable potential by making consumers more conscious of how they use products, and motivating companies to optimise lifecycle value of products.
- For washing machines, focusing on how people use the product is especially relevant, since the use phase is the main contributor to the environmental impact, and the impact can be influenced significantly by the way people use the product.

Since the consumer behaviour plays such an important role in the environmental impact of washing machines, the next section discusses how designers can play a part in creating sustainable consumer behaviour.

2.2 Creating sustainable consumer behaviour

2.2.1 Sustainability in washing machine use

To understand how sustainable consumer behaviour can be created in washing machine use in particular, it is first important to know what sustainable behaviour entails in washing machine use.

Key drivers for reducing environmental impact of washing machine use include:

- increasing the wash load (to increase efficiency by washing more clothes with the same resources)
- decreasing wash frequency
- the amount and type of detergent used
- using low temperature settings
- making optimal use of the machine's parts (through sharing, proper maintenance and recycling)

(Bourrier at al., 2011) (Koerner et al., 2011).

These factors play an important role in the environmental impact due to their direct effect on energy consumption, water use and waste generated. In order to establish how these factors can be influenced through product/service design, the following paragraphs describe existing models for creating sustainable consumer behaviour.

2.2.2 Models for creating sustainable consumer behaviour

Various models for creating sustainable consumer behaviour exist. Earlier research by Söderlund (1990) and Mansouri et al. (1996) showed that users felt that being provided with information about how to reduce energy consumption of appliances would help them reduce energy consumption. Kollmuss and Agyeman (2002) show a more complicated side to this, and state that apart from environmental knowledge and awareness, a large number of other factors influence the consumer behaviour. Demographics, people's ability to reduce environmental impact, economic factors, motivations, attitudes, and people's perceived responsibility play a role in their model as well. Ajzen (1991) confirms that factors like attitudes, social norms, knowledge and perceived control over behaviour can all affect their intentions and, as a result, their behaviour. He also adds that when behaviours have already developed into habits, the behaviour is more automated and happens with less consideration of these factors.

When the situation in which certain behaviours occur remains stable, habits have a strong influence on consumer behaviour. A habit happens when a specific situation (cue) triggers a specific response (script). (Jager, 2003)
Positive outcomes which result from that response increase people's motivation to repeat that behaviour, and repetition of that behaviour incrementally strengthens the link between the cue and the script. The automaticity that is built up during this process creates increased efficiency in the behaviour, a lack of awareness, makes the behaviour less intentional and less controllable from the part of the consumer. (Lally et al., 2010)

During the first phase of habit formation, the Declarative Stage, where the habit is first initiated, this automation does not yet take place, and factors like attitudes, knowledge, norms and motivations still play an important role in the formation of the habit. However, during the Knowledge Compilation Phase, the habit starts becoming more automated after repetition, before entering the Procedural Stage, where the habit is already formed, and direct positive outcomes of the behaviour for the consumer strengthen the link between the cue and the script further. (Jager, 2003)

Tang (2010) integrates these different views, and presents the model shown in *Figure 3*. In the declarative stage of habit forming, the user's intentions have a large influence on the behaviour, and these intentions are shaped by the user's attitude towards the behaviour (formed by the knowledge and beliefs), by social factors (influenced by perceived norms, by what role the user thinks they play in the result of the behaviour, and the user's sense of self-concept, or what they consider their responsibility).

To create sustainable consumer behaviour, various interventions are presented in Tang's (2010) model that can be used to influence consumer behaviour, ranging from solutions where the user makes the decision for a particular behaviour, to solutions where the decision is guided by the product/service. These behavioural change interventions are:

- Eco-information: providing the user information and insight into the environmental impact of their behaviour in order to help them reduce it.

- Eco-choice: providing the user with clear options of how they could reduce their environmental impact
- Eco-feedback: motivating the user towards environmentally and socially responsible behaviour by offering real-time feedback
- Eco-spur: guiding the user towards more sustainable behaviour by rewarding sustainable behaviour and punishing unsustainable behaviour
- Eco-steer: using constraints in the product design to guide the user towards sustainable behaviour
- Eco-technology: using technology to persuade and control the user behaviour automatically
- Clever design: without focusing on the user's awareness or decision making, make the user act sustainably automatically through the design of the product

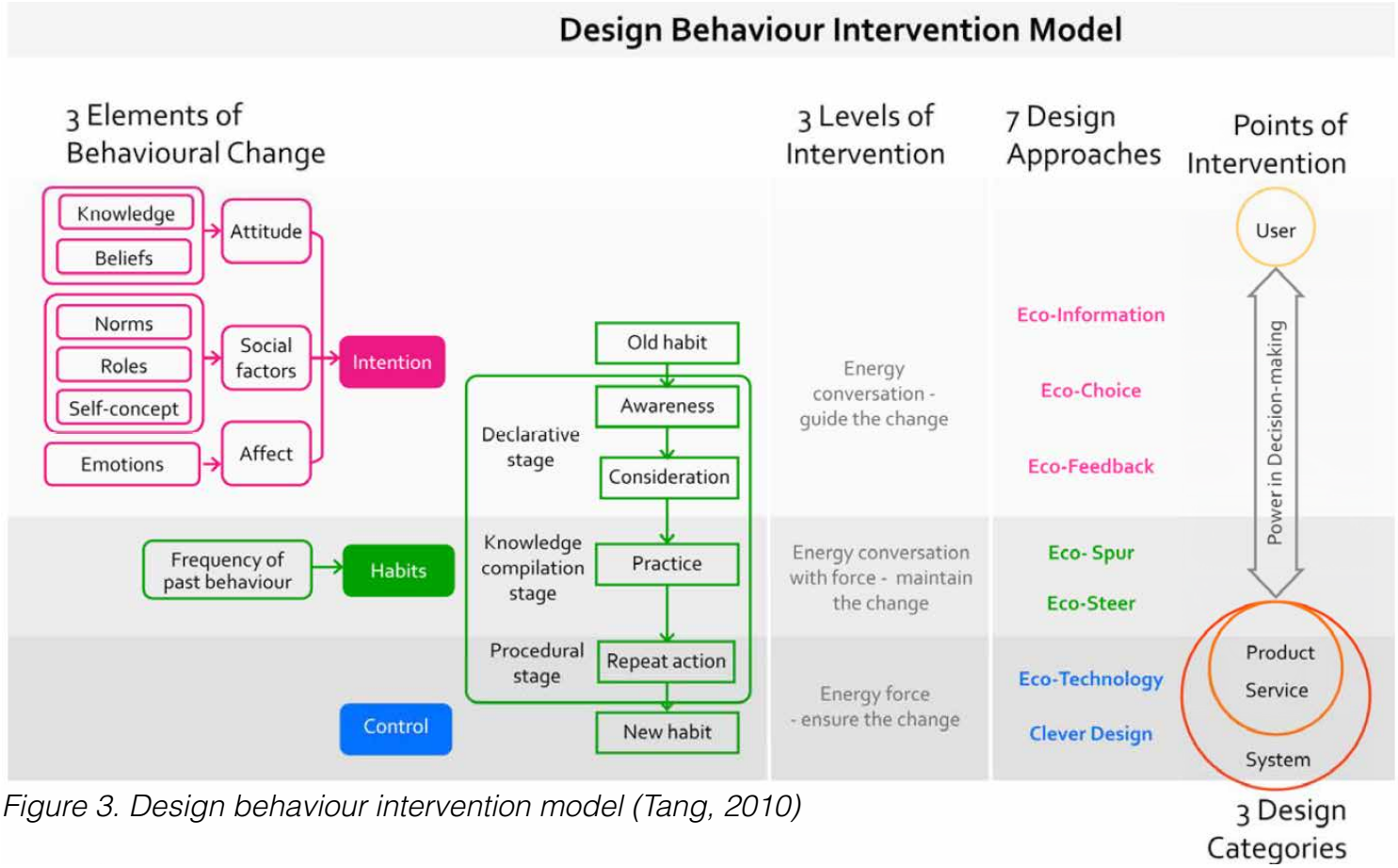


Figure 3. Design behaviour intervention model (Tang, 2010)

The interventions aimed at user-led decision making are linked to the declarative stage of habit forming, since the user's intentions have a large influence on their behaviour in that phase (Jager, 2003), whereas the interventions aimed at product/service led decision making are linked to the stages where the habit is already formed: the knowledge compilation phase and the procedural phase (Tang, 2010).

Since the user's behaviour in those later habit formation phases is then largely influenced by existing habits (Jager, 2003), the intervention for creating more sustainable behaviour cannot rely on the user's intentions in the decision making process. Instead, the habit either has to be made impossible to conduct (which could result in user resistance because of the lack of freedom of choice) or its performance environment which provides the habit's cue should be changed to prevent the behavioural script from being initiated (Verplanken & Wood, 2006) (Jager, 2003). The new use environment should aim to foster and strengthen the new desired habit (Verplanken & Wood, 2006), or the direct experienced outcomes should be changed to prevent the user from experiencing positive outcomes from an unsustainable habit (Jager, 2003).

2.2.3 Effectiveness of the behavioural interventions

Abrahamse et al. (2005) conducted research into the effects of various interventions aimed at reducing household energy usage in several studies. Providing information on its own did not necessarily create a change in behaviour, confirming that knowledge on its own is inadequate to change existing behaviours. Other intervention methods such as providing feedback, showing users sustainable options, sustainable goal-setting and giving rewards were in various cases successful in creating increased sustainable behaviour, but the effects were not always long lasting, so new sustainable habits were not always established and maintained, instead of remaining an occasional behaviour.

Tang (2010) states that the product/service led interventions present a large degree of certainty of reaching sustainable behaviour, since the decision making process is taken out of the user's hands. However, an added risk comes along that users can find these interventions less easily acceptable since their decisions are forced by the product/service. Wever et al. (2008) concur that the effectiveness of interventions aimed at creating sustainable consumer behaviour depends on both the certainty of creating new behaviour patterns, and on whether the users are willing to accept those interventions. Kobus et al. (2013) assess that the degree of behavioural change is influenced by factors like the user's motivation to change, which can be triggered by the chance to help solve environmental issues, or by other issues such as financial incentives or interest in new technologies. Also, in providing eco-information, the perceived trustworthiness of the system is of great importance in the effect of the intervention.
Apart from the user's motivation and attitude towards the intervention, the perceived intrusiveness is also influenced by the way the interventions are designed. In design that is created to influence consumer behaviour, not only is the perceived intrusiveness influenced by the strength of the influence, but also by the fact whether the influence is more apparent or more hidden, and if the user is aware of the influence. (Tromp et al., 2011)
Since the user's willingness towards interventions, and their perception of the intervention, are important to the effectiveness of the interventions, it is also important to take into account the challenges that are presented by product-service systems which share a lot of data with the user. These challenges can pertain to both the value that the users derive

from the interactions, as well as how they experience the interactions. Since these types of PSS's present the opportunity to companies to communicate a lot of data with the user, the company should focus on presenting clear value to the user.
With the user interacting with multiple touchpoints across a system, keeping the interaction coherent and the value for the user clear, may be challenging in the design of new solutions. (Cardona et al., 2014).

2.2.4 Conclusion

To summarise the issue of existing insights into creating sustainable consumer behaviour:

- For washing machines specifically, "sustainable consumer behaviour" would entail maximising wash loads, minimising the number of washes, minimising the amount of detergent used, using the lowest temperature settings and making efficient use of the machine's components.
- Providing users with information on how to reduce the environmental impact is not going to be enough to create change in the consumer behaviour, since that behaviour is influenced by a range of internal and external factors, like knowledge, attitudes, social norms, perceived control and responsibility.
- These factors may however not play the most important role when a behaviour has developed into a habit, since the behaviour then becomes more automated, and the established habit largely determines the future behaviour.
- Several design interventions have been determined which can be used to influence consumer behaviour, ranging from interventions where decisions are made by the user, to ones where the decisions are made by the product or service. The user-led interventions are more effective when habits are still being formed, whereas it is more useful to employ the product/service led interventions when the habits are already fully formed.
- In order to change an already established habit, the situation in which it takes place, which provides the cue starting the automated behaviour, should either be changed to stop the habit from taking place; or the directly experienced outcomes, which can strengthen or weaken the habit, should be adapted to promote the start of a new habit.
- The product/service led interventions present a larger certainty that the future behaviour will be led by sustainable choices, by for example making unsustainable behaviour impossible to conduct. However, when the influence of the intervention is both too strong and too apparent, users may consider them to be too intrusive to accept the intervention, if the user is not motivated to change.
- In a product-service system where data is shared with the consumer, like HOMIE's business model, to ensure the user's motivation to change, the value that the user derives from the presented data has to be kept central and clear throughout the service.
- When a new behavioural pattern is started because of a designed intervention, there is also the risk that the change will not be long lasting. Providing an environment that helps foster the sustainable habit can on the other hand help in establishing a sustainable, automated habit.

3 Internal analysis: HOMIE

This chapter provides an internal analysis of HOMIE as a company. First of all, the Business Model Overview (Chapter 3.1) will provide insight into what HOMIE does exactly, and what they offer their customers. Then the company's positioning is summarised in the Positioning Statement (Chapter 3.2).

3.1 Business model overview

This section will look into what it is that HOMIE does as a company, and will explain the company's business model.

Looking at the company from the perspective of Bocken et al.'s (2014) Business Model Framework *(Figure 4)*, the following paragraphs describe HOMIE's value proposition *(Chapter 3.1.1)*, ways of creating and delivering value *(Chapter 3.1.2)*, and ways of capturing value *(Chapter 3.1.3)*.

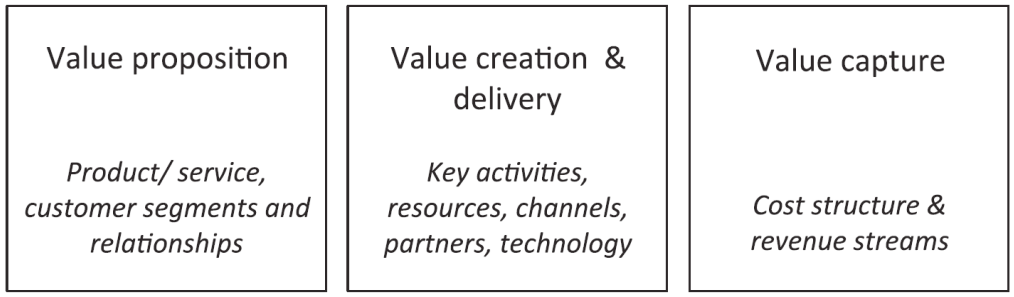


Figure 4. Business Model framework (Bocken et al., 2014)

The Business Model Canvas on page 14 *(Figure 6)* provides an overview of the various elements discussed in the following three sub-chapters.

3.1.1 Value proposition

This section will describe HOMIE's service, their intended customer segments, and ways of establishing customer relationships.

Product/service

First we look into what is is that HOMIE does as a company and the service they provide.

First of all, HOMIE acquires washing machines: Zanussi ZWF71443W models (see *Figure 5*). This particular model is currently used by HOMIE because of its relatively affordable acquisition price (€335.- for a new model), its A+++ energy efficiency label, which is the highest available label (European Union, 2017), and the fact that this particular model communicates efficiently with the washing tracker that HOMIE uses. This tracker is built into the machines at HOMIE, and sends data about which washing programmes have been used to the company via Wi-Fi connection, in order to make the pay-per-use payment model possible.

Figure 5. Zanussi ZWF71443W (Zanussi, 2017)

Key Partners

- Delft University of Technology (spin-out)
- Delft Enterprises (funding)
- Zanussi (washing machines)
- Bo-rent (transport)

Key Activities

- Acquiring washing machines/tracker parts
- Building the trackers into the washing machines
- Marketing the service
- Transport/installation of the machines
- Gathering user data
- Providing consumers with eco-information and eco-feedback to motivate sustainable behaviour
- Maintenance service (repairs/replacements)

Key Resources

- Personnel (3 founding members, engineer, accountant, intern)
- Social media: Facebook, Twitter, LinkedIn
- Zanussi A+++ energy label washing machines
- Product use trackers
- Direct customer feedback
- Funding

Value Proposition

- Reliability
- Control over what you have to pay
- Independence
- Low initial costs
- Sustainability

Customer Relationships

- Face-to-face interview
- Online questionnaires
- Customer website
- E-mail (monthly usage feedback mailing)

Channels

- Word-of-mouth
- Social media (Facebook, Twitter)
- Local newspaper advertisements
- E-mail
- Telephone
- TU Delft collaboration on courses

Customer Segments

- Short-staying customers
- Low-price focused customers
- Customers interested in sustainability

Cost Structure

- Workspace
- Personnel
- Washing machines
- Tracker components
- Repair/maintenance
- Transport

Revenue Streams

- Paying customers
- Funding

Figure 6. Business Model Canvas

When new customers join HOMIE, HOMIE will plan an installation date and will deliver and install the washing machine for free.

After the installation of the washing machine, the customer can start using the washing machine. The first month of washing is offered without charge, and after that month the customer will receive a payment request via email for the washing programmes that have been used. The washing programmes have higher prices when their temperature is higher, to encourage washing at low temperature settigns. Using PayPal or bank transactions, the customer transfers money to their HOMIE account, and with that credit they can pay their washes.

At the end of the first calendar month in which customers have had to pay for washing programmes, they will start to receive the first monthly intervention email. The monthly emails (also shown in Appendix A) are aimed at motivating the customer towards more sustainable washing behaviour, through the following steps:

- Mailing 1: Washing Data
  In the first email, users receive an overview of their washing programmes in the past month. They are shown how many washes they have done, which programmes those washes were, at which temperatures those washes were set and at which time of day they did the washes. The amounts of water and energy that were used for those washes are also shown, to make the environmental impact of the washing more visible. The email also features tips on how to wash more sustainably and reduce the water and energy consumption. This intervention is linked to the "Eco-information" step from Tang's (2010) model *(see Chapter 2.2.2)*.

- Mailing 2: Comparison to previous month
  The second email provides a similar overview of washing data, but presents it alongside the data from the first month, to show the change between the two months. The visualised change provides the users with an overview of what difference in impact is created when they choose to change their washing behaviour. This intervention is linked to the "Eco-choice" step from Tang's (2010) model.

- Mailing 3: Social comparison
  This mailing shows the users their own data, compared to data from the average Dutch household (of the same household size as their own). This social comparison is aimed at encouraging the user to think more about their environmental impact, and to show them where options for improvement are, by showing the differences between their data and the average data. This intervention is also linked to the "Eco-choice" step from Tang's (2010) model.

- Mailing 4: Goal setting
  The fourth mailing gives users the option to set a sustainable washing goal for the coming month. The user can choose a goal (such as "reducing the number of washes by 20%") and will then receive weekly feedback emails during that month, in which they will be presented with weekly washing data, and tips and encouragement on how to reach the set goal. This intervention is linked to the "Eco-feedback" step from Tang's (2010) model

- Mailing 5: Most used washing programme
  This mailing shows the users which washing programme they've used most up until that point in time, and shows how much water, energy and time that programme takes up. An alternative, less impactful

programme is also shown in the same manner, to provide the user with an insight into a more sustainable option, corresponding once more to the “Eco-choice” step from Tang’s (2010) model.

- Subsequent mailings
  After the fifth mailing, subsequent mailings feature an overview of the user data once more compared to the average Dutch household, followed by a more extensive overview of their monthly washing data.

Whenever repairs or replacement of the product are necessary, HOMIE handles these services for free and will come by to pick up the product. After a minimum 6-month period, the users can choose whenever they want to end the contract, and their washing machine will be picked up again, after which the machines can be refurbished and passed on to new customers.

Figure 7 shows an overview of the process that takes place in the service of HOMIE

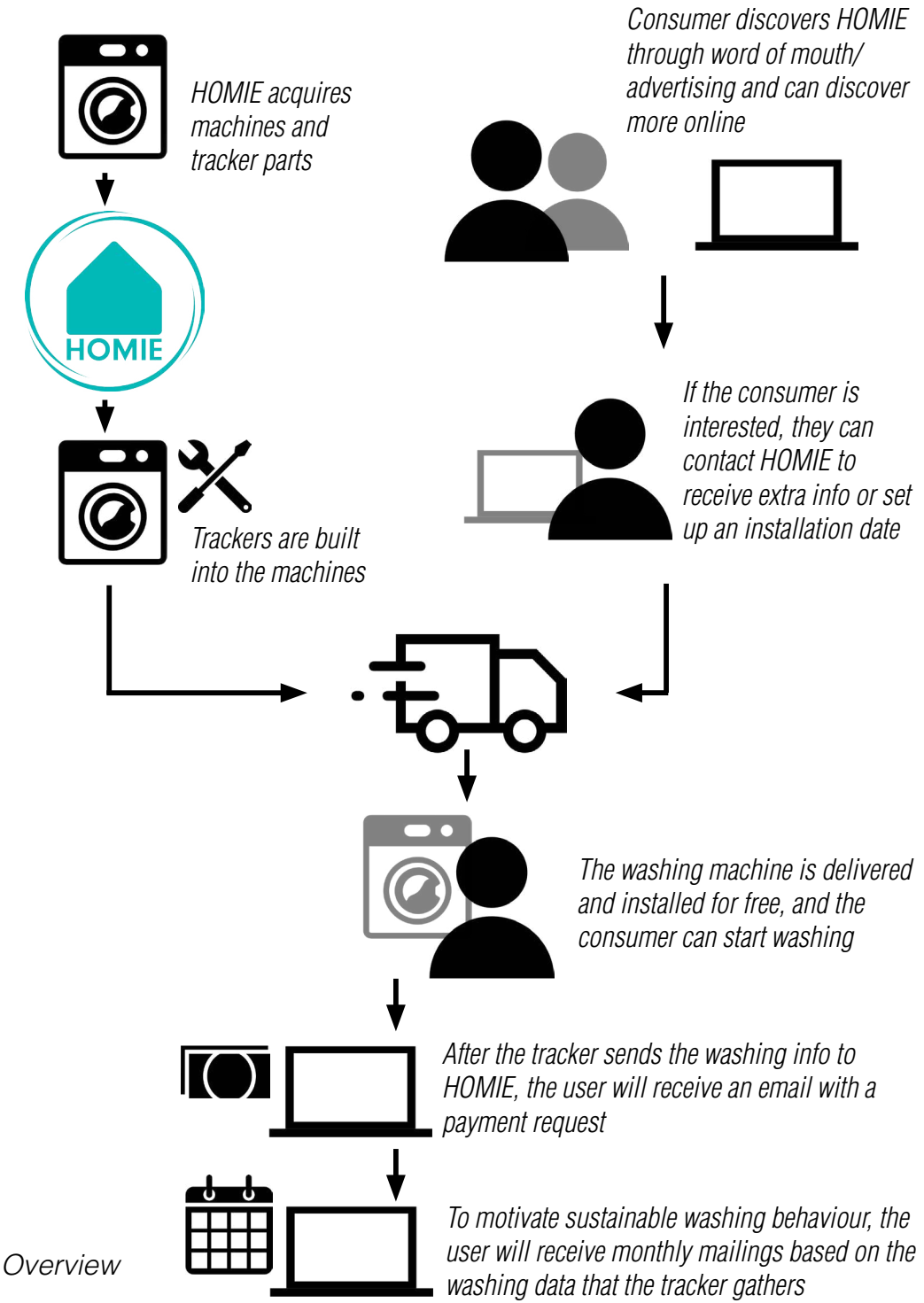


Figure 7. HOMIE Process Overview

Offered values

In this product-service system, there are several values that HOMIE aims to offer its customers. These values are both presented on the company's website (HOMIE B.V., 2017), as well as in their advertising *(see Appendix B).*

HOMIE aims to offer value to its customers in the following areas:

- Reliability
  The customer is always guaranteed a working product. All services, installation, repairs and replacements are offered for free to always ensure a functioning washing machine.

- Control over what is paid
  By only paying for each product use, customers know exactly what they will have to pay and can moderate their consumption, and thus their expenses, themselves. There are no additional or unexpected costs for the customers, and no subscription fees on top of the payments per washing session.

- Low initial costs
  Since the product remains the property of HOMIE, customers only pay a fee for use of the product, not a full price for ownership of the product. Whereas the acquisition of a washing machine would normally result in a high initial price, in this pay-per-use model the customers only start paying after doing their first paid washes.

- Independence
  Customers are not bound by long-term contracts or by the ownership of the product. If they want to leave HOMIE after the initial six months, they can easily return the washing machine to HOMIE. Due to the low investment costs, there is added value for customers who cannot commit for too long, and short contract durations are possible.

- Sustainable washing
  Since customers pay for the product use rather than the product itself, lower resource consumption results in a lower price. Apart from this, the products are all A+++ energy label products, and the company takes care of maintenance and repairs to ensure an extended product lifecycle. Additionally, customers are offered feedback and advice on how they can reduce the environmental impact of their washing behaviour.

Customer segments

HOMIE targets three different customer segments, based on the values that the pay-per-use service can offer.

- Short-staying customers
  Short-staying customers are one of the target segments of HOMIE. Because the pay-per-use model only offers customers the use of the product, rather than the ownership of the product, there is a financial and practical advantage for customers who will not stay in their current home location for a long time. If customers are living somewhere for only half a year, the acquisition of a washing machine comes with high costs, and they will have to find a way to get rid of the machine after they are done. HOMIE aims to target this type of customer by offering an alternative with low investment costs, and with less hassle since they will take the machine back when the contract ends.

  The factors of "low initial costs" and "independence" from the Offered Values *(previous page)* are of heightened relevance for this customer segment.

- Low-price focused customers
  Since the business model provides customers with free installation, maintenance, repairs and replacements, and the pay-per-use aspect results in lower initial investment costs for customers as well as control over how much they have to pay, customers focused on low prices (for example low-income households or students) are also one of the target customer segments of HOMIE. Households with limited financial resources might not want to invest large sums of money for the ownership of a washing machine, and they can adjust their washing schedule to fit the amount of money they want to spend.

  The factors of "low initial costs" and "control over what is to be paid" from the Offered Values are of heightened relevance for this customer segment.

- Sustainability-minded customers
  The third customer segment HOMIE targets entails the customers who have a heightened interest in sustainability. HOMIE only offers products with A+++ energy ratings, and the company tries to help customers to use the washing machines more efficiently (in relation to water and energy consumption). Customers are charged less for the colder washing programmes that require less energy and water, and customers receive information and incentives on how to reduce their environmental impact during washing.

  The factor of "sustainable washing" from the Offered Values is of heightened relevance for this customer segment.

Customer relationships

HOMIE currently maintains the relationship with its customers in several ways:

- Right after the installation of the washing machine, a short interview is conducted (on the customers' past experiences with washing machines, their reasons for choosing HOMIE and their current washing habits)
- There are online questionnaires that the customers receive 1 week,

1 month, 3 months and 6 months after becoming customers at HOMIE (on whether they are satisfied with their washing machine, their thoughts on their washing habits and on whether they think their knowledge on sustainability has increased or not)
- On the customer website, customers can log in and view their washing statistics and available washing credit
- The monthly feedback mailings *(as shown in Appendix A)*

3.1.2 Value creation and delivery

The key resources, activities, channels and partners needed for creating and delivering the value in HOMIE's business model are listed in the Business Model Canvas on page 14 *(figure 6)*.

Key resources
HOMIE currently has a very limited amount of personnel working at the company: apart from the three founding members, there is an engineer who programs the trackers and builds them into the washing machines, an accountant, a web developer and an intern.

Other key resources include the washing machines and the trackers themselves, financial funding, the company's brand and social media.

Key activities
HOMIE's main activities currently include acquisition of the washing machines and the trackers, building the trackers into the machines, marketing efforts, transport and installation of the washing machines, providing the feedback mailings and repairs/maintenance service.

Channels
The main channels through which HOMIE currently reaches its customers include word-of-mouth, social media (Facebook, Twitter and LinkedIn), the company's website, advertisements in local neighbourhood newspapers, telephone, e-mail, and guest appearances in several lectures at TU Delft courses.

Key partners
HOMIE is originally a spin-out company of the Delft University of Technology. Other key partners in HOMIE's business model include Delft Enterprises (responsible for early stage funding), Zanussi (manufacturer of the washing machines HOMIE provides to its customers) and Bo-rent (vehicle rental company used for most of the transport of the washing machines).

3.1.3 Value capture

Cost structure
Several costs are part of the cost structure in the business model of HOMIE, including workspace costs, personnel, acquisition costs of the washing machines and tracker parts, costs for handling potential repairs/maintenance and transportation costs of the washing machines.

Revenue streams
Revenue is gained through paying customers, and HOMIE also acquires financial input from funding.

To encourage the use of programmes that require less energy and resources, higher prices are charged for the higher temperature washing programmes.

The previously used pricing system included higher washing fees than the current pricing, but the customers would receive a rebate of €0.24 per wash at the end of each month. The idea behind this pricing system was that the price for each wash was intended to be all-inclusive and also include water and energy costs. The customers would then receive the rebate as compensation for the money they pay to their water and energy suppliers. Since colder programmes require less energy (and thus result in a lower energy bill) but the rebate was always €0.24, this was used to encourage the use of low temperature settings.

The current pricing system does not use this structure, and is simply €0.24 lower for each washing programme. Additionally, the new pricing system incorporates reduced prices for ECO-programmes. For the 40°C and 60°C washes, ECO-programmes are available on the machine, which cost €0.05 less than their regular counterparts. These programmes save energy by making use of longer soaking times rather than the higher temperatures to clean the laundry effectively.

	Old pricing	Current pricing
Cold wash	€1.37	€1.13
30°C *regular*	€1.42	€1.18
40°C *ECO*	€1.55	€1.26
40°C *regular*	€1.55	€1.31
60°C *ECO*	€1.71	€1.42
60°C *regular*	€1.71	€1.47
90°C *regular*	€1.93	€1.69
	(-€0.24 rebate)	

3.2 Positioning statement

To summarise the points of the previous paragraphs, the following statement provides an overview of HOMIE's positioning:

"HOMIE is the pay-per-use home appliance service

that provides short-staying customers, low income customers and sustainability-minded customers with

- *reliability*
- *control over what is paid*
- *low initial costs*
- *independence*
- *sustainable washing options*

because
- *they guarantee installation, repairs and replacements for free*
- *users only pay for each individual product use*
- *users can easily end their contract after the initial 6-month period*
- *they provide the consumer with information and advice on how they can reduce their environmental impact during use of the A+++ rated products*

unlike washing machine providers with classic business models, who
- *often do not offer service for free*
- *have the consumer pay for the ownership of the product*
- *do not provide insight into how to reduce environmental impact"*

3.3 Conclusion

The overview of HOMIE's business model provides an insight into what the company does currently, as to provide a starting point that can be taken into account in the development of new concepts. When creating new product or business model solutions, it is now possible to see which parts of such a new concept would require existing components of the business model, and which parts would require changes to parts of the business model.

The central value proposition of the company is also of importance to the development of new concepts, since HOMIE's values still need to be kept central in new solutions. As a result, the aspects of reliability, control, low initial costs, independence and sustainability in washing also come back in the list of Requirements *(Chapter 6)*.

4 External analysis: Competition

This chapter will describe the external environment around HOMIE, including both the company's competitors (Chapter 4.1) and the relevant trends and developments in the industry (Chapter 4.2).

4.1 Competitors

To determine which companies can be considered competitors, it is important to first determine the scope *(Figure 8)* within which competitors will be identified.

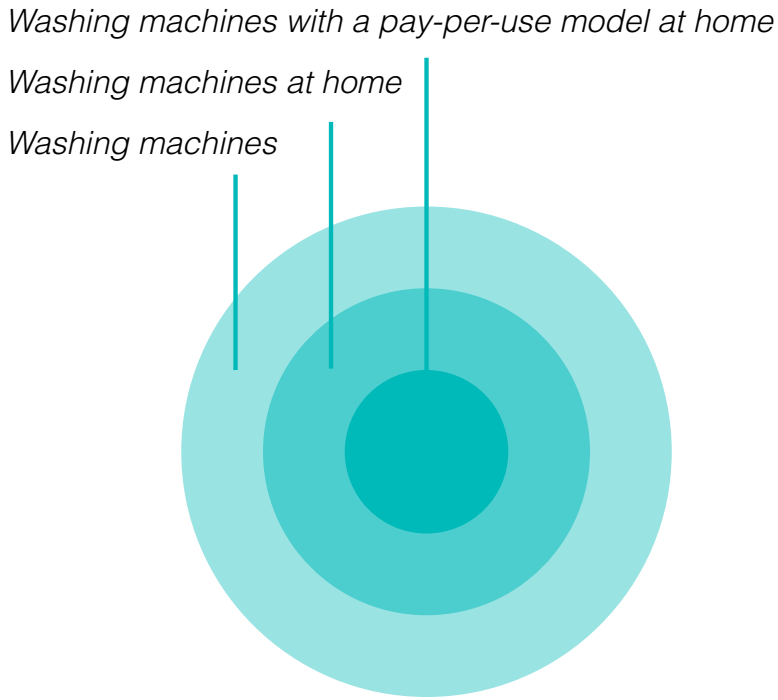


Figure 8. Product Category Scope

4.1.1 Product form competition (similar features with similar values)

For the closest circle in the scope *(Figure 8)*, companies with similar features and similar values are presented, or: companies that offer pay-per-use/pay-per-time-unit washing machines for use at home:

Bundles

Bundles is one of HOMIE's largest competitors in this competition scope. As a company with a pay-per-use element in their payment model, Bundles offers dryers, dishwashers, and two models of washing machines, both Mieles, for either a set monthly fee (Miele Classic for €20.95 or Miele W1 for €22.95), or a reduced monthly fee (€12.95 Miele Classic; €14.95 Miele W1) with an additional charge per wash (€0.40 per wash). They have a large customer base on social media. Their service also includes free delivery, installation, service and repairs. However, leaving the contract within five years will set a customer back €89.- (Bundles, 2017)

Splash

Splash offers a range of seven different washing machines for monthly fees (ranging from €11.-/month to €18.-/month), but their minimum prices are only available if customers sign up for a minimum contract length of 5 years. For shorter contracts the prices go up (a one year contract ranges from €17.-/month to €24.50/month), and there is an additional one-time fee depending on the exact duration, with a maximum €29.- for a one-year contract. Their service also includes free delivery, installation, service and repairs, and they have a customer base of 4.303 followers on Facebook. (Splash, 2017)

Other examples

Other companies within this category include Flown (Flown, 2017), Meo Lease (2017) and Skala (2017), but for the current comparison, only two of the biggest competitors are taken into account.

4.1.2 Product category competition (same product category)

The next layer of the scope is more generic, since it includes washing machines used at home, but also with classic acquisition business models where the product is simply bought. Consumers effectively get the same product that they can use at home, but these products do not present the same values as the pay-per-use/pay-per-time-unit models.

Most regular washing machine brands and points of sale fall within this category, so they will not be listed here. For the Value Curve in the next paragraph, a Zanussi ZWF71443W model is used to represent products from this category, since it is the same model that HOMIE provides to its customers.

4.1.3 Value curve

In this paragraph, the competitors listed above will be compared to HOMIE's offering to customers in a Value Curve, to provide a simple overview of how the competitors compare in repect to several criteria. HOMIE and the competitors will be compared on the topics of initial price, monthly price, convenience and water/energy efficiency. These criteria are based on the main needs of consumers in the washing machine industry, which will be discussed in *Chapter 5*.

Each company is scored on a qualitative scale of *Great, Good, Middle, Low* and *Poor,* to indicate where the differences lie between the companies. The value curve is shown after discussing the various values.

Initial price

To show the differences between the companies' business models, both initial price and monthly pricing are taken into account. The initial prices that customers have to pay for the companies' offerings are as follows:

HOMIE:	€0.-
Bundles:	€0.-
Splash:	€0.- (or €29.- for short-term contracts)
Classic business model:	€335.-

The initial price in a classic business model scores poorly, compared to the three other options. The price of €335.- listed here is what one would pay for acquiring the Zanussi ZWF71443W model that HOMIE uses. Splash is scored slightly lower than both HOMIE and Bundles, since they will ask for an initial fee in their short-term contracts.

Scores

HOMIE:	Great
Bundles:	Great
Splash:	Good
Classic business model:	Poor

Monthly price

If the average value of 3.1 washes/week for a Dutch consumer (I Prefer 30°, 2013), equal to 13.29 washes/month is used, and an average washing temperature of 40°C is used (close to the Dutch average of 41°C (I Prefer 30°, 2013)) to calculate the monthly prices of the various companies, the prices become as follows:

HOMIE:	(13.29 x €1.31)	€17.41
Bundles (Miele C1):	(€12.95 + 13.29x€0.40)	€18.27
Bundles (Miele C2):		€20.95
Bundles (Miele W1 1):	(€14.95 + 13.29x€0.40)	€20.27
Bundles (Miele W1 2):		€22.95
Splash (cheapest option):		€11.-
Splash (most expensive option):		€24.50
Classic business model:		€0.-

The extra money that users spend monthly on water and energy are not taken into account, since users have to pay those costs for all alternatives.

With these numbers, the classic business model is given a “great“ score for the monthly fee of €0.-, HOMIE and Splash are given the second lowest score for their monthly fees of €17.41 and €17.75 (average of cheapest and most expensive option at Splash), and Bundles has the highest monthly fee of €20.61 (also the average of the cheapest and the most expensive option of Bundles).

Scores

HOMIE:	Low
Bundles:	Poor
Splash:	Low
Classic business model:	Great

Convenience

Another important factor in washing machine use is convenience. To do laundry with minimal effort is a relevant benefit for consumers (as discussed in Chapter 5.3.4).
Here HOMIE, Bundles and Flown all score high since they all provide installation, maintenance, repairs for free during the entire contracts.

While in acquisition models the service might be offered by a store, this is not guaranteed everywhere.

Scores

HOMIE:	Great
Bundles:	Great
Splash:	Great
Classic business model:	Middle

Water/Energy Efficiency

Here the scores are high across the board, since all provide A+++ models and showcase sustainable mindsets in their vision. HOMIE and Bundles are the only companies with pay-per-use models though, where consumers are financially incentivised to wash more sustainably.

Bundles also sends newsletters with sustainable washing advice, like HOMIE does, so both HOMIE and Bundles receive high scores.

Scores

HOMIE:	Great
Bundles:	Great
Splash:	Good
Classic business model:	Good

Overall Scores

The Value Curve where all these scores are shown, can be seen in *Figure 9*.

The pay-per-use/lease models clearly show a contrast with the classic acquisition business model. Where the new business models provide benefit in terms of initial prices, the lack of a monthly price makes the classic business model more attractive in the long term. It is however in convenience and in energy/water efficiency that the pay-per-use models show promise.

Although HOMIE scores better than Bundles in this Value Curve due to the slightly more attractive monthly price, it should be noted that Bundles offers two different Miele washing machines, normally costing around €800.- as opposed to the Zanussi's €335.- price tag. As a result, in order to differentiate from Bundles, HOMIE should not just capitalise on the low monthly pricing, but also focus on offering increased value in terms of convenience and efficiency, since Bundles offers additional value with the high-end washing machines they offer.

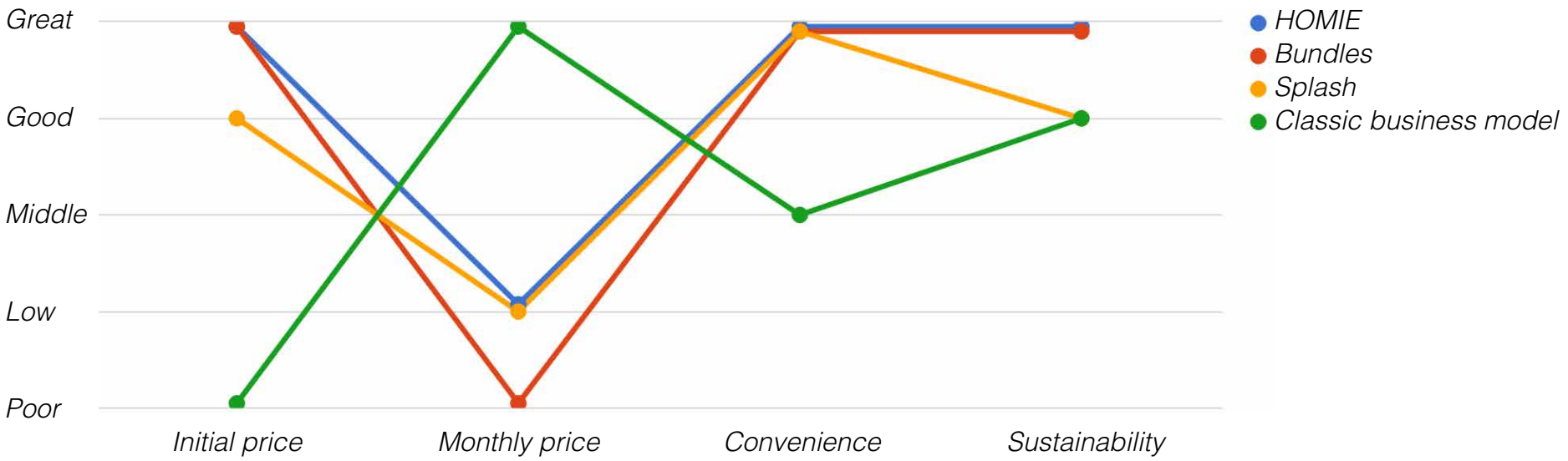


Figure 9. Value Curve

4.2 SWOT analysis

Since the goal of new concepts in this project is not solely to create more sustainable washing behaviour, but also to create value both for the customer and for HOMIE as a company, this subchapter will focus on a "SWOT" analysis.

This analysis will combine a look into HOMIE's strengths and weaknesses (SW) and a look into opportunities and threats (OT) in the laundry industry to establish areas of strategic interest for the new ideas in the Idea Generation chapter *(Chapter 7)*.

4.2.1 Strengths

- HOMIE has a close relationship with their customers (through direct contact, and feedback through surveys). This can help to build loyalty and to gain quick insight into customer needs.

- There is still a lot of adaptability to change and to experiment with new ideas due to the start-up nature of HOMIE. Since the company is experimenting with a new business model, changes can be made to further evolve and optimise the business model for the best results.

- The company is still one of the first in the field of pay-per-use washing machines at home, so the concept is still quite unique (See Chapter 4.1 for overview of competitors). There are not many competitors around in the pay-per-use segment of the washing machine market, so benefits that arise from the pay-per-use model are relatively unique to HOMIE.

- The ability to gain insight into the user washing data provides valuable insight into how the machines are used and how changes to the business model influence the usage patterns of consumers.

4.2.2 Weaknesses

- The company is still quite small, and does not have a large customer base yet. The company is still relatively unknown, and thus harder to find for new potential consumers.

- The customer only has the ability to choose a single model of washing machine, so brand loyalty to other brands or interest in specific models can discourage potential customers. Other competitors (See Chapter 4.1 for overview of competitors) do already feature more extensive product ranges.

- Since HOMIE utilises existing washing machines for their service, they currently have no influence on the product design at all.

- There is no guarantee of income for the service provider, thus creating an uncertain payback time for the washing machines. HOMIE acquires washing machines, and users pay just for the times that they employ a washing programme. The payback period can take a long time if the users do not wash very often.

- The newness of both the HOMIE brand as well as the newness of the pay-per-use payment model are both aspects that customers have little to no experience with. This could mean that customers might trust more established alternatives more, and as a result might be hesitant to choose for HOMIE.

- HOMIE currently has no presence in regular household appliance stores, and thus will not reach any potential customers that visit stores for their houshold appliances.

4.2.3 Opportunities

- In developed markets, where competition is intense and large volume growth of the market is unlikely, innovation centred around increased convenience, value and sustainability can offer competitive advantage for companies. (Nielsen, 2016)

- The role of sustainability has started to play an important role in politics (Rijksoverheid, 2017), resulting in an increased public awareness.

- The average washing temperature in Europe has dropped from 43°C to 41°C from 2008 till 2011, and the number of washes loaded at maximum volume has increased, indicating a gradual shift towards more sustainable washing behaviour. (I Prefer 30°, 2013) The decreasing temperature is supported by the Energy Saving Trust (2013) as well.

- The number of single-person households is increasing in developed markets due to higher divorce rates and increased average age at marriage. (Nielsen, 2016)

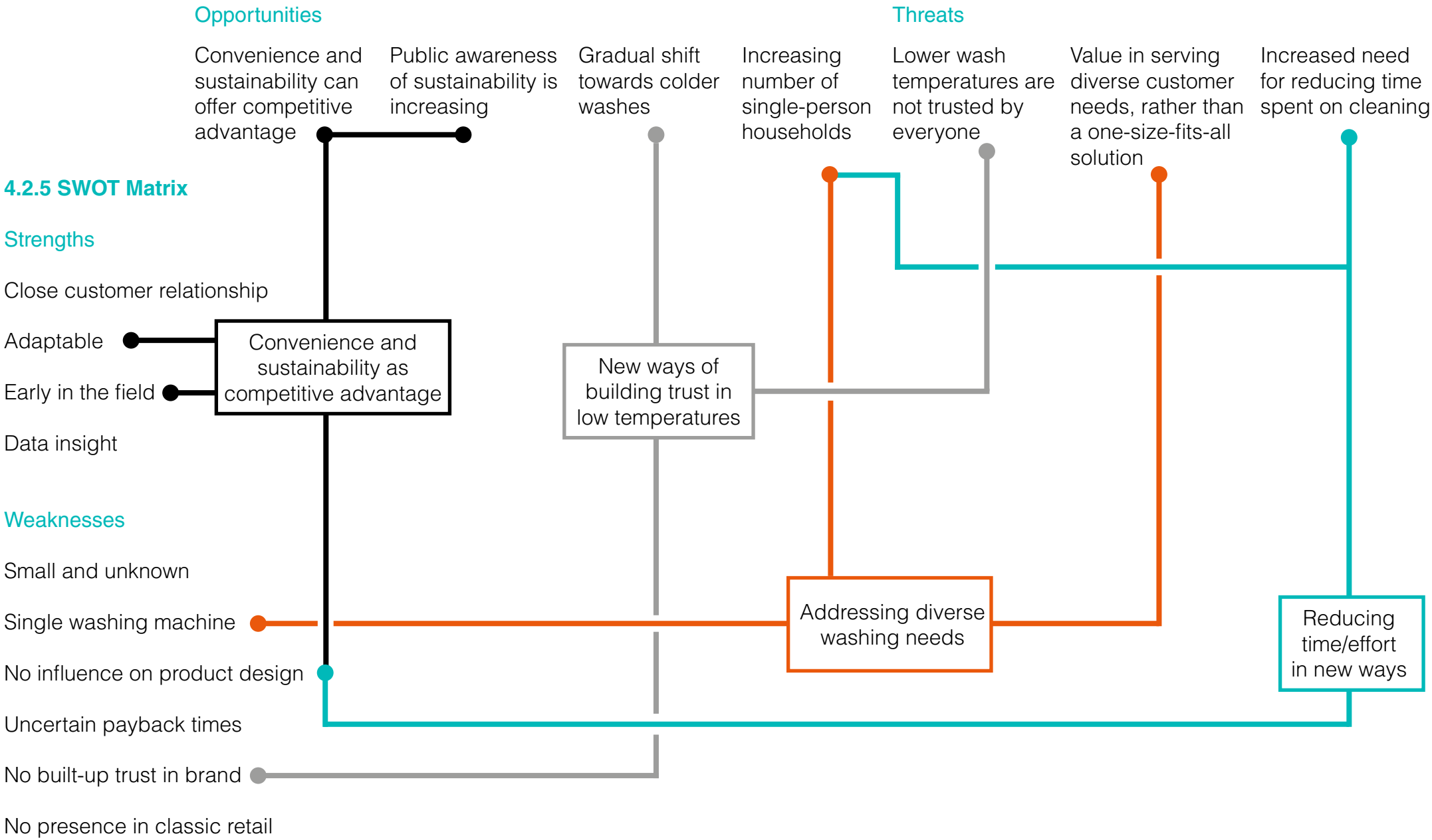
4.2.4 Threats

- Around 6 out of 10 participants in the UK study by I Prefer 30° (2013) indicated that they would consider colder washing temperatures if they felt their clothes would be clean. Only a third of the participants indicated that they would seriously consider lower washing temperatures, cleanliness being the key factor, indicating a mistrust among a number of participants of the effective cleaning results of low temperatures.

- As the result of the quick-paced lives of today's consumers, there is an increased need for products that reduce time spent on cleaning as a result. (Nielsen, 2016)

- An abundance of choice to address diverse customer needs, rather than presenting one-size-fits-all solutions, has been central to several recent successes in cleaning products. (Nielsen, 2016)

4.2.5 SWOT Matrix



4.2.5 Focus areas

Linking the strengths and weaknesses to opportunities and threats presents several areas that can be of strategic interest to HOMIE:

New ways of building trust in low temperatures

Since low temperatures are not yet trusted by everyone, and HOMIE cannot rely yet on built-up brand loyalty and trust, new ways have to be explored to generate trust in good washing performance at low temperatures.

Convenience and sustainability as competitive advantage

Although using convenience and sustainability as competitive advantage can be a valuable direction for HOMIE (see Chapter 4.1.3 too), the aspect of product design could become a more important issue when dealing with a focus on convenience, and HOMIE does not yet control the product design.

Reducing time/effort in new ways

Since one step towards sustainable washing is an increased use of the longer-running eco-programme, finding other ways to let the user save time on laundry can provide a valuable challenge for HOMIE, as the reduction of time and effort are important factors for consumers.

Addressing diverse washing needs

HOMIE currently provides only one washing machine model to its customers, in contrast to its competitors (see Chapter 4.1.3), and addressing diverse customer needs is proving successful in the current cleaning industry, rather than providing one-size-fits-all solutions.

These points are also taken into account in the Requirements chapter (Chapter 6).

5 Customer analysis

To determine the effect that HOMIE's business model already has on the washing behaviour of the customer, this section first provides an overview of average washing data from existing research, then explores the data measurements of HOMIE's customers in the past months.

The last part of this chapter focuses on gaining insight into how and why washing machine users' behaviour currently takes place the way it does.

5.1 Average washing data

To estimate how average consumers do their laundry, existing research on the topic is consulted to find out more about the wash loads, wash frequency, temperatures and water/energy consumption. Although the Literature Review *(Chapter 2)* indicated additional environmental impact factors (detergent use and efficient use of the product's parts), these are not taken into account in this current analysis. This is because there is no data available on these environmental impact factors.

Since HOMIE's consumers currently all reside in the Netherlands, data from the Netherlands is used when available in existing research, and otherwise nearby nations or European averages are used.

Wash Load

Research into European washing habits, through a 2011 survey with 5.249 respondents reporting their own washing data, revealed that roughly 68% of users fully load their washing machines when washing. Roughly 28% load their machines at 75% of total capacity, and the remaining 4% load their machine at 50% of its capacity. (I Prefer 30°, 2013)

Wash Frequency

Since household size has a very large influence on the quantity of laundry to be washed, and thus the frequency of washes, it is important here to find data that differentiates between different household sizes.

For the UK this information is available, based on self-reported data from roughly 86.000 households (Energy Saving Trust, 2013):

- 1 person household ~2.4 washes/week
- 2 person household ~3.9 washes/week
- 3 person household ~5.6 washes/week
- 4 person household ~6.8 washes/week
- 5+ person household ~8.9 washes/week

However, it should be noted that the nation household average for the UK is 4 washes per week, whereas the Dutch average lies at 3.1 washes per week (I Prefer 30°, 2013). Presuming that this difference in wash frequency average can be transposed to the averages of the different sizes of household, the Dutch values per household size would then be:

- 1 person household ~1.9 washes/week
- 2 person household ~3.0 washes/week
- 3 person household ~4.3 washes/week
- 4 person household ~5.3 washes/week
- 5+ person household ~6.9 washes/week

Temperatures

The average washing temperature in the Netherlands is 41°C, which is very close to the European average of 40.9°C. The frequency at which several temperature settings are used are listed below:

- ≤ 30°C 32.3% of all washes
- 40°C 43.1% of all washes
- 50°C 7.9% of all washes
- ≥ 60°C 16.8% of all washes

(I Prefer 30°, 2013)

Water and Energy Consumption

With an average of 50 litres of water per washing cycle (Energy Saving Trust, 2013), and the Dutch average of 3.1 washes per week (I Prefer 30°, 2013), the weekly water consumption should come to 155 litres of water per week, equaling 674 litres per month or 8.082 litres per year.
The aforementioned washing behaviour results in a yearly household energy consumption of 96.6 kWh in the Netherlands, or 8.05 kWh per month (I Prefer 30°, 2013).

5.2 Data from HOMIE's customers

The goal here is to establish whether over the course of being a customer at HOMIE, the washing behaviour of the customers has actually changed, and whether that change is significant.

The goal of the intervention emails (as described in Chapter 3.1.1) was after all to motivate sustainable washing behaviour (as identified in Chapter 2.2.1), by

- Increasing washing loads/decreasing the number of washes
- Reducing washing temperatures
- Reducing detergent use

The last point that was identified (making optimal use of the washing machine's parts) is not listed for this part of the research, since HOMIE's business model does not aim to tackle that point through consumer behaviour, but through maintenance and refurbishment of the machines in the pay-per-use model. Secondly, there is no data available on the amount of detergent that consumers use, so this part of the research cannot provide insight into whether detergent use has changed over time.
For the other points, the effect of more sustainable consumer behaviour should result in decreased water and energy consumption. An additional point of interest is the use of the eco-programme, which provides an alternative to high temperature settings by utilising longer soaking times rather than heat and movement to increase cleaning effect.

As a result, the question here is: do the current intervention emails influence the users in how sustainable their washing behaviour is, and can that effect be considered significant?

5.2.1 Method

Before people started washing with their HOMIE washing machine, they were asked in a short survey (See Appendix C) how often they generally did laundry, which programmes they used and at which temperatures. These surveys provide the necessary information to determine washing frequency and average washing temperatures of the users, before they became customers of HOMIE.

When they were washing as customers of HOMIE, all their washing data was of course sent to HOMIE, since this is also necessary for the pay-per-use payment system (as described in Chapter 3.1). Each month, for each user the number of washes was determined, as well as the programmes they used. Research has already been conducted at HOMIE to determine the amount of energy and water that is used for the different washing programmes of HOMIE's washing machines (see Appendix D). Combining these measurements with the monthly data on which washing programmes were used by the users, the monthly water and energy consumption of the users has been determined, and this data has also been presented to the users in their monthly mailings.

This data (number of washes per month, eco programme use, washing temperatures, water and energy consumption) was input into data analysis software programme SPSS for a Repeated Measures ANOVA Analysis, to see whether there are significant differences (significance value below 0.05) in how the values for the environmental impact factors change over time.

The Repeated Measures ANOVA is chosen here due to the fact that each month, data is gathered from the same participants, and the Repeated Measures ANOVA can check for how the data develops over time in the values of specific participants, rather than viewing all data points as being unrelated to each other.

The number of subjects (consumer) taken into account in the tests varies slightly (from N=18 to N=20) since the Repeated Measures ANOVA removes a subject from the analysis entirely if one or more data points are missing for that subject.

The data is categorised into different months:

- Month 0: This month represents the data on how users did their laundry before they became customers at HOMIE. There is only data available for frequency and temperature in this month, since this data is based on self-reported values from the short interview at the installation of the HOMIE washing machine.

- Month 1: This month represents their first month of washing at HOMIE, for which the users did not have to pay

- Month 2: This represents the first period of time that users have to pay for their washing, but still before the first user mailing.
  Since user mailings are sent at the beginning of each calendar month, the number of days that "Month 2" entails actually differs per user. For example: if a user becomes a HOMIE customer on the 10th of March, he/she will start paying for washes from the 10th of April onwards, and will receive the first mailing at the start of May, only having had 20 days of paid washing in April. To compensate for this difference in time period over which the data is measured, the data is multiplied by a factor to match a 30-day month.

- Month 3: This month represents the calendar month following the first user mailing (the washing data).

- Month 4: This month represents the calendar month following the second user mailing (comparison of washing data with the data from the previous month).

- Month 5: This month represents the calendar month following the third user mailing (comparison of washing data with average data from Dutch washing machine users)

- Month 6: This month represents the calendar month following the fourth user mailing (proposing a sustainable washing goal)

- Month 5: This month represents the calendar month following the fifth user mailing (comparison of most used washing programme with a more sustainable one)

The subsequent months are not taken into account in the analysis, since washing data is not yet available in those months for all HOMIE customers.

5.2.2 Results

Frequency (N=18)

The differences from month to month for wash frequency produced significant results.

The test produced a significant Greenhouse-Geisser value (Sig.=0.01), (used because the sphericity assumption was not met).
The wash frequency rose significantly after users became customers at HOMIE (Month 0 > Month 1), before dropping down significantly after customers started paying for the washes (Month 1 > Month 2).

After receiving the intervention mailings the values did not change significantly (Month 2 - Month 7).

	Sig.
Month 0 (11.1) > Month 1 (15.1)	0.036
Month 1 (15.1) > Month 2 (10.3)	0.002

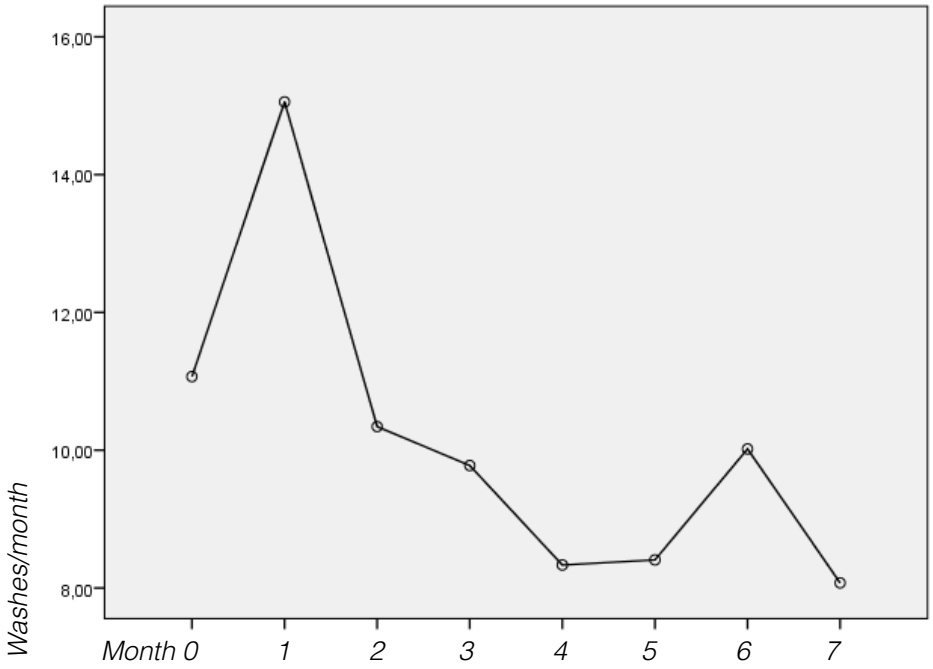


Figure 10. Frequency

Eco programme (N=19)

There were no significant results in the month-to-month differences in the use of the eco programme.

The test produced an insignificant Greenhouse-Geisser value (Sig.=0.774), (used because the sphericity assumption was not met).

	Sig.
Month 1 (0.705) > Month 2 (0.538)	0.044

Temperature (N=17)

The temperature did not change significantly in the analysis.

The test produced an insignificant Greenhouse-Geisser value (Sig.=0.174), (used because the sphericity assumption was not met).

Water consumption (N=19)

Water consumption showed a significant drop between Month 1 and Month 2, after customers had gone into their first paid month at HOMIE.

The test produced a significant Greenhouse-Geisser value (Sig.=0.01), (used because the sphericity assumption was not met).

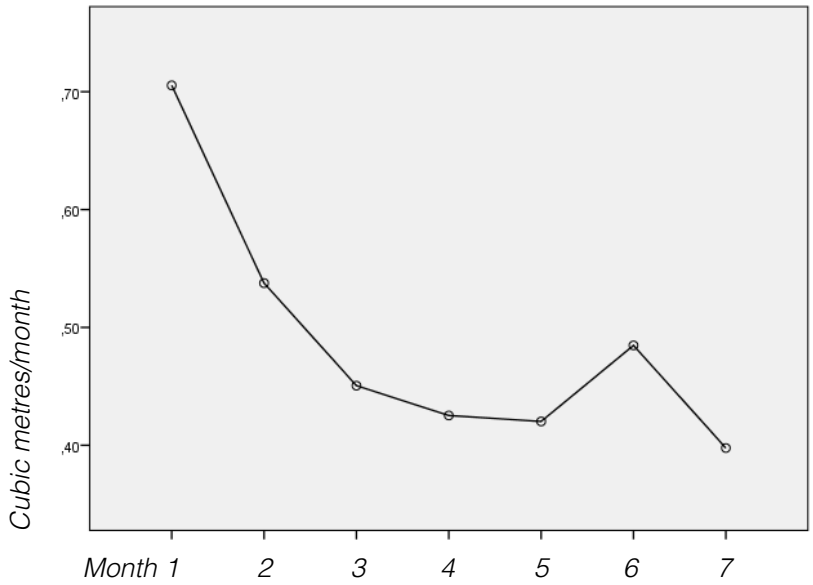


Figure 11. Water consumption

Energy Consumption (N=19)

Energy usage showed a significant drop after customers had gone into their first paid month (Month 1 > Month 2).

The test produced a significant Greenhouse-Geisser value (Sig.=0.001), (used because the sphericity assumption was not met).

	Sig.
Month 1 (8.59) > Month 2 (6.50)	0.019

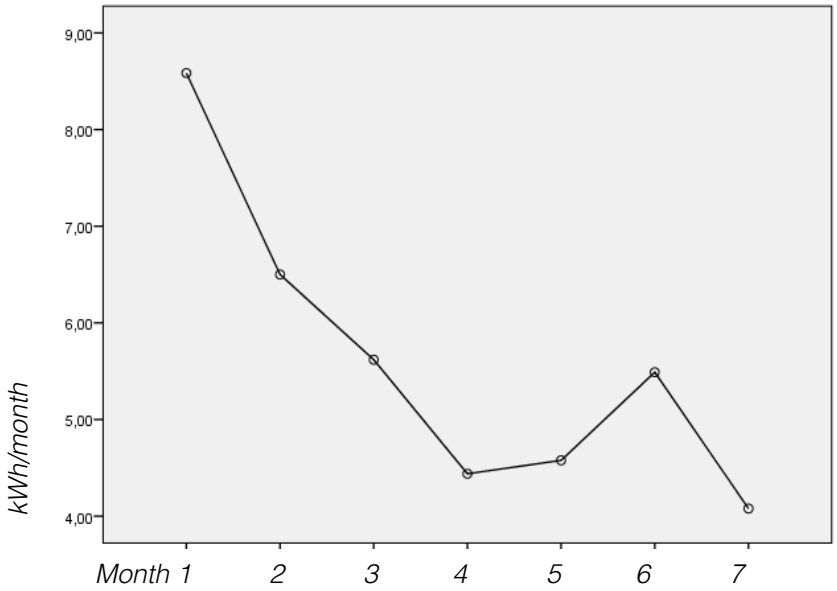


Figure 12. Energy consumption

5.2.3 Conclusions

Differences between different months

The most significant change in washing behaviour in the current data happens between month 1 and 2, so after customers start paying for their washes at HOMIE. The three variables that produced significant results were frequency, water consumption and energy consumption. Since the wash frequency directly influences the amounts of water and energy that are consumed, it makes sense that these three variables move analogously, and it suggests that the month of free washing motivates customers to simply do more laundry.

The steep and significant rise in wash frequency between month 0 and 1, when customers have joined HOMIE, might support the assumption that the free month promotes a higher washing frequency, but it should be noted that the value for month 0 is self-reported rather than measured, so it may in fact not be as accurate as the rest of the data.
Interestingly, the two variables that are promoted most in the user mailings, the temperature and the use of the eco-programme, show no significant changes at all.

In conclusion, the current user mailings do not seem to create a significant change in washing behaviour, but during the month of free washing, the wash frequency is significantly higher.

On the nest page, the European wash load averages (Figure 13), the contrast between the Dutch average temperature and the temperature average of all HOMIE washes (Figure 14), and the wash frequency of Dutch households and HOMIE households throughout the months (Figure 15) are shown.

Figure 13. Wash loads (Europe)

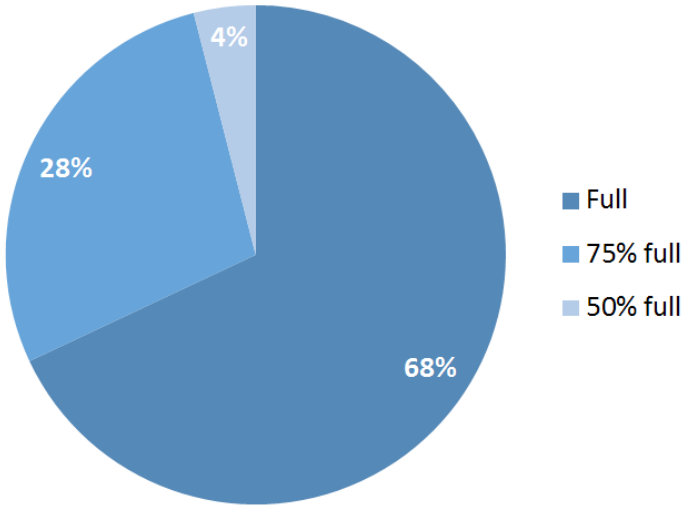


Figure 14. Average temperature (NL & HOMIE)

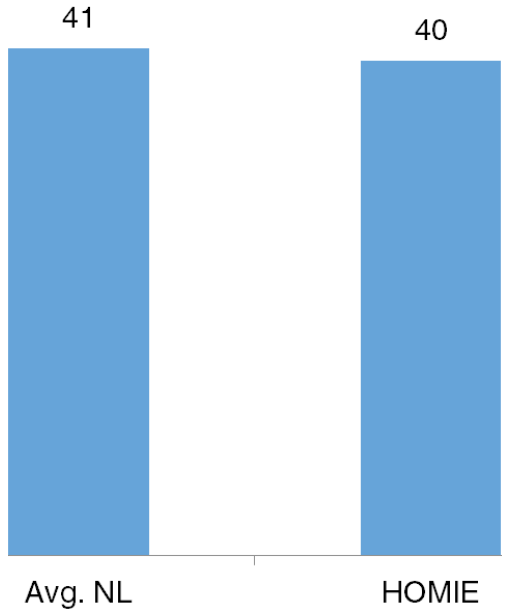
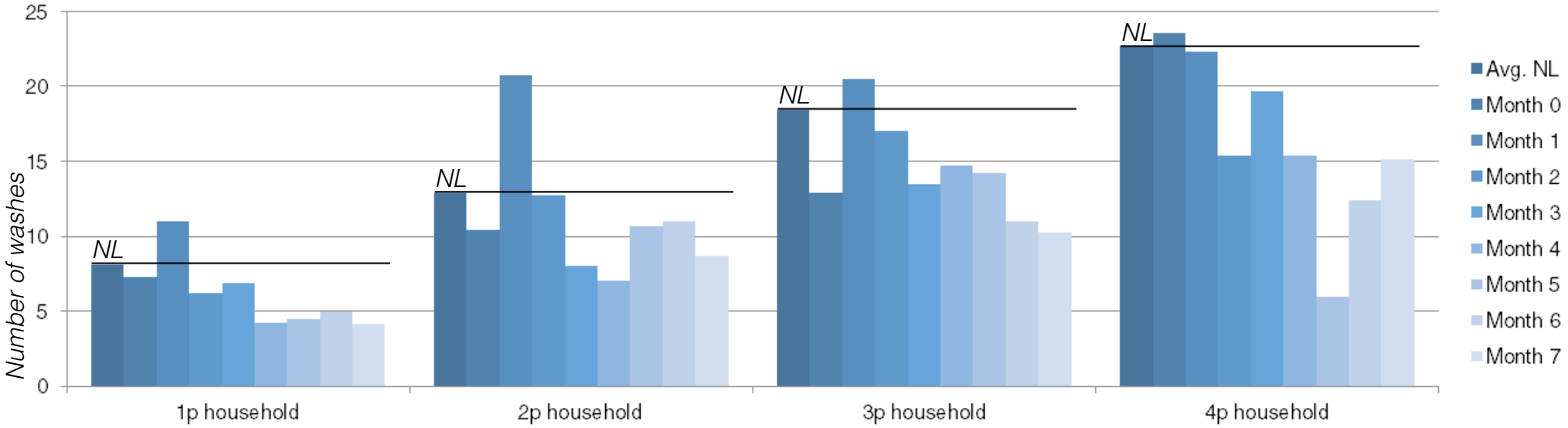


Figure 15. Wash frequency NL (overall value) & HOMIE (per month)



Differences between the Dutch average and HOMIE

Although there is no insight on the wash loads or detergent use of HOMIE customers, the wash frequency, washing temperatures and efficient use of the washing machine's parts can be compared.

Wash frequency

Using a one-sample T-test, the Dutch average wash frequency was compared with HOMIE's customers' wash frequencies:

- The Dutch average number of washes per month lies at a value of M=13.3.
- The differences between HOMIE customers' self-reported data on their wash frequency from before joining HOMIE, and the Dutch average, are not statistically significant (Sig.=0.307)
- The differences between the monthly wash frequencies of customers when washing at HOMIE (M=11.1), and the Dutch average (M=13.3), are statistically significant (Sig.=0.004) (Figure 16)

The fact that the difference between the Dutch average and the customers' pre-HOMIE average is not significant, and the difference between the Dutch average and the customers' at-HOMIE average is significant, tells us that HOMIE's business model does have a significant impact on reducing customers' wash frequency.

A significant rise in wash frequency occurs among HOMIE customers going into their free month of washing, rising from M=11.1 to M=15.1, the only month with a higher mean than the Dutch average, and a significant drop takes place directly after, when going into the first month of paid washing (M=10.3). These are the only months between which there is a significant difference.

What this tells us is that the payment model does have a significant impact on the customers' wash frequency, but the individual mailings throughout the months do not.

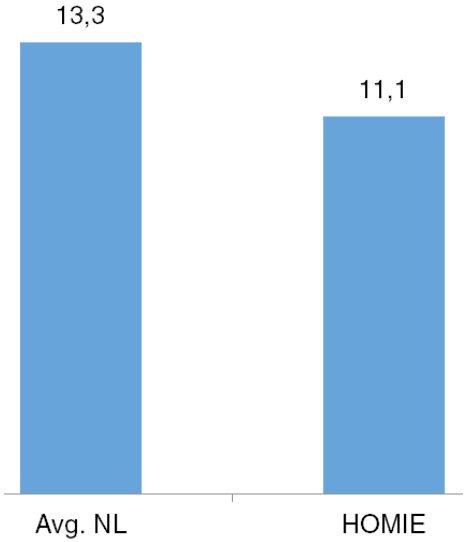


Figure 16: Average wash frequency (NL & HOMIE)

Temperature

Using a one-sample T-test, the Dutch average washing temperature was compared with HOMIE's customers' wash frequencies:

- The Dutch average washing temperature lies at a value of M=41.
- The differences between HOMIE customers' self-reported data on their washing temperatures from before joining HOMIE, and the Dutch average, are not statistically significant (Sig.=0.979)
- The differences between the monthly wash frequencies of customers when washing at HOMIE (M=39.9), and the Dutch average (M=41), are statistically significant (Sig.=0.046) (Figure 17)

The fact that the difference between the Dutch average and the customers' pre-HOMIE average is not significant, and the difference between the Dutch average and the customers' HOMIE average is significant, tells us that HOMIE's business model does have an impact on reducing customers' washing temperatures.

No significant changes occur between different months of washing at HOMIE, so the monthly mailings seem to have no significant effect on the washing temperatures.

Making optimal use of the machine's parts

Although there is no statistical analysis related to the factors of sharing washing machines, proper maintenance and recycling, HOMIE's business model does guarantee that washing machines are properly maintained to lengthen their lifespan, and they move on to new customers if a previous customer ends the contract with HOMIE. HOMIE's business model guarantees these factors, whereas regular ownership models do not, so the washing machines' lifespan is increased.

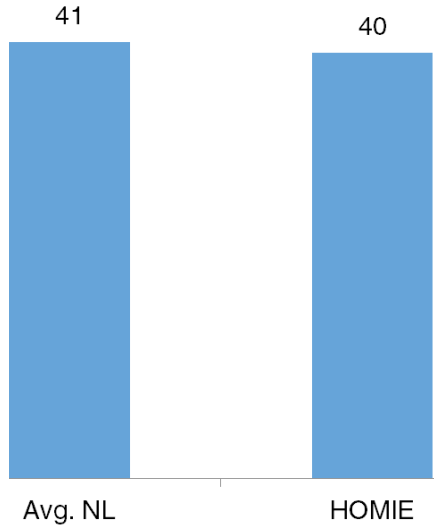


Figure 17: Average wash temperature (NL & HOMIE)

Overall conclusion

Although little can be said concerning HOMIE's effect on wash load sizes and detergent use, the current business model does have a statistically significant positive effect on both the wash frequency and the washing temperature. Both HOMIE's average wash frequency and wash temperature have significantly lower values than the Dutch average.

The only statistically significant difference in wash frequency between different months of washing at HOMIE, takes place around the month of free washing. The free washing month creates a spike in the wash frequency data, but there are no significant differences between other months and no significant differences between the temperatures throughout the months.

This suggests that the monthly feedback mailings to HOMIE's customers seem to have no significant effect on the customer behaviour (since that would result in more significant differences between the different months), whereas the payment model does have a significant influence on the washing behaviour (which is shown by the overall effect on wash frequency and temperature, and the significant rise in frequency during the free month).

5.3 Current use processes - interviews

In order to be able to form new behaviour in washing machine use, there has to be an understanding of how and why the old behaviour occurs. Literature already provided insight into which factors influence the environmental impact of washing machine use, namely: wash load, wash frequency, washing temperature, detergent use and efficient use of the product's parts. (Bourrier et al., 2011) (Koerner et al., 2011)
However, literature does not tell us why people go for certain unsustainable behavioural patterns. To better understand current unsustainable customer behaviour, interviews were conducted to find out how decisions are currently being made by washing machine users. The goal of these interviews was to discover where in the use process the participants currently make unsustainable decisions, to find out the reasons why they make those decisions, and to understand what positive outcome they get out of those decisions.

Based on Tang's (2010) model from the Literature review (Chapter 2.2.2), the interviews focused on establishing participants' currently held knowledge and beliefs related to sustainability in washing, experienced social norms and self-concept (their own envisioned role in creating the impact), and current use patterns.

The outcomes are used to establish when moments of unsustainable washing behaviour currently take place, and to find out how and why they take place, in order to identify potential opportunities for creating more sustainable washing behaviour.

5.3.1 Method

Interviews were chosen as the research method because it was necessary to find out participants' motivations and reasons behind their behaviour. These insights cannot easily be gained from a questionnaire, since there the researcher cannot ask further in order to find out more about motivations behind answers. A setting like a focus group, with multiple participants being part of the discussion at once, can sometimes help to get people to bring up new ideas and insights in each other, but also runs the risk of participants conforming to a group's opinion, whereas here it is important to find out a participant's own personal reason that he/she goes through a specific behaviour when doing the laundry.

Nine participants were interviewed in total for this part of the research. Participants were chosen to fit with HOMIE's three customer segments: participants who are only staying in their current living location for a short while, participants who consider low costs the most important aspect of choosing a washing machine, and participants who pursue a sustainable lifestyle.

For each of the three groups, three participants were selected, of whom one would be a HOMIE customer and the other two were not, in order to get insights from both participants who already receive intervention mailings and use a pay-per-use model, as well as from participants who are not influenced by those factors.

An interview guide was used to interview the participants (included in Appendix E), and the interviews took up 15-25 minutes each. Seven of the interviews were conducted by phone, the other two in person, and the audio of all the interviews was recorded, either using a mobile phone, or using a microphone plugged into a laptop to record the phone conversations.

5.3.2 Results

The interviews were summarised shortly after conducting them as can be seen in Appendix F, by listening to the recordings and writing summaries along with them. The participants' current laundry processes were established by listing every decision made in the washing process. Additionally, their knowledge and experienced social norms concerning sustainability were also listed, as well as the wash results they considered the most important.

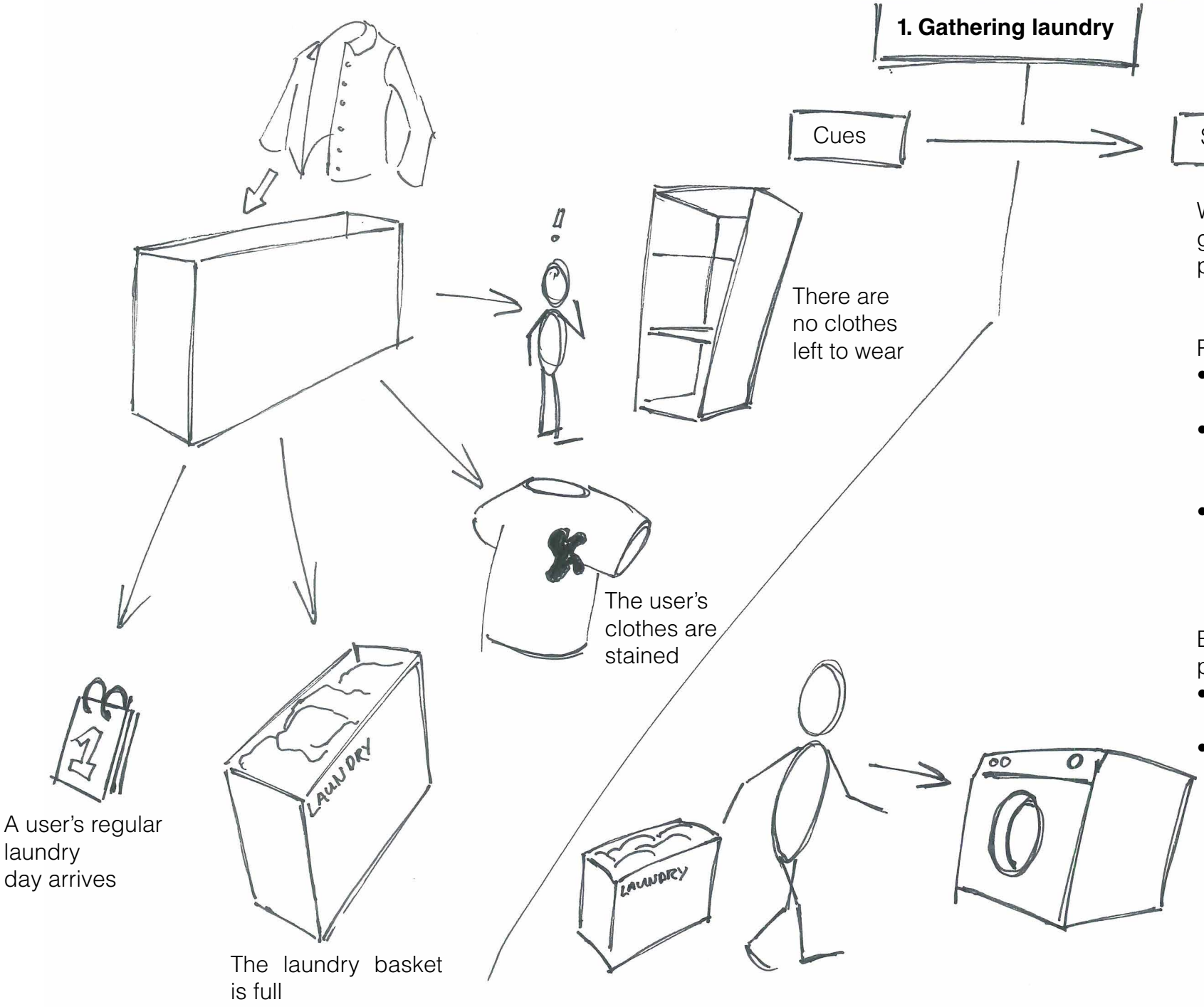
All participants were able to describe a regular laundry process that they would always use and that they had been using for an extended period of time, indicating formation of habitual patterns. As a result, the cues, scripts and experienced outcomes, due to their important role in how habits are formed and can be influenced (as discussed in Chapter 2.2.2) are the main outcomes presented in this results section.

The processes were divided into several steps to indicate where in the use process each use decision is made and which habitual cues, scripts and experienced outcomes take place in that use process step.

These process steps are:

- Gathering laundry - the ongoing process of gathering laundry, up to the moment that the participant decides to bring the laundry to the washing machine
- Preparing the wash - the part of the process where the machine is filled with laundry and detergent is added
- Starting the wash - the process step of selecting the washing programme and starting it
- During the wash - starting from when the wash is started, up to the moment that the user comes to collect the laundry from the machine
- After the wash

Various unsustainable behaviours were identified in these steps of the use processes. On the following pages, overviews are visualised of which cues, scripts and outcomes take place in the use process steps, so that these can be utilised in the Idea Generation process (Chapter 7) to create ways to change user habits towards more sustainable behaviour.



With the current amount of gathered laundry, the washing process is started.

Positive outcomes:

- The user can wash whenever is convenient
- The user does not have to bother about laundry until it is necessary
- Stains are cleaned quickly, so they have no lasting effects

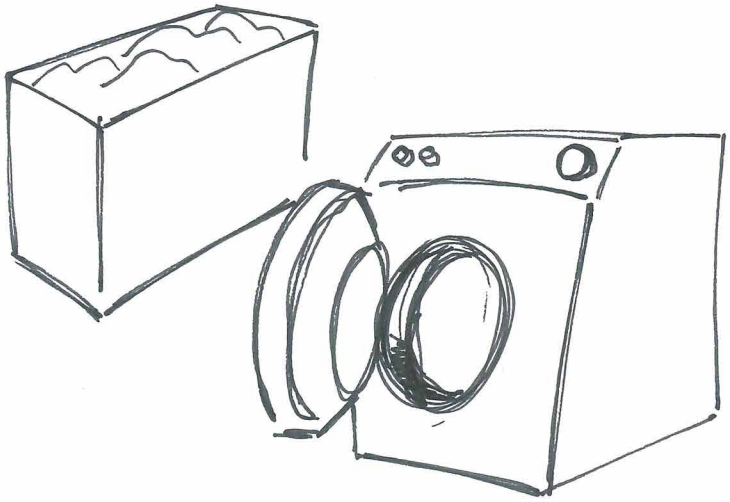
Environmental impact potential:

- Decreasing wash frequency
- Increasing wash loads

2. Preparing the wash

Cues

The laundry has been brought to the machine



The machine has to be filled

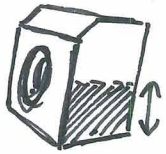
The detergent has to be added

Scripts

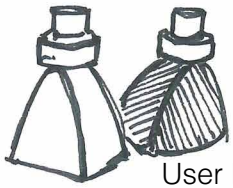
Clothes are separated

Clothes are not separated

The machine is filled until it is entirely full



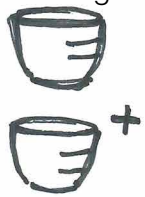
Space is left open inside the machine

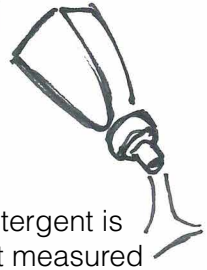


User has various detergents

The user uses a single detergent

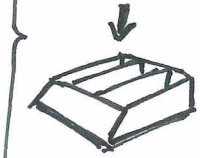
Recommended dose detergent





Detergent is not measured precisely, or more than recommended is used on purpose

Detergent cup is added to laundry directly



Detergent is poured into the detergent tray

Positive outcomes:

- Washing with a full machine? The user does not have to do laundry as often
- Not a full machine? Planning is more convenient
- Separating clothes: the clothes will last longer
- Not separating clothes: less bother for the user
- More detergent provides a fresh smell
- Less detergent is both cheaper and creates less waste
- Not measuring detergent precisely is easier and more convenient

Environmental impact potential:

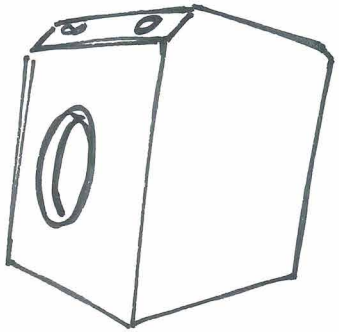
- Increasing wash loads
- Better colour/clothes preservation
- Less detergent use

3. Starting the wash

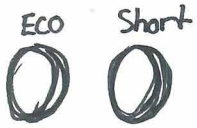
Cues

Script

The loaded machine has to be started



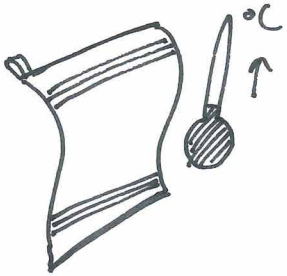
A temperature has to be selected



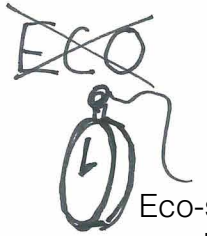
A programme has to be selected

Low temperature is used for regular washes

Low temperature are not trusted to be effective, 30/40 degree is minimum



Towels, dishcloths and bed linens are always washed at high temperatures



Eco-settings are never used due to the extra time it takes

Positive outcomes:

- The laundry is fresh and clean after washing
- The user feels the laundry is fresh and clean after washing
- Using high temperatures instead of the eco-setting for thorough washing takes less time and requires less planning.

Environmental impact potential:

- Lower temperature settings for regular washes
- Increase use of the eco-programme for thorough washes
- Lower temperature settings for thorough washes

5.3.3 User needs

Additionally, participants were also asked what the main results were they sought after when doing the laundry, and these are incorporated into the Requirements in Chapter 6.

All nine participants mentioned effective cleaning of the laundry as a main aspect they sought when doing laundry.
Seven of the participants mentioned that a good smell from their finished laundry was one of the main results they look for in the end result of their wash.
Finally, good colour preservation of the laundry was mentioned as an important factor by two participants.

5.3.4 Other research on user needs

These three aspects are all very much related to wanting effective washing results. Other research on the topic of consumer's needs in the washing industry shows that the factors of convenience and efficiency are also high on consumers' list of important washing needs.

Nielsen (2016) lists product performance, convenience, efficiency and product choice as main consumer needs for cleaning products in general, based on a global survey with over 30 000 participants.

Euromonitor International lists efficiency (in water and energy usage) as the top factor found important by participants in their worldwide survey, followed by factors related to convenience (Baus, 2015).

In the survey for new HOMIE customers (Appendix C), the answers most often mentioned when asking for washing needs were also related to convenience, efficient washing and effective washing.

As a result, the list of Requirements (Chapter 6) also incorporates these consumer needs of convenience, effective washing and efficiency in washing.

6 Requirements

Based on the gathered information from previous chapters, this chapter lists the requirements (6.1) and wishes (6.2) for the new concepts. The concepts have to fit with the list of requirements. The wishes are used to compare concepts with each other, in order to determine which one fits the criteria for this project the best.

6.1 Requirements

The concept should focus on reducing excessive consumption patterns of washing machine users (Chapter 2.1.1), which entails the following points:

- The concept should improve (see next requirement for explanation) one or more of the following environmental impact factors (Chapter 2.2.1):
    - Increasing wash loads: stop users from under-filling the washing machine
    - Decreasing washing frequency: stop users from washing more often than necessary
    - Decreasing the used temperatures: stop users from using higher washing temperatures than necessary
    - Decreasing detergent consumption: stop users from using more detergent than needed
    - Making more efficient use of the product parts: increase the number of users that make use of a single washing machine
- Since the current washing behaviour of users can be considered to be developed habits (Chapter 5.3), the concept should, in relation to the aforementioned environmental impact factors, accomplish one or more of the following points (Chapter 2.2.2):
    - Remove the habit script: make an unsustainable habit impossible to conduct
    - Replace the habit cue: change the environment in which an unsustainable habit is performed in such a way that it removes the cue that currently initiates the habit, and provide an environment that motivates the repeated performance of sustainable behaviour over time
    - Replace the experienced outcomes of the habit: remove the positive outcomes that users experience from conducting unsustainable habits, and provide positive outcomes for sustainable behaviour
- In order to influence the habit cues, scripts and experienced outcomes, the concept should use one or more of the following intervention methods to create the desired change (Chapter 2.2.2):
    - Eco-information: provide the user with insights on the environmental impact
    - Eco-choice: provide the user with a clear, sustainable option
    - Eco-spur: guide the user towards sustainable behaviour using reward and punishment
    - Eco-steer: use constraints in the product design to guide the user towards sustainable behaviour

    - Eco-technology: use technology to automatically persuade and control the user's behaviour
    - Clever design: make the user act sustainably without the user's awareness or active choice

The interventions are ordered starting from interventions where decisions are still user-led, to those where the product leads the use decisions.

- The concept and its intervention in the user behaviour have to be accepted by the user. To make this possible, the user has to be motivated to accept the intervention, and for this the concept has to stay centred around the central values for the user (Chapter 2.2.3). This means the concept should offer the user benefit related to the following factors:

    - The concept has to create an apparent positive impact on the environmental impact (Chapters 4.1, 4.2, 5.3.4)
    - The concept has to increase the experienced convenience of the washing process, by saving the user time and/or effort (Chapters 4.1, 4.2, 5.3.3)
    - The concept has to assure the user of effective washing results, including certainty of clean and fresh laundry, preservation of colours (5.3.3), and the certainty that specific items (towels, dishcloths, bed linen) undergo intensive cleaning (5.3.2)

- In order to compete with other businesses in the pay-per-use washing machine sector, HOMIE's price per single wash should not exceed €1.55 (which is the highest average price per wash among the analysed competitors: Bundles's monthly €20.61 divided by 13.29 washes per month) (Chapter 4.1.3).

- In terms of feasibility, it should be possible for HOMIE to actually create the new concept. If it is not yet possible to create the new concept within HOMIE's current business model (Chapter 3.1.2), then the concept should present a solution on which new resources could be acquired or partnerships could be created to make the new direction possible.

- To fit with HOMIE's value proposition (3.1.1), there are several other requirements for the concept:

    - Reliability: to ensure that the user always has a working product, the installation, repairs and replacements are offered for free, when necessary
    - Control: to ensure that the user is in control of the washing costs, there are no additional fees, unexpected costs or initial costs apart from the price per wash
    - Low initial costs: there are no initial costs for the user
    - Independence: the user is not bound to long-term contracts or other obligations, and after an initial period of six months the user can end the contract
    - Sustainability: apart from the sustainability elements mentioned in the other requirements, washing machines in the concept have to have an A+++ energy label

6.2 Wishes

- To create a higher degree of certainty that there will be a significant influence on the environmental impact, the design interventions should focus on product-led decision making as much as possible, while still being accepted by the user, since users are less likely to accept the design interventions when choices are taken away from them. (Chapter 2.2.3)

- The concept should have an impact on as many of the environmental impact factors as possible. (Chapter 2.2.1)

- The break-even point in the concept's cash flow should come as early as possible: since the user does not pay for the ownership of the product but for each wash, the revenue will take a period of time before it breaks even with the investment costs per washing machine. A concept with lower investment costs will reach a break-even point and generate profit for HOMIE earlier.

7 Idea generation

This chapter will discuss the process through which this project's main concepts were developed.
The idea generation process took place in three main phases. For each phase the used idea generation methods will be discussed, followed by some of the ideas developed during that phase.

7.1 Phase 1: Three idea directions

Methods used

The first round of the idea generation process started off with basic brainstorm sessions using "How-To" questions to establish ways of improving the environmental impact of the use process. "How-to" statements such as "How to get users to lower the temperature when starting the wash" were used for the idea generation. During one of the early sessions, two other TU Delft design students also joined in with the idea generation process to broaden the range of ideas.

The generated ideas were then categorised, in order to establish an overview of what kind of broad directions could be further explored. This categorisation happened based on which "delivery method" the ideas employed to motivate users towards more sustainable behaviour. In other words: which physical medium did the idea make use of to deliver the behavioural interventions?

For each of those "delivery methods", morphological charts were made where all ideas linked to a single delivery method were listed. On these charts, the separate ideas were arranged by which environmental impact factor they targeted.

The morphological charts were then used to combine the ideas in such a way that the delivery method would apply to as many environmental impact factors as possible.

Developed ideas

The very first ideas were solutions for specific parts of the design problem, and aimed to tackle only one environmental impact factor at a time.

A broad range of ideas was established, ranging from, for example, ways of providing users with feedback to introducing new service models.

When the ideas were being categorised, three large categories emerged, centred around three design intervention "delivery methods":

- Delivering the intervention through an app
- Delivering the intervention using the washing machine's tracker
- Delivering the intervention through the design features of the washing machine

Within each of the categories, ideas were combined to target as many environmental impact factors as possible, and the main outcomes of this phase are shown on the following page.

Main ideas from phase 1:

App (Figure 18)

The first idea direction brought ideas together that would only require the use of an app. A scheduling tool linked to a user's personal calendar would pick quiet times in the user's schedule to plan an ECO-wash. After starting a wash, the app would immediately send the user information on the environmental impact of the wash. Finally, the app would show the user a comparison of the washing programme he/she had chosen, and another, more sustainable one.
These ideas were chosen to strengthen the effect of the feedback by providing it directly after selecting a wash, compared to the current user mailings which take place at the end of the month.

Figure 18

Tracker (Figure 19)

The second idea direction made use of the fact that HOMIE currently already installs trackers in the washing machines. Connecting the tracker to the outside of the machine, and adding a screen to it, would provide an opportunity to give feedback during the choice process of the user, rather than sending it afterwards. By combining this idea with a washing machine that already features a weight sensor, the screen could show the user how much more laundry could still be added before the drum would be full. While selecting a washing programme, the screen would immediately show the environmental impact of each programme on the screen. The background would gradually change colour from green to red as increasingly unsustainable programmes would be chosen.
These ideas were combined to change the on-site cues for the user, and add new cues directly at the decision making moment, to discourage unsustainable behaviour.

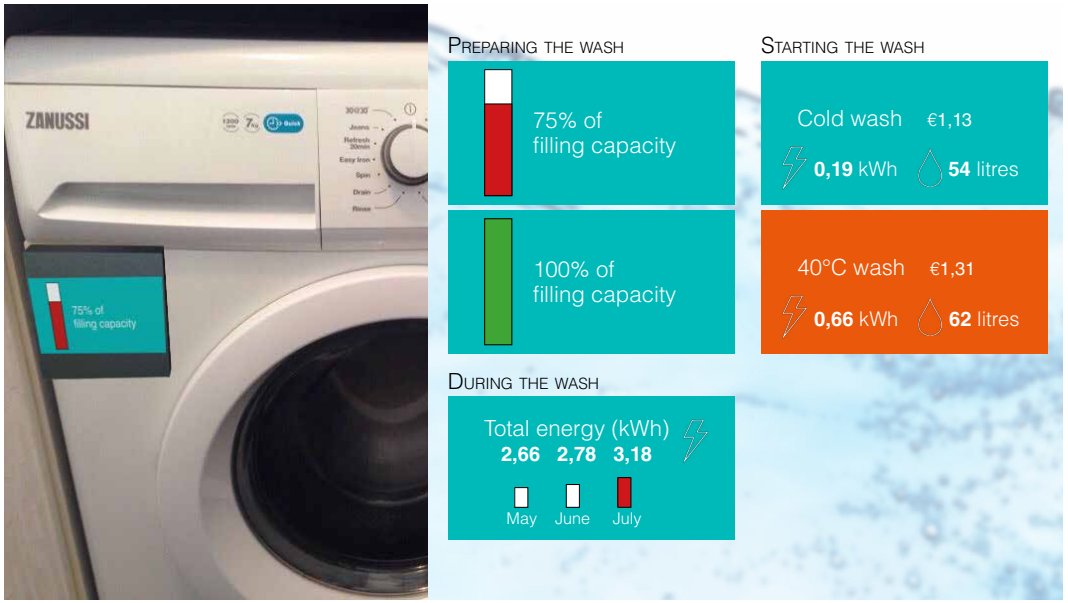


Figure 19

Changes to the washing machine (Figure 20)

The third direction made use of the product design of the washing machine itself to enhance sustainable behaviour and making the use decisions more product-led.

An automatic detergent tray enabled the user to start a wash without adding detergent, since the machine would feature a detergent holding compartment that would automatically dispense an efficient amount of detergent. When starting a wash with an under-filled drum, a red light would blink and the user would have to push an additional confirmation button to allow an under-filled wash to start. The ECO-mode would automatically be engaged, and the user would now have to make the active decision to disengage it. The screen would feature similar feedback to the tracker concept. Finally, an adapted laundry basket would be offered alongside the product, featuring several compartments with the same volume as the washing machine's drum. This would allow the user to easily see whether they had gathered enough laundry to fill the drum.

These ideas were combined to create a solution that provided more intrusive design interventions compared to the other two ideas.

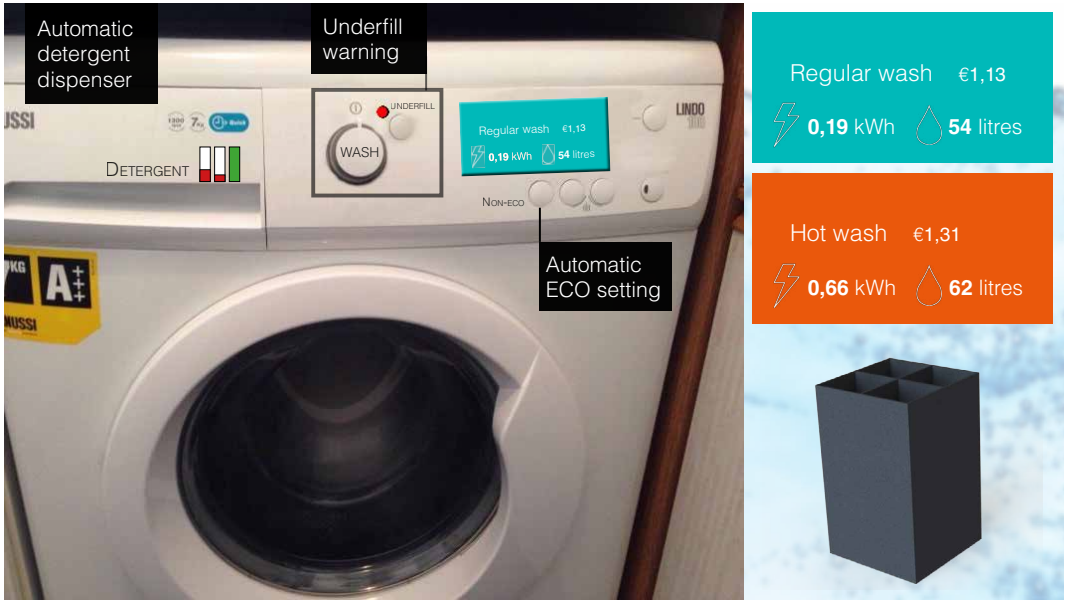


Figure 20

7.2 Phase 2: Three entirely new directions

Methods used

After evaluating the ideas from the first idea generation phase, it became apparent that a new iteration in the idea generation process was needed. The ideas from the first phase were mainly centred around providing feedback. However, one of the main findings from the literature chapter (Chapter 2) was that feedback on its own has often proven itself to be inadequate in creating actual behavioural change, so a broader range of ideas was needed.

As a result, the second phase of the idea generation started off with a creative session. Roughly 120 people participated as part of an employee activity day the 6th of July 2017 at the faculty of Industrial Design Engineering at the TU Delft. The time span of the creative sessions was determined in advance by the faculty to be roughly 20 minutes. The 120 participants were split up in four groups, and each group would have a single 20 minute session. In groups of five, the participants were briefly told about HOMIE's business model and what sustainable washing behaviour entails. They were then asked to come up with as many ways as possible on how to motivate washing machine users towards more sustainable behaviour, and to try to come up with as broad a range of ideas as possible.

The ideas that resulted from this session were transcribed and categorised. After filtering out the categories that corresponded to ideas that had already been thought of in the first phase of this idea generation, the new ideas from the creative session were later on used as extra input during brainstorm sessions.

To broaden up the scope of the ideas, various delivery methods of the interventions were explored (figure 21) to think of more varied ways of creating interventions in the use processes.

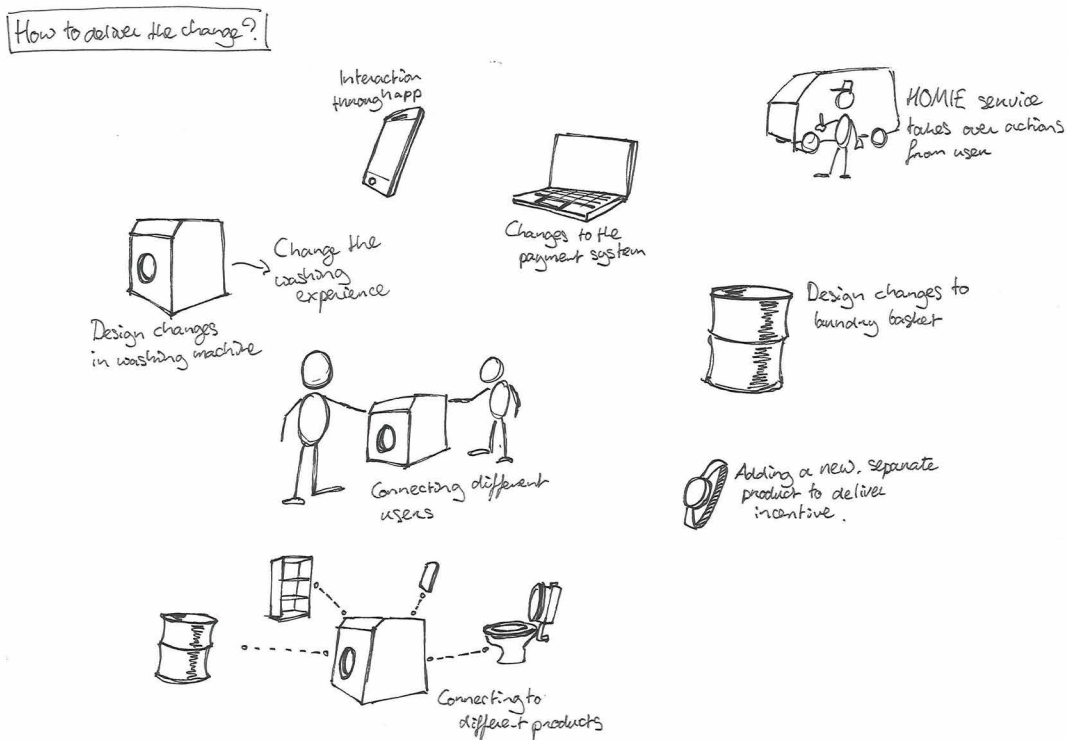


Figure 21

Then How-To questions were used to combine each of Tang's (2010) intervention methods, with the habit cues, scripts and experienced outcomes from each environmental impact factor (Chapter 2.2.1)

After categorising the ideas per type of design intervention, the method of attribute listing was used to motivate the creation of extra ideas that had not yet been thought of before the categorisation step.
The Design with Intent method (Lockton et al., 2010) was also used to provide additional ideas before establishing the concept directions.

Three main categories of ideas were then developed into concept directions, which all focused on different design interventions (Tang, 2010) in order to make fuller use of the range of interventions proposed by Tang (2010).

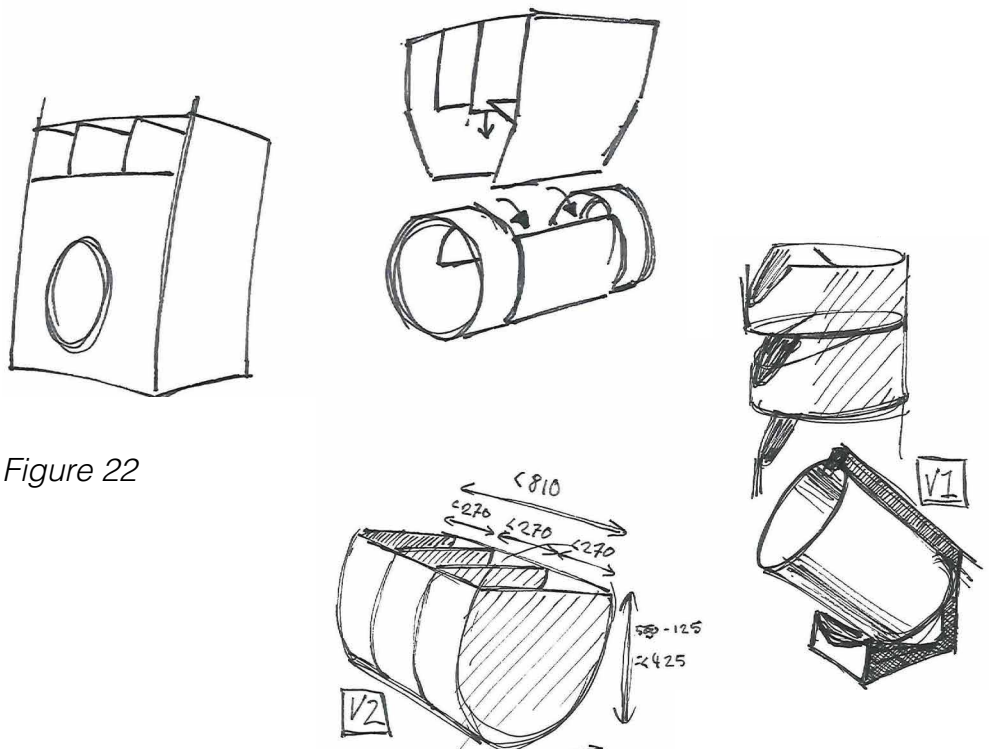


Figure 22

Developed concept directions

- One focused on utilising as many product/service-led decisions in the use process as possible, to maximise the effect on the environmental impact. This meant the automisation of choosing wash loads, the wash frequency, the temperature choice and the regulation of detergent. The idea was to move towards a concept where the user would add laundry at one end of the product, and receive clean laundry from the other end of the product.

  Although it proved relatively simple to develop way to automate temperature and detergent regulation, several alternatives had to be considered for the loading of the washing machine. The original idea was to let the users to gather laundry in the top of the machine (Figure 22), and the machine would automatically release the laundry into the drum when a full load size was reached. However, this proved difficult when dealing with a front-loading washing machine, since laundry would have to come in through the wall of the drum. Also, the size of the washing machine would have to significantly increase, if multiple full loads would have to be gathered inside the washing machine.
  Instead the choice was made to enter a filled laundry basket into the wash drum as an insert. The idea behind it was that the user would not have to bother with sorting out wash loads and seeing how much would fit inside the machine. Instead, the drum would be the exact size of the inner dimensions of the drum (Figure 23).

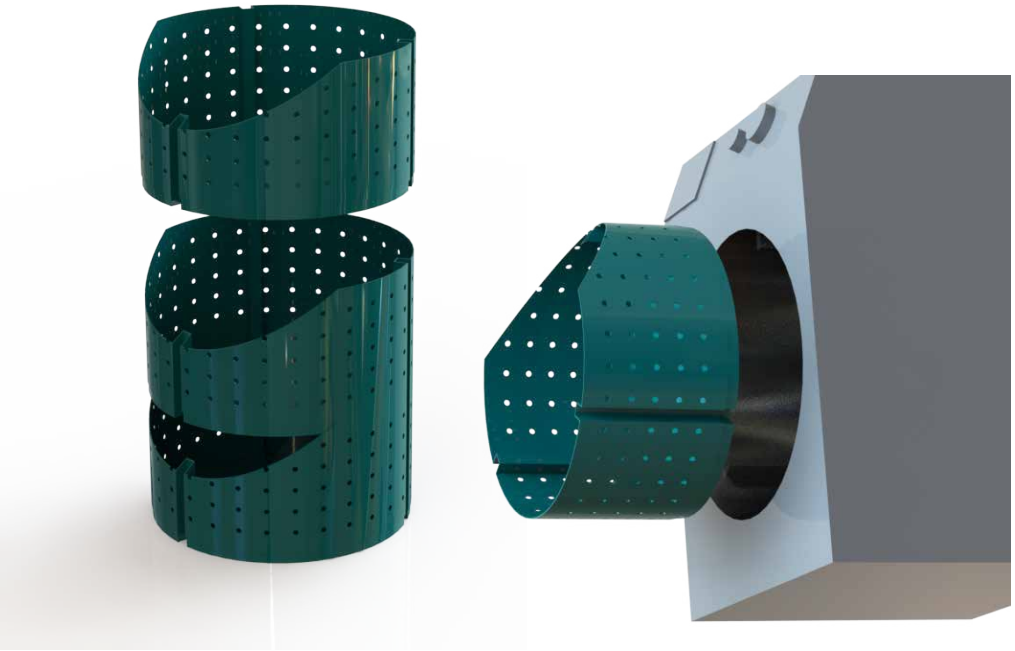


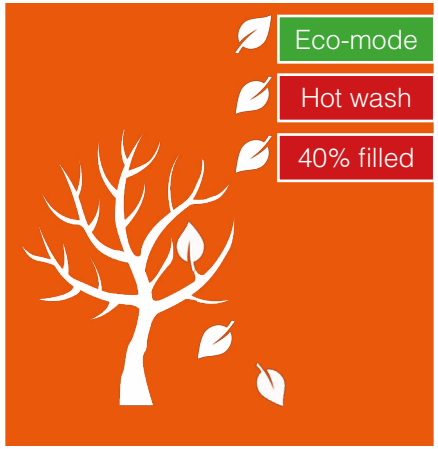
Figure 23

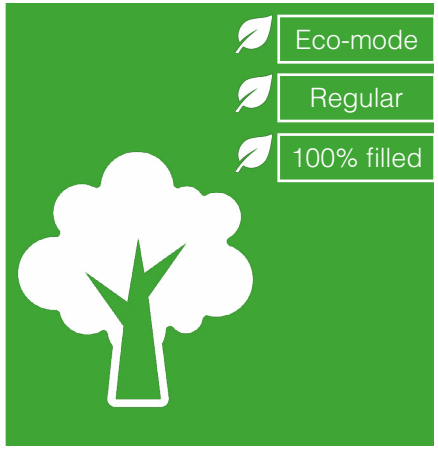
- Another concept direction focused on leaving all choices to the user, but using as many aspects of the interaction with the washing as possible to guide the user in making sustainable choices. This direction would showcase the negative aspects of unsustainable washes to the user at the moment of selecting a wash. The direction also focused on making sustainable programmes more pleasant for the user in order to guide the behaviour.
  This direction was chosen since the Literature chapter (Chapter 2) indicated a risk of losing user acceptance when using fully product-led decision making in a design intervention.

This concept also derived several functions from the Design with Intent method (Lockton et al., 2010). During loading, the machine would show a process bar slowly completing, with the environmental impact of the wash being indicated per kilogramme of clothing, to incentivise the user more towards a full wash (as in the Partial Completion method from Lockton et al. (2010)).
(Figure 24)

Figure 24: washing machine screens

Also, a virtual tree was used to show the built-up effects of sustainable or unsustainable washing in a way that could evoke empathy with the tree.
(Also inspired by Lockton et al. (2010))





Additional features of this concept included the release of a fresh fragrance and bright light (Figure 25) when completing a sustainable wash, an adapted detergent tray which made over-filling difficult (Figure 26), and hiding the high temperature options in a menu to make them more difficult to find.

Together these options all aimed to guide the user to behave sustainably, by making the sustainable choice more pleasant or less bothersome to complete than the unsustainable choice.

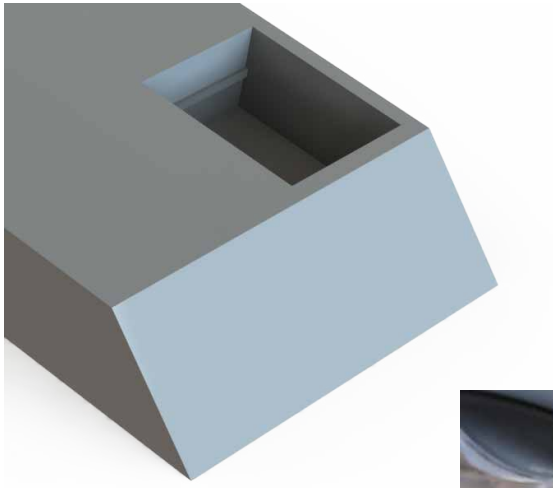


Figure 26

Figure 25: LED on inside of washing machine door (Miele, 2017)

- A third concept direction focused on integrating solutions where the design of the product would remain unchanged, in contrast to the other two directions. This concept direction was chosen for its simple solutions that would be possible to implement without significant changes to HOMIE's business model. This in contrast to the other two concept directions, which rely largely on changes to the product design.
  This concept included a sticker on the front panel, to rephrase the temperature settings, with the goal to combat any possible negative associations with cold washes in general (Figure 27).

A more energy efficient washing machine model would be used, and the earlier described laundry bag with wash load-sized compartments (Figure 28) would also be part of the concept.

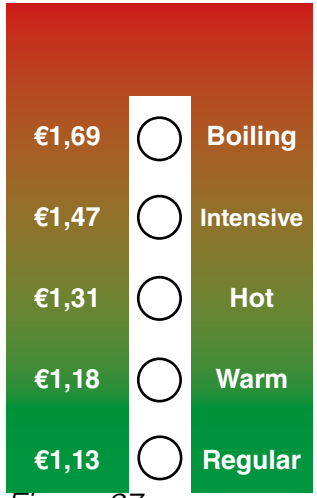


Figure 27

Figure 28

7.3 Phase 3: Creating the final concepts

Methods used

After re-evaluating the concept directions from the second Idea Generation phase, several specific questions were developed to improve the concept directions:

Concept 1 (automated concept)

- What other ways are there to load the machine? The inserts (see Chapter 7.2) would require extensive rebuilding of the washing machine inner and outer drum (to allow the insert to enter through the front) and would add relatively little in terms of convenience for the user.
- How can the selection of specific colour or fabric types be automated? The concept featured ideas for the automatic detection of dirt levels in the water, but the fabric type and colour of the laundry still had to be selected with a button, thus limiting the user convenience benefits that automation presents.

Concept 2 (concept that guides through the washing experience)

- What different ways are there to show the environmental impact of the washes? The “impact per kilogramme of laundry“ indication was meant to show how the amount of laundry in the drum affects the environmental impact of the wash, but it makes the information more confusing for the user.

Concept 3 (solutions that require no business model change)

- How can the basket be made more useful? Different users might split their laundry into different numbers of wash loads, and the one-size-fits-all laundry bag divides the bag up in a single way.

Additional ideas

- Are there any business model solutions that could also provide potential value for this project? The current solutions were all very much focused around product design solutions. Since the project focuses on the roles of both product design and business models, some business model ideas that were initially not chosen during Phase 1 and Phase 2 of the idea generation might still become interesting if they are more fully taken into account and considered.

Developed concept adaptations

Concept 1 (automated concept)

Earlier on in the design process, the use of wash load-sized laundry bags that could be washed together with the laundry was already considered. The bags would function the same as small laundry bags that serve to protect delicate laundry items, but would now be big enough to contain a full load of laundry, rather than a single item. The idea was originally discarded, since the assumption was made that the laundry would not have room to move around inside the bag, and the effective cleaning of the wash would be hampered by this.

However, the company Guppyfriend (Guppyfriend, 2017), has put a laundry bag on the market which has been tested for its functionality when washing full wash loads. The problem is solved here by making the laundry bag twice the size of what is needed, and then filling it only half way to allow for movement inside.

As a result, the idea of the laundry bag replaces the original inserts, since the laundry bag requires no adaptations to the drum. Instead of greatly increasing the number of bags users will need, the bag will

feature several indicator lines which show to which point the bag needs to be filled for different types of laundry.

To allow for automation of fabric selection and colour detection in the concept, solutions were developed which can be seen in the following chapter.

Concept 2 (concept that guides through the washing experience)

Instead of showing how much energy/water a user is consuming "per kilogramme of laundry", a much more insightful and easy to understand alternative was chosen. The screen will now not show the amount of resources that are required for the washing programme, but will simply show the amount of resources that a user is *wasting*. Indicating how much water and energy are being wasted can take into account both the wash load as well as the programme settings.

Concept 3 (solutions that require no business model change)

Since the laundry bag from the first concept could also be used with a completely regular washing machine, the bag provides an excellent solution for this concept as well.

Additional ideas

Earlier on in the idea generation, several business model ideas aimed at making users share wash loads together were also developed. Combining two people's wash loads could present a solution to the fact that people might not have enough laundry of a single type to fill the washing machine drum with.

However, the ideas were not chosen originally since they did not present much value to the user. They would have to let others into their house to wash, or when sharing with people living in the same house,
the price differences between the washing programmes could increase disagreements on which washing programme to use.

However, the automated washing machine concept provides a more suitable context for sharing wash loads. The automatic temperature selection removes the need to agree on a setting and a price beforehand.

Furthermore, in business models where a guest would pay a host for the use of the host's washing machine, the concept could also increase the level of trust between partaking users.
The laundry bags can be used by users to agree on what consitutes "a full load of laundry", and there will be no need to discuss whether it is necessary to split the wash load into two separate loads, which might otherwise be misused in order to make more money off the guests.

The following chapter discusses the three concepts, starting with the "solutions that require no business model change", followed by the "concept that guides through the washing experience", before moving on to the third concept: the "automated concept".

8 Concepts

This chapter will discuss the three concepts that were developed in the previous chapter.

8.1 Concept 1: HOMIE+

The regular HOMIE washing machine and payment model, but now with extra features

This concept presents several ways of motivating sustainable washing behaviour without making any changes to the product design of the washing machine itself. The storyboard will show how users will experience washing with this concept, and afterwards the concept will be described in more detail, before comparing the concept to the established requirements (Chapter 6).

8.1.1 Use process

1. In this first concept, the user gathers his/her laundry in custom-made laundry bags (Figure 29). The bags feature clear indicator lines that show to which point the bags should be filled, and having a number of three to four bags facilitates easy colour and/or fabric separation for the user.

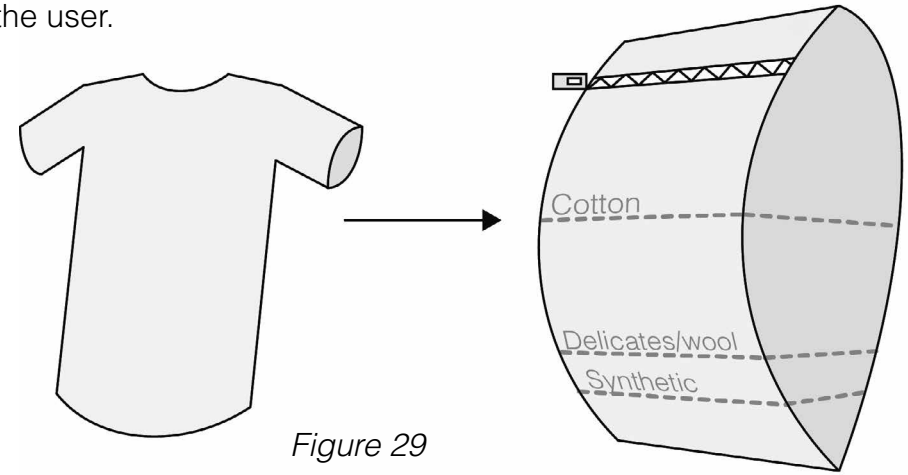


Figure 29

2. Once a bag is filled to the appropriate level, the bag can be closed with a zipper and can be taken to the washing machine to start a wash. Several indicator lines are shown on the bag's exterior, since different types of fabrics are recommended to be washed at different load sizes (Figure 30).

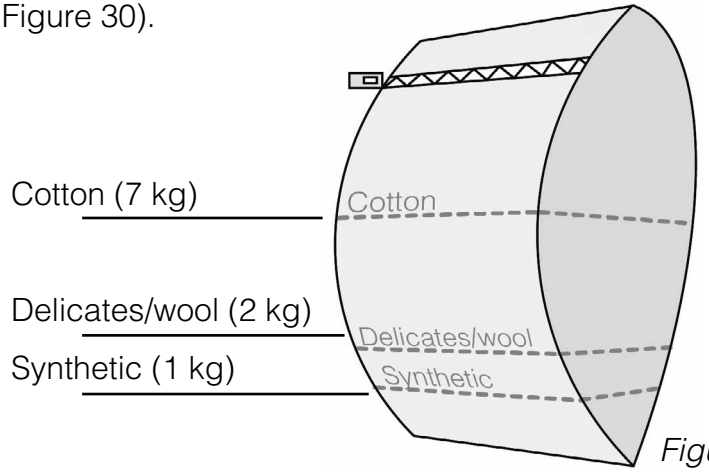


Figure 30

3. The bag in its entirety, with the laundry inside, can be inserted into the washing machine to be washed (Figure 31). The user selects a washing programme, but the temperatures on the front panel are covered by a sticker indicating the heat levels in descriptions rather than temperatures (Figure 32), in order to counteract the intuitive mistrust some people have of cold washing programmes.

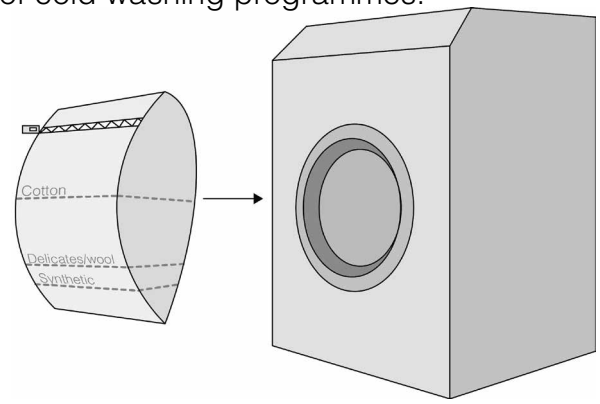


Figure 31

4. After starting a wash, the user receives feedback on their washing behaviour immediately through the HOMIE app, providing clear insight into the amount of water and energy they are wasting compared to a more sustainable washing programme. (Figure 33)

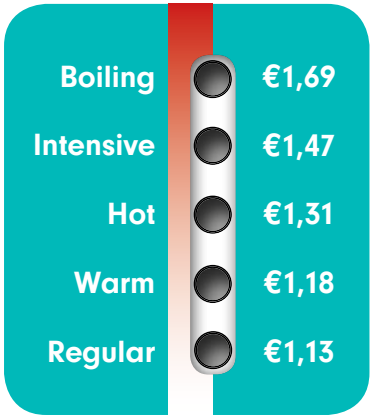


Figure 32

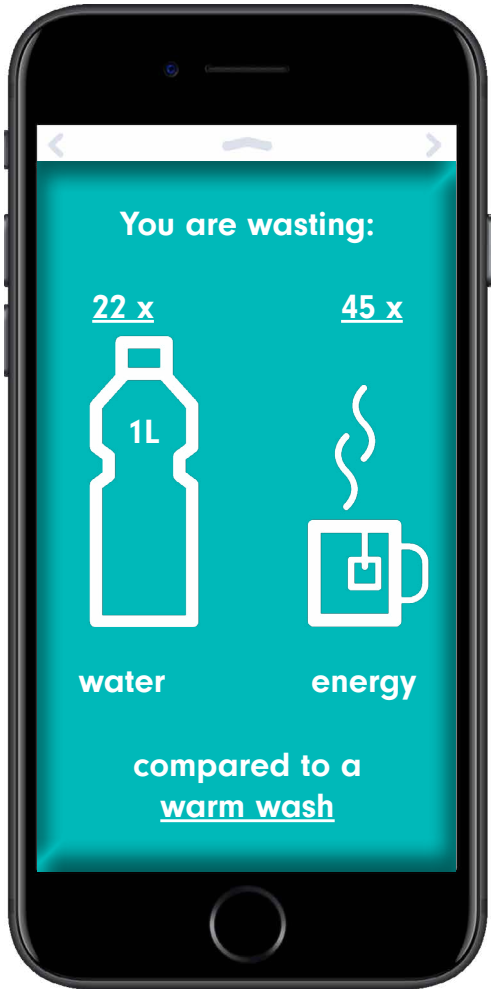


Figure 33

5. When the wash is finished, the user will receive an app notification that the wash is finished, along with an update on their sustainability tree. This digital tree avatar either withers or grows after each wash, depending on whether the wash had a high CO_2 impact or not. The amount of growth/decrease is calculated to be parallel to the amount of CO_2 an actual tree sequesters. (Figure 34)

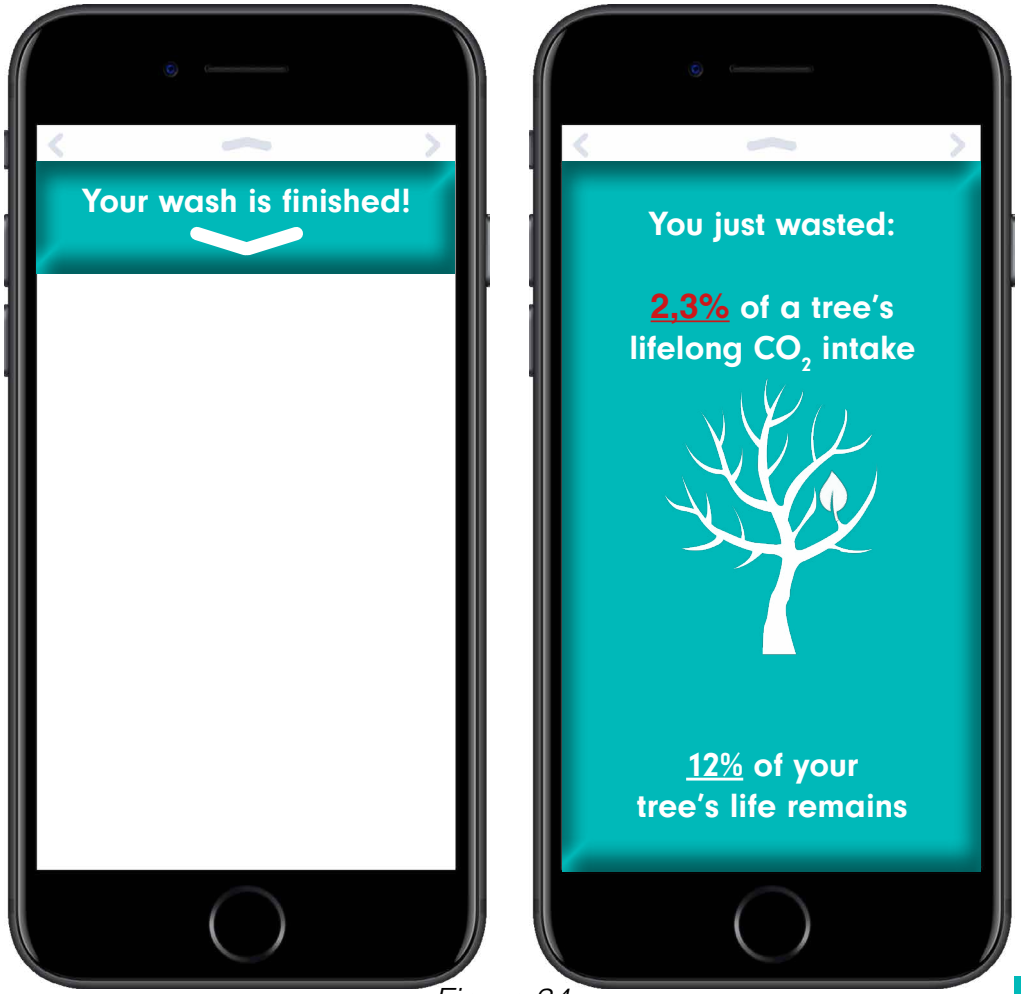


Figure 34

8.1.2 Description

Laundry bags

The laundry bags (Figure 35) help the user to wash with full loads rather than under-filling the machine and wasting energy and water on smaller amounts of laundry. By using multiple bags, the user can separate the laundry immediately while gathering it. When a bag is filled with a full load of laundry, the user can see that the load is appropriate for a full wash because of the indicator lines (Figure 35), instead of only being able to see the load sizes after separating the laundry. For the user, this removes the step of having to separate the laundry at another moment, and since the bag is made to be washed along with the laundry, the laundry does not need to be removed from the bag before starting a wash.

The laundry bags are designed so they can be used for various types of materials. As indicated in the Zanussi ZWF71443W's product manual (Zanussi, 2017A), not all fabrics can be washed at a full load (a full load is equal to 7 kilogrammes of laundry in the case of the Zanussi ZWF71443W (Zanussi, 2017A)). Although cotton can be washed with a full drum, wool and delicate fabrics should only be washed with a 2 kilogramme load, and synthetics at only 1 kilogramme per load. Instead of having a separate laundry bag for each type of fabric, separate indicator lines printed on the bag show to which point the bags should be filled for different types of fabric (Figure 35).

Figure 35: the laundry bag

The bag's measurements are significantly larger than the maximum wash load size itself is. This is to ensure that there is empty space left inside the bag even when it is filled with a full wash load worth of laundry. If the bag would be filled completely, the laundry would be packed tight and would have no space to move around, hampering the effectivity of the cleaning process. The dimensions shown below have been chosen to suit a drum size of 53 litres (the drum size of the Zanussi ZWF71443W (Zanussi 2017A)). The chosen dimensions (Figure 36) allow the load to fill 85% of the machine's interior, or 45.05 litres, (thus leaving 15% space inside the machine allowing the laundry bag to move around), and ensure that the bag itself will not be packed tight with laundry.

With a width of 600 mm and a length of 800 mm, the full volume of the bag is:

*800 * π (600 / π)* ^{2} *=*
*92 * 10* ^{6} *mm* ^{3} *=*
92 litres

With these dimensions, the bag is roughly the volume of a wash load of 45.05 litres.

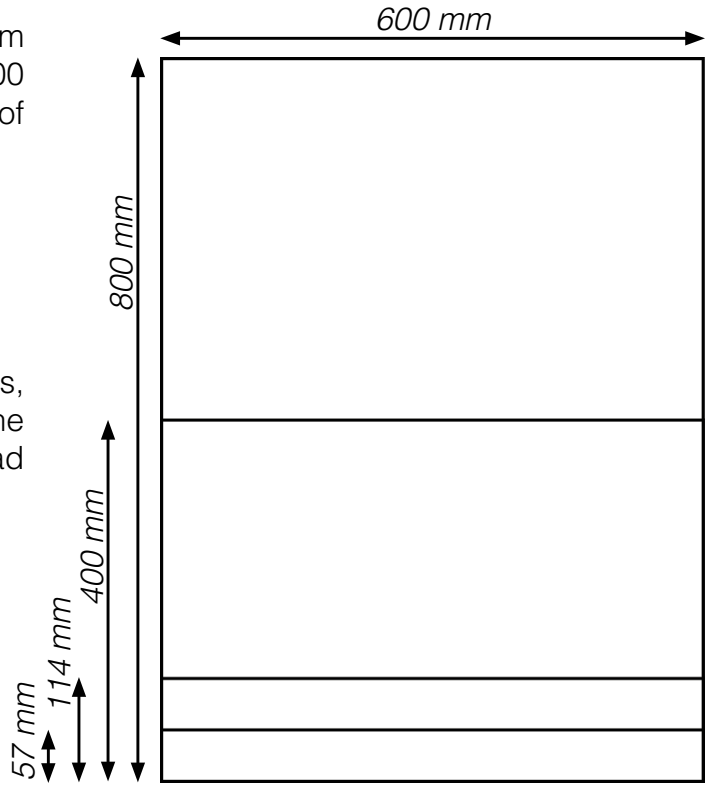


Figure 36: bag dimensions

The bag will be made from a nylon mesh. Nylon is chosen for its strength and durability (American Fiber Manufacturers Association, Inc., 2017), which are necessary features for a laundry bag that will be washed very often with laundry inside. Its suitability as a material is proven by the fact that protective singe-item laundry bags which are currently on the market, are also often made from nylon. It is also possible to print clearly visible patterns on nylon mesh (Figure 37).
The bag is closed with a zipper to ensure that the laundry cannot get out during the wash.

Figure 37: Printed nylon mesh (Aliexpress, 2017)

Front panel sticker

The sticker that is added to the front panel of the washing machine (Figure 38) functions to motivate users to use lower temperature settings. The descriptions on the sticker frame the available settings differently than just listing the temperatures. The “cold” and “30°C” settings are now listed as “regular” and “warm” for example (Figure 39). The goal of this change is to remove negative connotations some users intuitively have with cold temperature settings (as shown in Chapter 5.3), by reframing these temperatures as “the regular settings” instead of “the coldest settings” in the users’ minds.

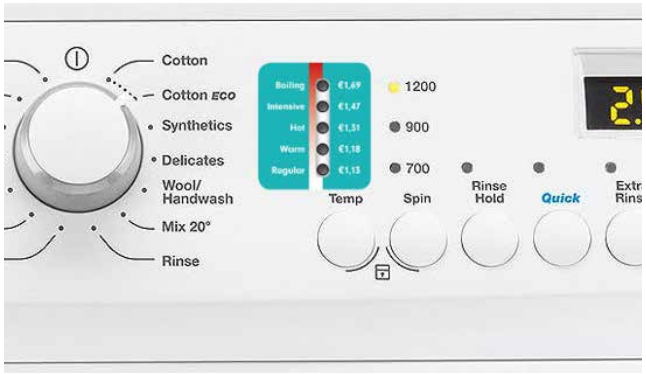


Figure 38: Sticker placement

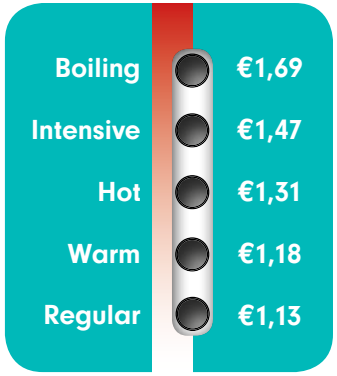


Figure 39: Sticker

Along with the descriptions, the sticker also features a colour gradient as a visual cue to associate the higher temperature settings with higher energy consumption, and the HOMIE wash prices are listed on the sticker as well. Since the pay-per-use model can help to make users more aware of their environmental impact resulting from the product use (Tukker, 2004), making the payments clearly visible at the temperature selection itself now links its effect to the user’s decision making moment.

Mobile app

To provide the user with feedback directly after selecting a wash, rather than at the end of the month, a HOMIE mobile phone app provides washing information on both water and energy consumption.

The information includes how much water and energy the user is consuming extra, compared to a cold washing programme, with the amount of water being represented by litre bottles of water, and the amount of energy represented by cups of tea (a cup of tea takes roughly 0.03kWh to make (Aldred, 2008)), to make the information more relatable and meaningful for the user, compared to listing just numbers (Figure 40).

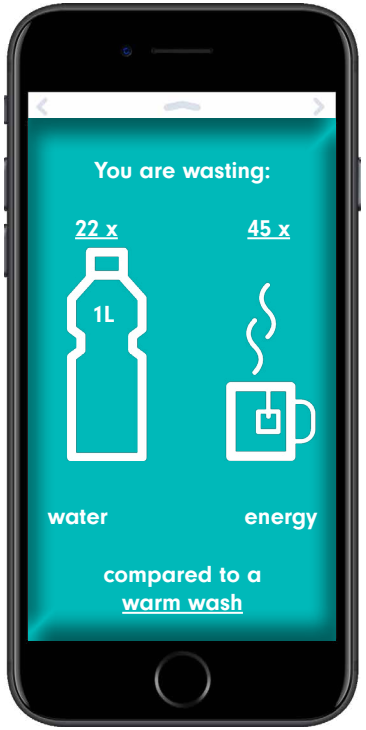


Figure 40: App feedback

After finishing a wash, an update is given on the status of a user’s personal tree in the app, which withers or grows depending on whether a user chooses an unsustainable or a sustainable washing programme. The tree starts off lively with a health value of “100%“, but when users choose unsustainable washing programmes, percentages are detracted and the tree visibly starts to wither as time goes by. The tree is used to motivate the user to wash more sustainably using empathy with the tree as a motivator (see Chapter 7: Idea Generation), and to keep the user more engaged with the environmental impact effects over time.

Sustainable washes will add to the score and will make the tree become healthier again (Figure 41).
Since an average urban tree will sequester about 39 kilogrammes of CO_2 in a 10-year lifespan (EPA, 2017), the amount of CO_2 impact that is the result of choosing an unsustainable washing programme will be compared to the value of 39 kilogrammes to calculate the percentage.

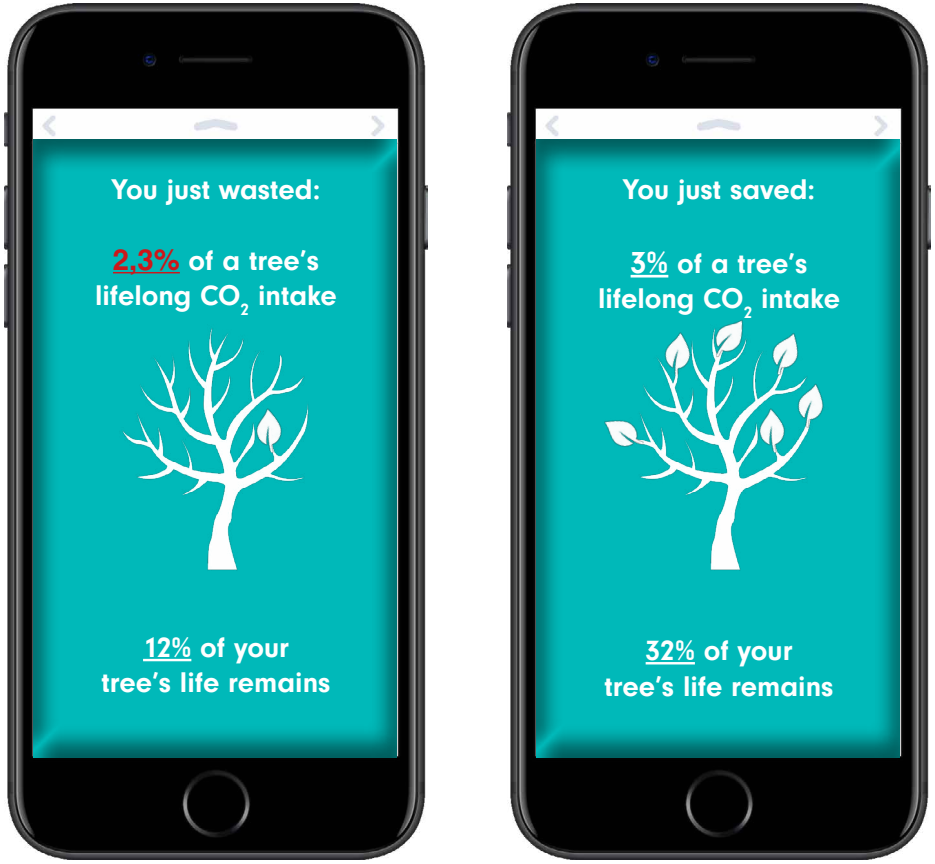


Figure 41

To establish which washes are considered "sustainable" and which ones are considered "unsustainable", the washes will be compared to a neutral benchmark. Since the average Dutch washing temperature was established to be 41°C (I Prefer 30°, 2013), as already discussed in Chapter 5.1, a 40°C ECO programme will be used as the neutral benchmark. This way the regular 40°C programme, which is closest to the Dutch average, will be the first programme to show a negative impact on the tree's life, to encourage users to wash more sustainably than the nationwide average. The regular 30°C programme will be the first programme to show a positive impact on the tree's life status.

As an example:

A 90°C wash consumes 1.2 kWh more energy than a 40°C ECO programme (Appendix D).

With 1 kWh generating roughly 0.744 kilogrammes of CO_2 (EPA, 2017), this is equal to 0.893 kilogrammes of CO_2, or 2.3% of the tree's 39 kilogrammes of CO_2.

The app is used for other purposes as well, in order to let the users receive the feedback even if that is not the main functionality they are looking for in the app.
The app will feature the function to check up on the amount of washing credit a user still has in his/her account and to add to it, to show an overview of the washes a user has done, and to give a notification when a wash is finished (a functionality currently provided through e-mail).

8.1.3 Evaluation

Now the concept will be evaluated using the requirements that were established in the Requirements chapter (Chapter 6).

Environmental impact factors

The concept influences the following environmental impact factors:

- Wash frequency
- Wash load
- Temperature

Scripts/cues/experienced outcomes

The concept addresses several habit scripts, cues and experienced outcomes, as they were discussed in Chapter 5.3:

For wash frequency/wash loads

- The cue of starting the laundry process when the basket is full is maintained, but now used as a cue to a sustainable script, since a laundry bag filled to the line equals a full wash load.
- To counter the need for a scheduled laundry day, the bags (in which the laundry is already separated) remove the extra process step of separating laundry for the user. This way the user can immediately see which bags are still under-filled when starting the laundry process, and the user now knows that that particular bag can wait until a later date.

For temperature

- Whereas normally the temperatures are shown on the front panel as a cue, the descriptions that are now featured on the sticker now function as the cue. By calling a “cold programme” a “regular programme” instead, the cue is changed to counter the script of users not trusting a “cold” setting.
- Listing the washing programme prices on the sticker adds another cue to discourage warmer settings.
- The feedback and the sustainability tree provide positive experienced outcomes for using cold washes, and negative experienced outcomes for using hot washes. The effect of the tree builds up over time, and helps to motivate sustainable behaviour in the long run.

Used intervention methods

- Eco-information: The washing feedback through the app
- Eco-choice: The indicator lines on the bags show the sustainable option of washing with a full load
- Eco-spur: The growth of the sustainability tree is shown as a reward for sustainable choices

Factors influencing user acceptance

- *Apparent influence on environmental impact:* Although there is no guarantee of improved environmental impact, the user can clearly see the benefits in the feedback if he/she does adapt the washing behaviour
- *Convenience (reduced time/effort):* The laundry bags make additional

time and effort spent on separating the laundry unnecessary
- *Assurance of good washing results (clean/fresh/colours/specific treatments):* Since the user is in full control of the decisions, he/she can always be certain that settings are chosen that create a good washing result.

Washing price

The washing prices will stay the same as they currently are.

Feasibility (required business model changes)

New elements in the business model include

- *Key partnerships:* Since HOMIE has no resources to produce the laundry bags, a new partnership could include any company that had the resources to produce nylon mesh bags with print. Also, an external app development agency would be needed create the washing feedback app.
- *Cost structure:* Extra investment would be needed for the printing of the stickers, for acquiring the laundry bags, and for the development of the app. These factors are taken into account in the Concept Comparison (Chapter 8.4).

HOMIE value proposition

No changes occur in relation to HOMIE's value proposition elements of reliability, control, low initial costs, independence and the use of an A+++ machine.

8.2 Concept 2: The guiding HOMIE

The HOMIE washing machine that guides towards saving resources

The second concept presents solutions where behavioural intervention methods such as eco-spur and eco-steer (Tang, 2010) are utilised to encourage and facilitate sustainable washing behaviour, and in this concept the user is fully in charge of the decision making process.

8.2.1 Use process

1. This second concept starts when the user starts loading the machine. A screen on the front panel of the washing machine (Figure 42) provides real-time feedback on how full the drum is, and feedback is provided on how much water and energy would be wasted by not filling it further.

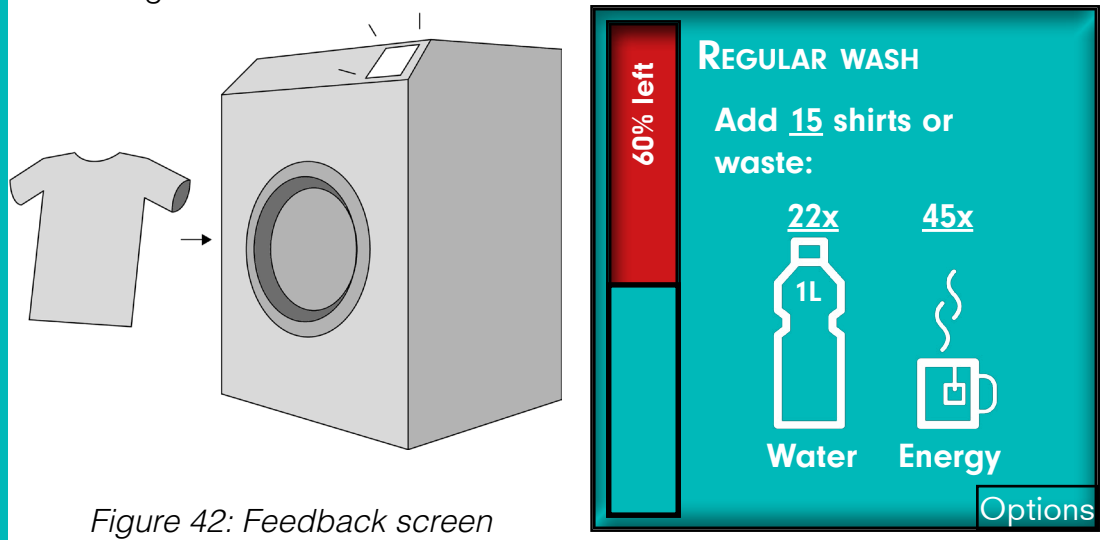


Figure 42: Feedback screen

2. Although the type of fabric can be selected using a button on the front panel, the selection of temperatures and the option to disengage the ECO-mode are not immediately available on the front panel. If the user wants to select different temperature settings, these can be reached through options in the on-screen menu (Figure 43).

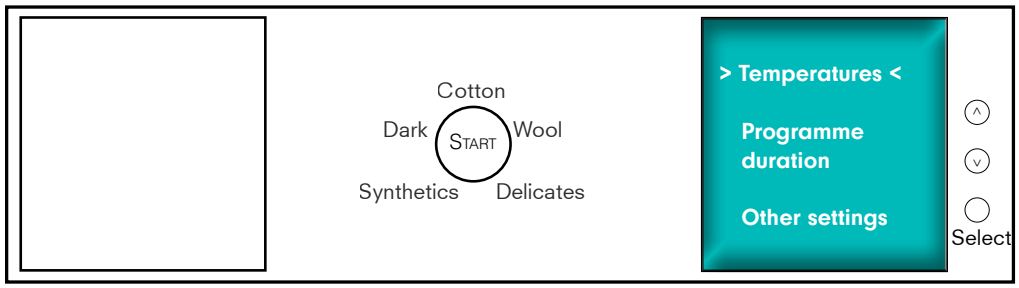


Figure 43: Options menu

3. The screen colours change when programmes of higher environmental impact are chosen (Figure 44), and the options are not represented by the temperatures, but by descriptions (Figure 45).

Figure 45

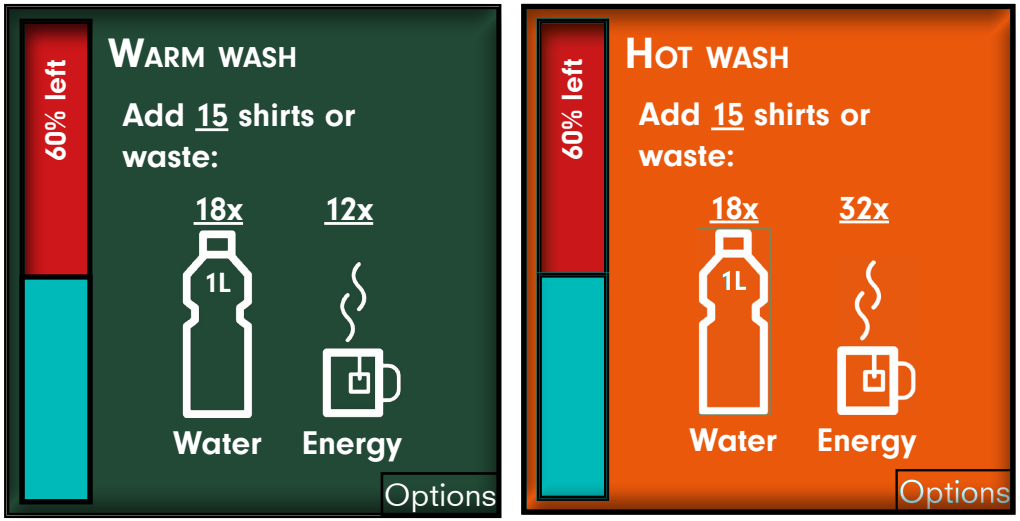


Figure 44: Two wash screens

4. When the user chooses one of the warmer programmes, the machine offers the user an option to switch to a more sustainable programme before the wash can be started (Figure 45).

Figure 45

5. The regular detergent tray can be used to add detergent to the wash. However, the part where the detergent is be poured in, is now smaller in size. The detergent cannot flow away before the tray is closed, to ensure that the user does not add more detergent than necessary when using the tray (Figure 46).

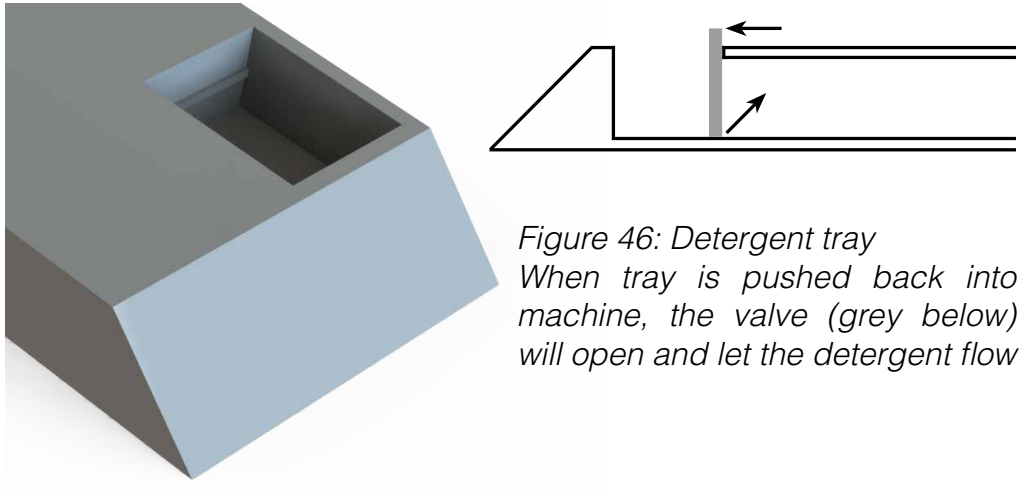


Figure 46: Detergent tray
When tray is pushed back into machine, the valve (grey below) will open and let the detergent flow

6. When the wash is started, the sustainability tree update (also described in the first concept) is shown, and shows the developing growth or withering of a user's personal tree over time. Wash load size, temperature and selected programme are taken into account, and add to the life of the tree. The CO_2 impact resulting from making unsustainable choices, is used to calculate how large a percentage of its life the tree loses or gains. The full 100% value corresponds to the actual amount of CO_2 a tree would sequester in its lifetime.

7. When the wash is finished and the user opens the door, a fresh fragrance is released and a bright light shines upon the laundry in the case of a sustainable wash (Figure 47). For an unsustainable wash the colour of the light changes to red gradually, dependent on the temperature, and the fresh smell is not released inside the machine. The light and fragrance are used to make the sustainable washes more satisfying to the user.

Figure 47: LED on inside of washing machine door (Miele, 2017)

8.2.2 Description

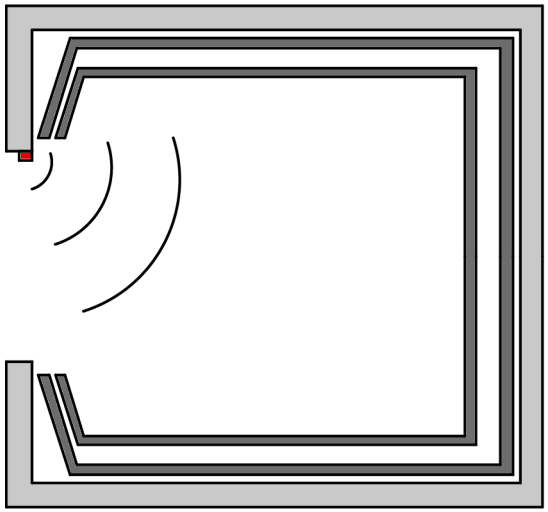
Washing machine features

The washing machine incorporates various new features in this concept. First of all, the machine features an adapted front panel (figure 48) with a new display screen and a new button lay-out. The screen provides direct feedback and information during the washing process, rather than HOMIE's current way of providing feedback at the end of the month. Buttons next to the screen are used to select options in the menu. The things that are shown on the screen are explained in the next section.

Figure 48: Front panel

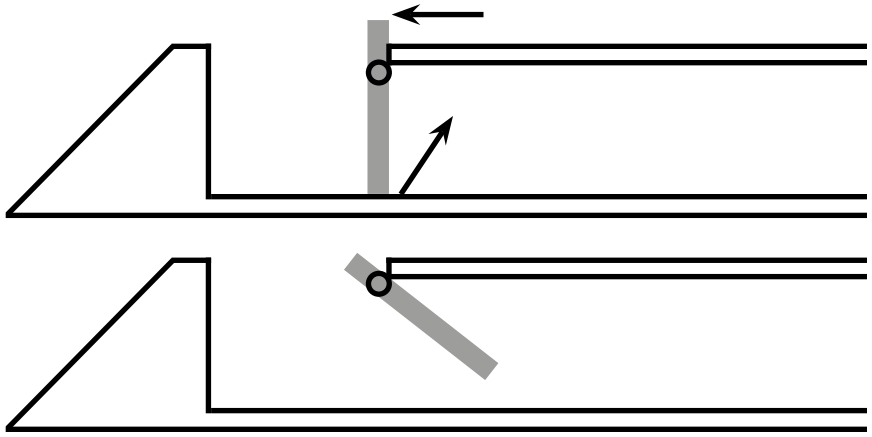
A diffuse ultrasonic distance sensor is used to measure accurately to which point the washing machine is filled. An ultrasonic distance sensor is chosen because its functionality is not reduced by different colours and difficult surface areas (important factors when dealing with laundry), in contrast to other types of sensors, and the response time of the echo can be accurately used to measure distance (Kinney, 2001). (Figure 49)

Figure 49: Ultrasonic sensor placement



The detergent tray is adapted to make adding too much detergent much harder than it currently is. When the tray is opened, the part where detergent can be added is smaller than it normally is because a valve temporarily closes it. This way, only a regular amount of detergent for a single wash can be added at a time. Closing the tray will open the valve, allowing the detergent tray to function normally (Figure 50).

Figure 50



To improve the favourable results the user encounters when opening the washing machine after a cold wash, a fresh smell is blown through the machine after cold washes, to associate the freshness with sustainable washes. Additionally, a light is shone inside the machine: bright white after cold washes, a colour often associated with cleanliness (Bruens, 2007), and increasingly red light for hotter washes.

To release the fresh smell, a small amount of detergent-rich water is saved up during the early washing programme, and air is blown through into the washing machine drum to spread the fresh detergent smell (Figure 51 & 52). A white and a coloured led-light are used to shine the light into the machine, and these are positioned just above the rubber door seal, on the inside of the machine (Figure 53).

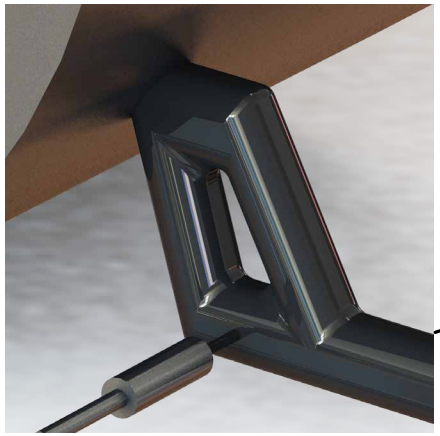


Figure 51, the outlet seen from the outside

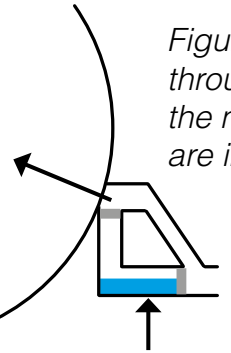


Figure 52, air is blown through the outlet into the machine, two valves are indicated in grey

Figure 53: LED on inside of washing machine door (Miele, 2017)

Different screens

The screen is used for several functions. First of all, it shows the user clearly how full the machine is and how much fuller it can be loaded. A progress bar is used to make the goal seem more attainable for the user. Also, apart from the percentage in the wash load bar, the machine states how many pieces of laundry can be added to complete a full load, thus making it easier for the user to understand what is still needed to finish a full load. (Figure 54)

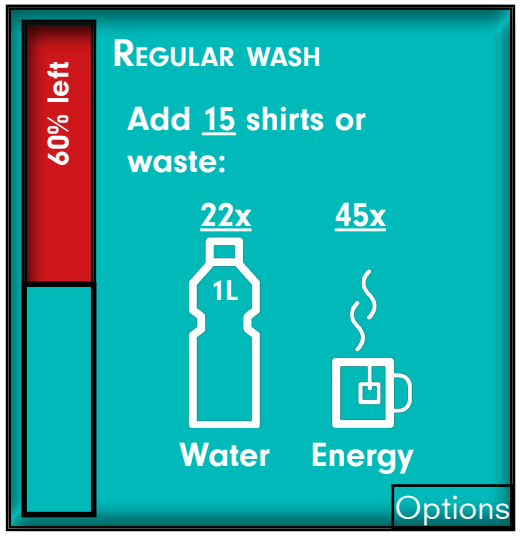


Figure 54

The amount of energy and water that the user is wasting by under-filling the machine and by choosing unsustainable settings are shown in the same manner as the first concept (Chapter 8.1), with litre-bottles for the amount of water and cups of tea for energy. Additionally, the colour of the screen gradually changes from green to red as a wash's settings are becoming less sustainable.

The machine is normally set at a cold washing programme with eco-mode engaged, and to discourage changing these settings, the other temperatures and short cycles can only be reached through an "options" menu. Here the temperature settings are not shown in degrees Celsius, but as words describing the temperature settings, in order to diminish any negative connotations users might have with a wash that is called "Cold".

Selection options in menu:

Options > **Temperatures >** **Temperature selection**
Programme duration > **Disable ECO-mode**

The sustainability tree feature, also present in the first concept, is included in this concept to motivate the user towards sustainable behaviour through empathy, and to keep the user engaged over time since the tree changes in respect to long-term behaviour. The feature functions largely the same as described in Chapter 8.1.2, the only difference being it now also takes the wash load into account when calculating the percentage value that the tree gains or loses. A half-filled wash for example will result in the tree's life losing a percentage twice as high as it would with a full wash, since the amount of energy is now spent on only half the amount of laundry.

8.2.3 Evaluation

Now the concept will be evaluated using the requirements that were established in the Requirements chapter (Chapter 6).

Environmental impact factors

The concept influences the following environmental impact factors:
- Wash load
- Wash frequency
- Temperature
- Detergent use

Scripts/cues/experience outcomes

The concept addresses several habit scripts, cues and experienced outcomes, as they are discussed in Chapter 5.3:

For wash frequency/wash loads
- A new cue is added to prevent both the script of under-filling the machine as well as the script of filling the machine till it is crammed full. The loading bar and the instruction to add a number of pieces of laundry extra provide a new cue to motivate the user to load the machine to an appropriate level.
- The directly visible feedback on the amount of water and energy wasted also provide a negative experienced outcome for the user if the washing machine's drum is not filled.

For temperature
- Whereas normally the temperatures are shown on the front panel as a cue, the descriptions that are now featured on the screen function as the cue. By calling a "cold programme" a "regular programme", the cue is changed to counter the script of users not trusting a "cold" setting.
- The cue of having to select a temperature is also removed for the user. If a user want to select a different temperature, he/she now has to look for it in the on-screen menu, without any cue initiating this process.
- The feedback and the sustainability tree provide positive experienced outcomes for using cold washes, and negative experienced outcomes for using hot washes. The effect of the tree builds up over time, and helps to motivate sustainable behaviour in the long run.
- When a hot wash is chosen, or the ECO-mode is disabled, the machine adds a new cue by asking the user whether he/she would still like to switch to a more sustainable programme.

For detergent use
- The experienced outcome of convenience when not measuring the detergent is removed by closing the part of the detergent tray where the detergent is added.

Used intervention methods
- Eco-information: The washing feedback on the screen
- Eco-choice: Offering an alternative, more sustainable, washing programme as a choice
- Eco-spur: The growth of the sustainability tree is shown as a reward for sustainable choices

- Eco-steer: The detergent tray constrains the process of adding detergent to the tray to stay within the measures of a recommended detergent amount

Factors influencing user acceptance

- *Apparent influence on environmental impact:* The user is constantly shown how each choice influences the environmental impact, and the machine offers alternative choices to reduce the impact as well.
- *Convenience (reduced time/effort):* Adding the correct detergent takes less effort now, since no external measuring cup is needed anymore.
- *Assurance of good washing results (clean/fresh/colours/specific treatments):* Since the user is still in full control of the decisions, he/she can always be certain that settings are chosen that create a good washing result.

Washing price

The washing prices will stay the same as they currently are.

Feasibility (required business model changes)

New elements in the business model include:

- Key partnerships: HOMIE does not have the resources to manufacture the adapted washing machine within its current business model. A business partner would be needed to manufacture the washing machine, and could be a company like Gorenje (Gorenje, 2017). Gorenje has already indicated interest to HOMIE in developing new washing machine models aimed at sustainability, so this household appliance manufacturer could be a suitable partner for the production of such a washing machine.
- Cost structure: The manufacturing costs of the washing machine (and for HOMIE, the acquisition costs) would rise due to the addition of the new front panel, the LCD screen, the new programming, the distance sensor, the adapted detergent tray, the in-drum lighting and the fragrance release system. These factors are taken into account in the Concept Comparison (Chapter 8.4).

HOMIE value proposition

No changes occur in relation to HOMIE's value proposition elements of reliability, control, low initial costs, independence and the use of an A+++ machine.

8.3 Concept 3: The HOME-run

One push of the button to complete the entire wash

The third concept is aimed at using behaviour intervention methods where the use decisions are not made by the user, but by the product-service system. Utilising intervention methods such as “clever design” and “eco-technology” (Tang, 2010), the design of the product is aimed at taking away the choice from the user where possible and implementing sustainable usage decisions automatically.

8.3.1 Use process

1. The user gathers laundry inside several nylon mesh bags, separated by colour and/or fabric type (Figure 55).
Once the laundry reaches the indicator line on the bag, the amount of laundry is big enough to fill the washing machine.

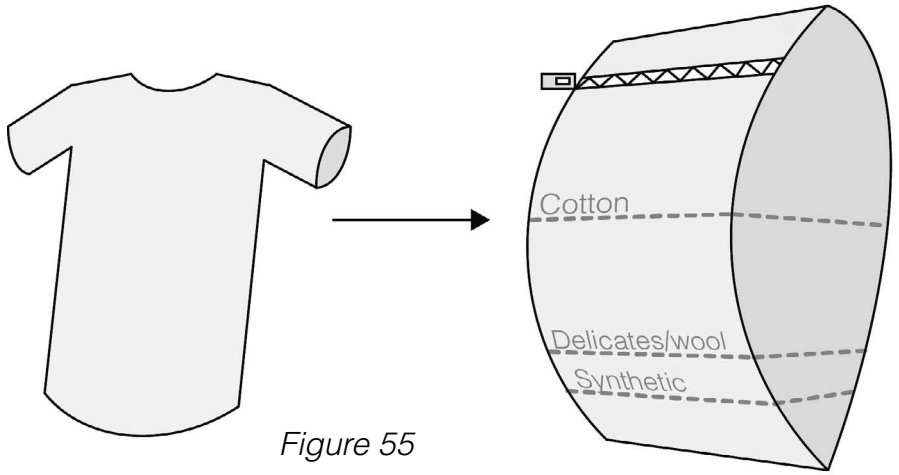


Figure 55

2. The full laundry bag can be taken to the washing machine. The complete bag can be put into the machine, and can be washed with the laundry inside.
A red tag on the bag can be scanned by the machine to select a specific type of fabric that will be washed (Figure 56).

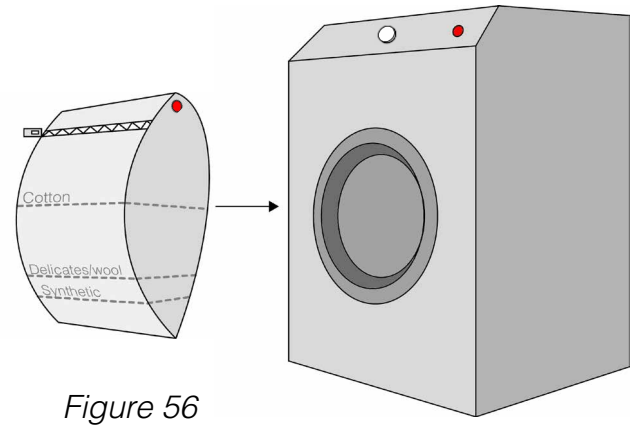


Figure 56

3. The only thing the user has to do is to start the wash with a single push of a button.
The washing machine can tell the colour of the laundry, weigh the amount of laundry in the machine, and can tell how much dirt there is in the water.
Using this information, the machine will automatically choose the temperature, the amount of water, and automatically adds an appropriate amount of laundry detergent to the wash (Figure 57).

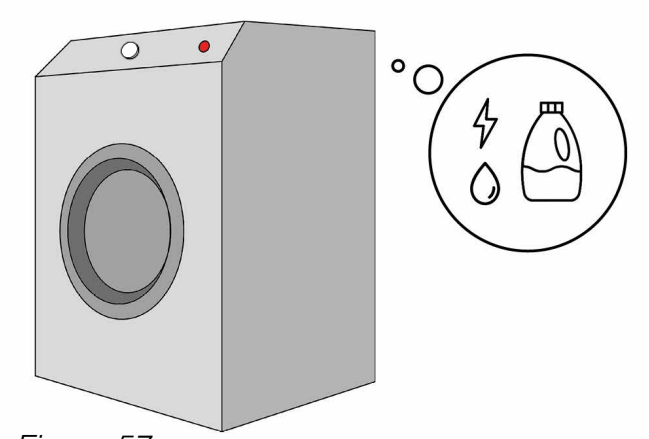


Figure 57

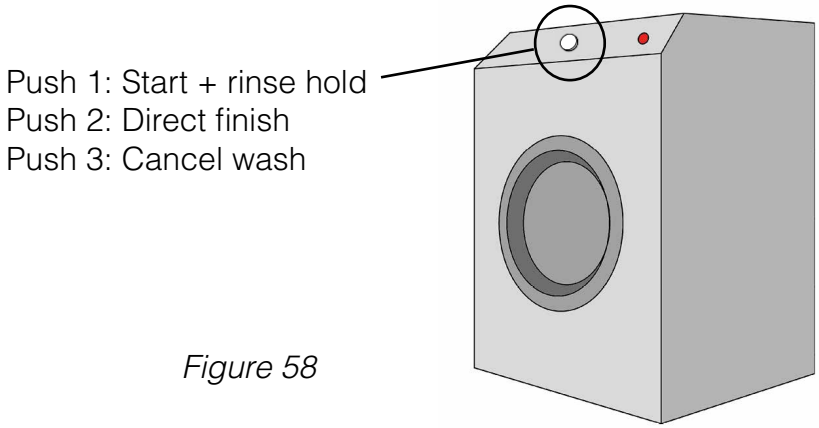


Figure 58

4. The machine automatically implements a rinse-hold function, stopping the washing cycle with the last rinse water still in it, allowing the user to choose later on when exactly to finish the wash. This prevents the clothes from developing a smell after sitting half-dry in the machine for hours. Instead, the clothes stay fresh in the water, and are only drained and spun dry when the end of the programme is initiated. Ending the wash can be done by pushing the “Start/Finish” button on the machine again.

Pushing the button twice at the start, or pushing it at any time after having started the wash, will make the machine forgo the rinse-hold function and finish the wash in one go (Figure 58).

5. Apart from the individual washes, users can also choose to match up with other users to wash together, using the HOMIE app. The app allows users to create groups (for example people in the same student house, same sports team or family members) to do combined washes with. If several users share a machine, they can check in individually when starting a wash to indicate that their credit will pay for the wash that is being started.

If a user selects another person to combine a wash with (Figure 59), and the other accepts the invite to share a wash (Figure 60), the costs of the wash will be split between the partaking people, allowing users to split washing costs for fuller wash loads.

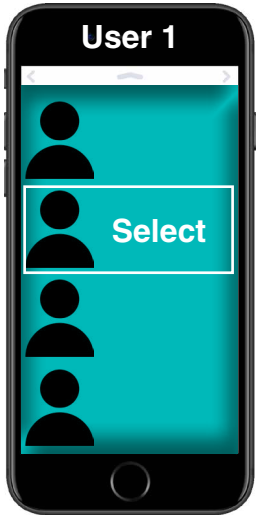


Figure 59 Select user to share wash with

Figure 60 Confirming that the wash will be shared

6. Another option is that people who do not have a washing machine yet (or whose washing machine is broken) can check if anyone in the neighbourhood has made a washing machine available for sharing. In this case a guest can make use of a host's washing machine and pay the regular HOMIE fee, plus an additional fee as payment for the host.

This way the guest has a more affordable option than a launderette, and the host is able to make money off the interaction. Using the laundry bags ensures that users can agree objectively on how much laundry constitutes a full wash load (without the possibility for the host to make extra money by splitting laundry into more loads for example), and the machine still makes all the choices, so the washing result is guaranteed.

8.3.2 Description

Laundry bags

For gathering the laundry, the user makes use of a similar laundry bag to the one discussed in Concept 1 (Chapter 8.1). In this case, an NFC tag is added to the top of the bag to enable the user to scan the tag at the washing machine (Figure 61). The top of the bag features the word “Synthetics”, “Delicates” or “Wool”, and the machine will adapt the maximum temperature and spinning speeds to which fabric type is scanned. This way the user can have the different types of fabric separated already while gathering the laundry, and the only thing that needs to happen to start a wash is to scan the NFC tag and to push the start button on the machine.

The NFC tag only needs to be scanned to select a fabric that requires an adapted washing programme. If a wash is started without scanning an NFC tag, the machine will choose a regular cotton programme. This way, the user can also decide to gather different colours of cotton in the separate laundry bags and gather cotton wash loads instead.

Waterproof NFC tags that can withstand washing machine temperatures are already available (ZipNFC, 2017), so the laundry bag can still be washed without any problem.

Figure 61

Machine features

The washing machine will have an adapted front panel, featuring only the NFC scanner (Figure 62) and a single “start/finish” button, since the machine will make all choices concerning the wash settings automatically.

Figure 62

The machine will decide the required amounts of water and detergent for a washing programme utilising a weight sensor, to adjust for the amount of laundry in the drum. Additionally, “fuzzy logic” technology allows the machine to monitor the level of dirt in the water, and to adjust the amount of water, detergent and heat accordingly (Samsung, 2017A). Using an optical sensor, the machine can assess the level of dirt in the water (measuring the reduction in water transparency), and use this information to create adapted washing programmes (Halase & Hatagar, 2015).

Detergent is dispensed into the washing water automatically by the machine, the necessary amount also being determined through the fuzzy logic. The technology already exists, and allows for effective cleaning, no risk of overusing detergents and it helps prevent damage to the machine’s components as a result of detergent overuse (Home-Tech, 2016) (Samsung, 2017B).

With an existing Whirlpool washing machine described by Home-Tech (2016) (Figure 63), the detergent tray can hold enough detergent for 36 washes. If a similarly sized tray is divided into three sections (for colours, white and dark laundry detergent) (Figure 64), it can be made to hold 18 loads worth of coloured laundry detergent, and 9 loads for white and dark laundry detergent each. This tray will need to be regulated using three valves instead of the regular single valve to be able to release each detergent separately.

Figure 63: The detergent tray (blue in the picture) is large enough to hold 36 washes worth of detergent (Whirlpool, 2017)

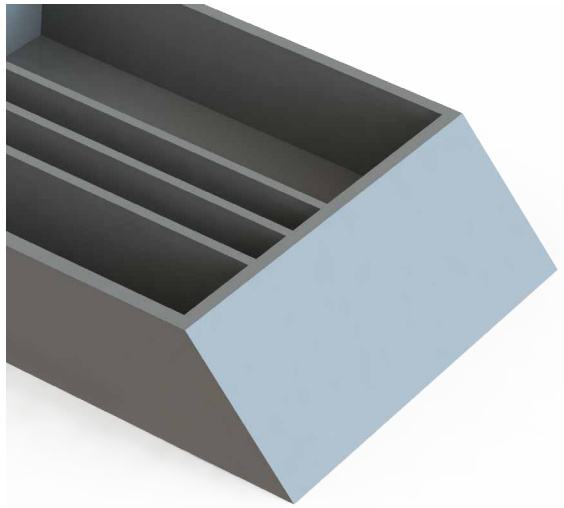


Figure 64: Tray with divisions

In order to select the right colour of laundry detergent automatically, an LED will shine light upon the laundry (Figure 65), and a photodiode will measure the amount of light that is reflected by the wash load. If the light reflected off the laundry would reach below a certain value (calibration will be needed to assess what the exact light intensity cut-off value would be), the machine would choose the dark laundry detergent. For a white wash, the photodiode would have to measure a light intensity above a specific value, with the coloured laundry detergent being selected in between these two measurement points.

Photodiodes are able to measure light intensity both precisely and linearly, making them suitable for this purpose (Agarwal, n.d.).

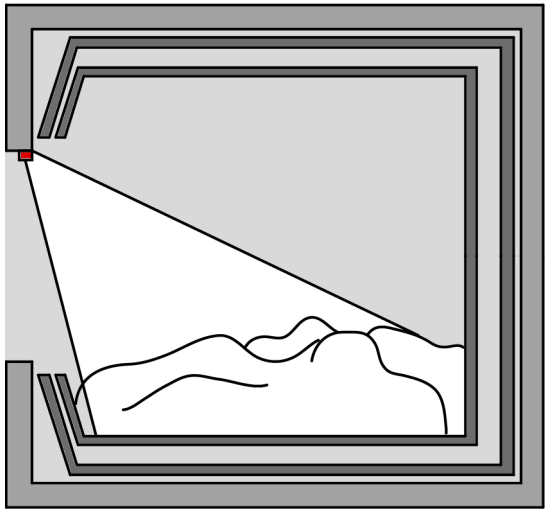


Figure 65: LED shining on the laundry in the wash drum

Although the laundry is inside the laundry bag, a wide mesh used for the nylon would let the colour of the laundry shine through clearly eough to differentiate between light and dark wash loads. The following picture (Figure 66) shows how the colour of laundry can clearly be seen through nylon mesh.

Figure 66: Laundry bag with both white and dark clothing inside (Walmart, 2017)

Business model

To facilitate multiple people making use of a single washing machine, and to make it easier to do shared loads with other users and fill the washing machine up more easily, a mobile phone app is also part of this concept.

In the app, users can invite other users into groups, to facilitate for example sports teams or people sharing apartments to wash together.

Figure 67

When starting a wash, a user can check in to indicate that he/she is starting a wash at that moment, so that HOMIE's payment system will know that the current wash registered by the washing machine will be paid by that specific user's credit (Figure 67).

If two or more users are adding laundry to the wash load, the person who is starting the wash can invite the others through the app to share the washing costs (Figure 68).

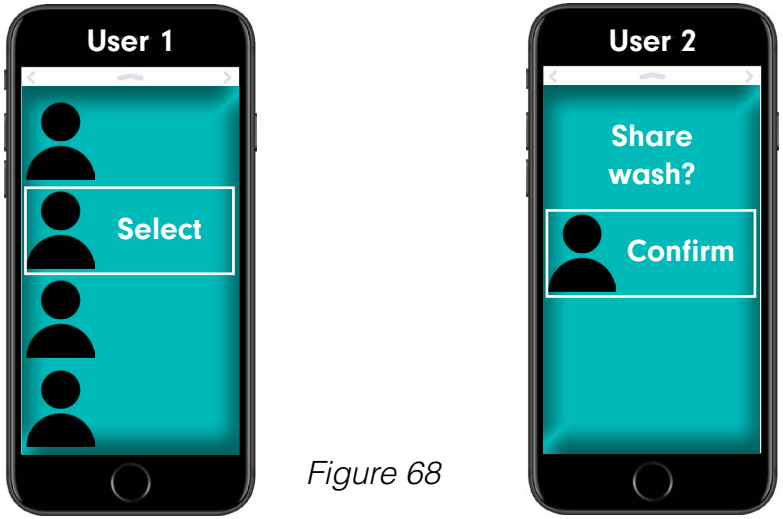


Figure 68

Additionally, if a user wants to let other people wash at his/her washing machine (if a nearby friend has no working washing machine for example), the other person can also install the app and check in at the washing machine. The guest will then pay both the regular washing price and an additional fee for the user who has made the washing machine available.

Due to the automated functionality of this washing machine and the single-load sized washing bags, this specific concept is suitable for these group and sharing options. Users cannot misuse the system and pretend that laundry has to be split into extra loads to make extra money off a guest, and users sharing a wash will not be able to disagree on specific wash settings since the machine chooses them automatically.

8.3.3 Evaluation

Now the concept will be evaluated using the requirements that were established in the Requirements chapter (Chapter 6).

Environmental impact factors

The concept influences the following environmental impact factors:

- Wash load
- Wash frequency
- Temperature
- Detergent use
- Efficient use of the product's parts

Scripts/cues/experienced outcomes

The concept addresses several habit scripts, cues and experienced outcomes, as they are discussed in Chapter 5.3:

For wash frequency/wash loads

- The cue of starting the laundry process when the basket is full is maintained, but now used as a cue to a sustainable script, since a laundry bag filled to the line equals a full wash load.
- To counter the need for a scheduled laundry day, the bags in which the laundry is already separated remove the extra process step of separating laundry for the user. This way the user can immediately see which bags are still under-filled when starting the laundry process, and the user now knows that that particular bag can wait until a later date.

For temperature

- The cue of having to choose a temperature is removed altogether since the choice is now made by the washing machine.
- Since the machine adapts the temperature to the observed dirt levels in the water, the user does not have to doubt the effectiveness of the temperature. There is no need to doubt the effectiveness of an energy efficient wash, since the machine will let the temperature rise if it is actually needed.
- The automatic rinse-hold function is used to make it more convenient for the user to use a long washing programme duration. Whereas normally the ECO-programme could be considered more difficult to schedule, the rinse-hold function allows the user to come back to end the wash at any point later in the day, rather than having to be present at a specific moment when the wash is ended.

For detergent use

- The cues related to adding detergent are removed entirely, since the machine regulates the detergent automatically.

For efficient use of the product's parts

- Sharing the machine can have several positive outcomes for users in this concept. Washing at someone else's HOMIE washing machine is more affordable than visiting a launderette, letting someone use your washing machine can earn a user money, and sharing a wash with others allows users to split costs.

Used intervention methods

- Eco-choice: The indicator lines on the bags show the sustainable option of washing with a full load. Sharing the washing machine with others is also a choice that is made available in this concept.
- Clever design: Without involving the user in the decision making process, the temperature, the amount of detergent and the washing programme are all chosen automatically.

Factors influencing user acceptance

- Apparent influence on environmental impact: the user knows that the most sustainable options are chosen in relation to the water, energy and detergent consumption.
- Convenience (reduced time/effort): the laundry bags make additional time and effort spent on separating the laundry no longer necessary. Additionally, the washing process now only requires a single push of a button, and all the settings and the adding of detergent are taken care of.
- Assurance of good washing results (clean/fresh/colours/specific treatments): since the machine observes the level of dirt in the water and can adapt the washing programme to it, the user knows that the machine will use additional resources to clean effectively when it is needed.

Washing price

There will now be a single price per wash. The user does not make choices regarding the temperatures anymore, so the separate prices for each washing temperature are no longer needed. The price of €1.31 per wash will be used, since this is the middle option (40°C) of HOMIE's current prices. This means that the income from the washing prices will stay roughly the same, as the current temperature average of HOMIE's customers was established to be 37°C in Chapter 5.1.

Feasibility (required business model changes)

New elements in the business model include:

- *Key partnerships:* HOMIE does not have the resources to manufacture the adapted washing machine within its current business model. A business partner would be needed to manufacture the washing machine, and could be a company like Gorenje (Gorenje, 2017). Gorenje has already indicated interest to HOMIE in developing new washing machine models aimed at sustainability, so this household appliance manufacturer could be a suitable partner for the production of such a washing machine.
- Since HOMIE has no resources to produce the laundry bags, a new partnership would include any company that had the resources to produce nylon mesh bags with print.
- Also, an external app development party would have to create the washing feedback app.
- *Cost structure:* The manufacturing costs of the washing machine (and for HOMIE, the acquisition costs) would rise due to the addition of the new front panel, the new programming, the weight sensor, the optical sensor, the photodiode+LED combination and the adapted detergent tray.
- Extra investment would also be needed for acquiring the laundry bags, and for the development of the app. These factors are taken

into account in the Concept Comparison (Chapter 8.4).

HOMIE value proposition

No changes occur in relation to HOMIE's value proposition elements of reliability, control, low initial costs, independence and the use of an A+++ machine.

8.4 Concept Comparison

In order to choose which concept presents the most value in regard to the established criteria, the concepts will be compared using the wishes that were listed in Chapter 6 (Requirements).

8.4.1 Design interventions focused on product-led use decisions

To increase the degree of certainty that the interventions will have a significant effect on the washing behaviour, using the design interventions from Tang (2010) which focus on product-led decision making, are preferred over the ones where the decisions are still led by the user.

HOMIE+

Using eco-information, eco-choice and eco-spur as design interventions, the concept is very much centred around **user-led** decision making.

The guiding HOMIE

Also using eco-information, eco-choice and eco-spur, this concept utilises the eco-steer intervention as well, moving **more towards product-led decision** making.

The HOME-run

Three of the environmental impact factors are addressed using the eco-choice intervention, the others are addressed by clever design interventions, where the use decisions are fully **product-led**.

8.4.2 As many environmental impact factors as possible

To influence the full range of different elements that play a part in generating the environmental impact (Chapter 2.2.2), the concept has to influence as many environmental impact factors as possible

HOMIE+
This concept targets **3** of the environmental impact factors:
- wash load
- wash frequency
- temperature

The guiding HOMIE
The second concept targets **4** of the environmental impact factors:
- wash load
- wash frequency
- temperature
- detergent use

The HOME-run
This concept targets all **5** of the environmental impact factors:
- wash load
- wash frequency
- temperature
- detergent use
- efficient use of the product parts

8.4.3 Break-even point

Appendix G presents overviews of rough cost estimations for the three concepts.

If the same washing price is maintained throughout all three concepts – €1.31 (the price of a 40°C wash at HOMIE (Chapter 3.1.3)) – and an average number of 13.29 washes per month (derived from the Dutch average of 3.1 per week (I Prefer 30°, 2013)) is used for the calculation, the break-even point for the different concepts can be compared using rough estimation of the investment costs per concept.

Rough estimations are made to calculate the costs for each concept. The assumption is made that an external party will manufacture the adapted washing machine models (for the "Guiding HOMIE" and "HOME-run" concepts) and provide it for a similar price margin to that of the currently used Zanussi model.
UK Whitegoods (2016) estimated the production costs of an average washing machine to be around 40% of its price in the store, so the costs for additoinal product components in Appendix G are multiplied using this same margin.

In this calculation, the break-even point for a single machine happens after the following period of time:

	Investment/machine	Break-even point
Current HOMIE model	€ 385.-	23 months
HOMIE+	€ 435.-	25 months
The guiding HOMIE	€ 485.-	28 months
The HOME-run	€ 585.-	33 months

8.4.4 Conclusion

The fully automated "HOME-run" concept presents the most value in terms of making a difference in the environmental impact of washing machine use and offering convenience to the user. It tackles all 5 environmental impact factors, and focuses mainly on product-led decision making, increasing the likelihood of influencing the environmental impact (as discussed in Chapter 2.2.3).

However, for HOMIE, a company that does not manufacture washing machines, this concept also requires the most resources outside the company's reach. The concept willl require a key partnership with a company (e.g. Gorenje) that is willing to create a new washing machine adapted to motivate sustainable washing behaviour. The higher investment costs mean that the concept will take roughly 8 months longer (a 32% increase in time) to break even compared to the first concept.

As a result, a combination of the "HOMIE+" and the "HOME-run" concepts is chosen. The first concept presents solutions that are easily implemented with HOMIE's current resources, which require relatively little extra investment. These solutions could be implemented in the near future, leaving time to prepare for the implementation of the "HOME-run" concept (Figure 69).

Of the two concepts that feature product design changes, the "HOME-run" concept shows the most extensive potential for both environmental impact improvement and offering convenience to the user. This concept would require a period to create a new partnership for the development and manufacturing of the new washing machine features. Since Gorenje has indicated interest in developing new washing machine models suited for pay-per-use models and aimed at generating less environmental impact (Chapter 8.3.3), the company could be a suitable candidate to develop this concept further with, given its experience in the home appliance market.

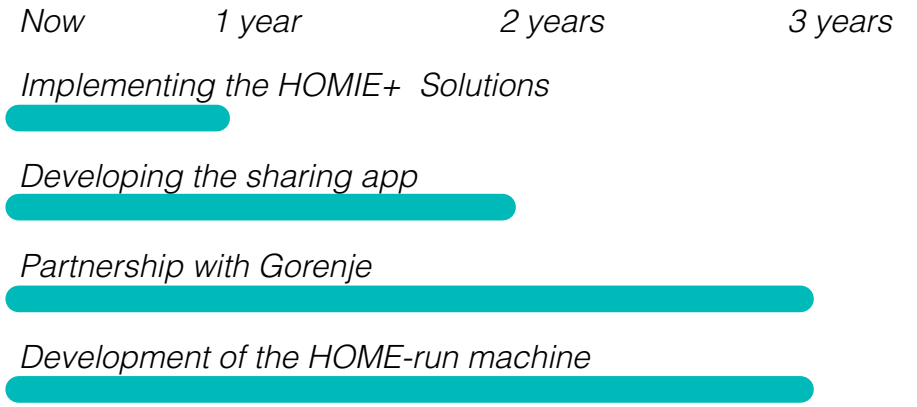


Figure 69: Envisioned time line

Necessity for validation

The use of product-led decision making in the HOME-run concept creates a higher likelihood of establishing change towards more sustainable washing behaviour than other design interventions that leave the choices to the user instead (Tang, 2010) (Wever et al., 2008).

However, the Literature chapter (Chapter 2) indicated that the user acceptance of these design interventions is another essential factor in the effectiveness of creating sustainable behaviour (Wever et al., 2008), since the user acceptance can be hampered when the user feels that the intervention is too intrusive (Tromp et al., 2011). As a result, the user has to be motivated to change (Kobus et al., 2013) in order to accept the design interventions, which is why it is essential that the concept performs well enough in regard to the user's needs.

The next chapter focuses on establishing an insight into how people view the HOME-run concept in regard to the user needs listed in the Requirements chapter (Chapter 6).

9 Validation

9.1 Goal

The “HOME-run” concept, chosen as a long-term solution in Chapter 8.4, uses design interventions to reduce the environmental impact of the washing process that are mainly focused around product-led decision making (Tang, 2010). As discussed in the Requirements (Chapter 6), although design interventions centred around product-led decision making increase the likelihood of creating a difference in the environmental impact, they are also more likely not to be accepted by users because the users are not in control of the decisions (Tang, 2010). When using this type of intervention, the user has to be motivated to accept these interventions. For this, the concept has to stay centred around the central values for the user: the apparent potential to reduce environmental impact, an increase in convenience (related to saving either time or effort), and the certainty of getting effective wash results (Chapter 6: Requirements).

In order to know whether the automated washing experience of the “HOME-run” could be successfully implemented, this validation chapter focuses on assessing the user acceptance of the concept.

The research question of this validation is:

- Will users accept the interventions from the “HOME-run” concept?

Sub-questions are:

- What would motivate participants to accept the concept?
- What would deter the participants from accepting the concept?
- Do the users perceive the concept as being more sustainable than a regular washing machine, more convenient and more trustworthy in providing effective washing results?
- Is there a difference between demographic groups in user acceptance of the concept?

9.2 Method

A survey was chosen as a method to answer the research questions, since it allows for the quick assessment of the opinions of a large group of participants and to assess potential differences between demographic groups among the participants. The survey was spread through social media, and was filled out by 77 participants, ages ranging from 18 to 82 (with an average age of 34.1), with 61% female and 39% male participants.

The survey itself is shown in Appendix H. After showing the participants a quick storyboard of the interaction with the “HOME-run” concept, the participants were asked several questions:

- Overall opinion: participants were asked to give scores on two Likert scale questions (7-point Likert scales, 1 being the lowest possible score, 4 the neutral score, and 7 the highest score) to indicate their

overall opinion of the concept, before answering two open questions where they could list reasons why they would or would not want to make use of the concept.

- Convenience: three Likert scale questions were used to assess whether participants thought the concept would be more or less convenient compared to a normal washing machine interaction.
- Effective washing result: three Likert scale questions were used to assess whether participants would feel more secure of an effective washing result than they would be when using a normal washing machine interaction, or less secure.
- Sustainable washing: four Likert scale questions were used to assess whether the participants thought the concept would reduce the environmental impact of the washing process or not.

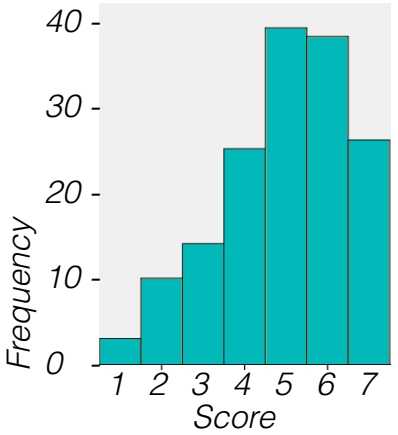
For each of the four question groups, the averages of the Likert scale questions were taken to provide an overall score for that subject. The results from the two open questions about why participants would want to make use of the concept or not, were categorised to provide an insight into the most prevalent listed reasons.

9.3 Results

Overall opinion

The overall opinion Likert scales gave an average score 4.97, indicating a generally positive opinion of the concept (Figure 70).

Figure 70: Overall opinion



For the reasons why participants would want to make use of the concept:

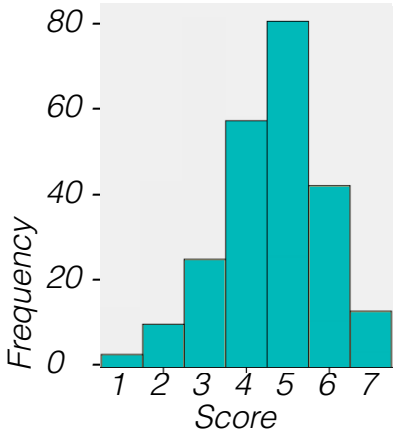
- 35 indicated that they would consider the concept to be easier to use
- 15 indicated it would be less effort
- 14 indicated they thought it would save them time

On the other hand, for the reasons why participants would not want to make use of the concept:

- 14 indicated they would doubt the results of the wash
- 11 thought the bags would be more of a hassle to handle
- 10 indicated they wanted to retain more control of the washing process

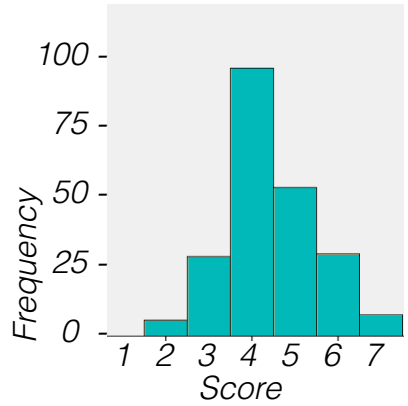
The overall convenience (Figure 71) of the concept scored a 4.65 average, again scoring above 4, indicating that the average participants considered the concept to be more convenient than a regular washing process.

Figure 71: Overall convenience



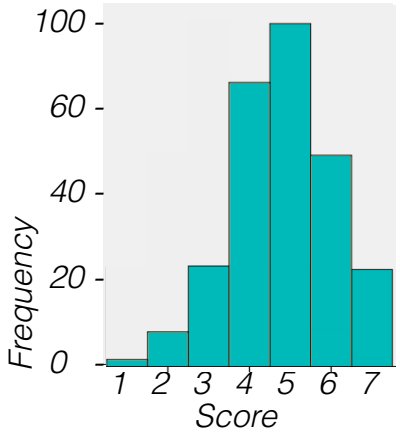
The overall trust in the effective washing result (Figure 72) scored 4.43, indicating that on average, participants believed the concept to provide a higher degree of certainty of an effective washing result than a normal washing machine. However, here the results peak at a neutral score of 4, rather than at 5 like with the previous points.

Figure 72: Trust in effective cleaning



The sustainable washing (Figure 73) score average was 4.80, indicating that participants on average believed using the concept would help reduce the environmental impact.

Figure 73: Sustainability



A One-Way ANOVA statistical analysis was used to see whether there was any significant connection between the overall opinion and either the age group or the number of years people had been doing the laundry. This analysis produced no significant results, so neither the amount of time people had been washing nor their age influenced their overall opinion of the concept.

9.4 Conclusion

Overall the “HOME-run” concept scores well in terms of user acceptance. All average scores were above 4: overall opinion, convenience, trust in washing results and perceived sustainability.

However, the reasons listed for not wanting to use the concept provided insight in how the concept could be further improved:

- 14 of the participants (18%) did not fully trust the concept to always provide effective washing results (the “trust in effective cleaning“ results also provided the lowest average Likert-scale scores). Four participants indicated that they had doubts about whether specific washes (sports clothing, bed linens, delicates) would receive the correct wash treatment that they wanted.
- 11 of the participants (14%) thought the bags would be inconvenient to use. The convenience could be improved by making the laundry bags less of an effort to sort out and handle. Having several bags lying around, each of which is meant for a specific fabric type, was considered to be inconvenient by these participants.
- 10 of the participants (13%) did not feel comfortable giving away all control over the washing process.

9.5 Adapting the concept

In order to improve the user acceptance of the “HOME-run” concept based on the identified reasons from the survey for not accepting the concept, several adaptations were made.
These changes were intended to make the laundry bags more convenient to use, to enable users to develop more trust in the concept to provide effective washing results, and to provide an increased feeling of being in control of the washing process. The following adaptations were added to the concept:

Laundry bags

The NFC tags were removed from the laundry bags. This change allows users to use any bag they want to gather a specific load of laundry, without having to sort through the bags first to find the correct one. Additionally, the bags are now closed using a cord instead of a zipper, requiring less effort to open and close (Figure 74).

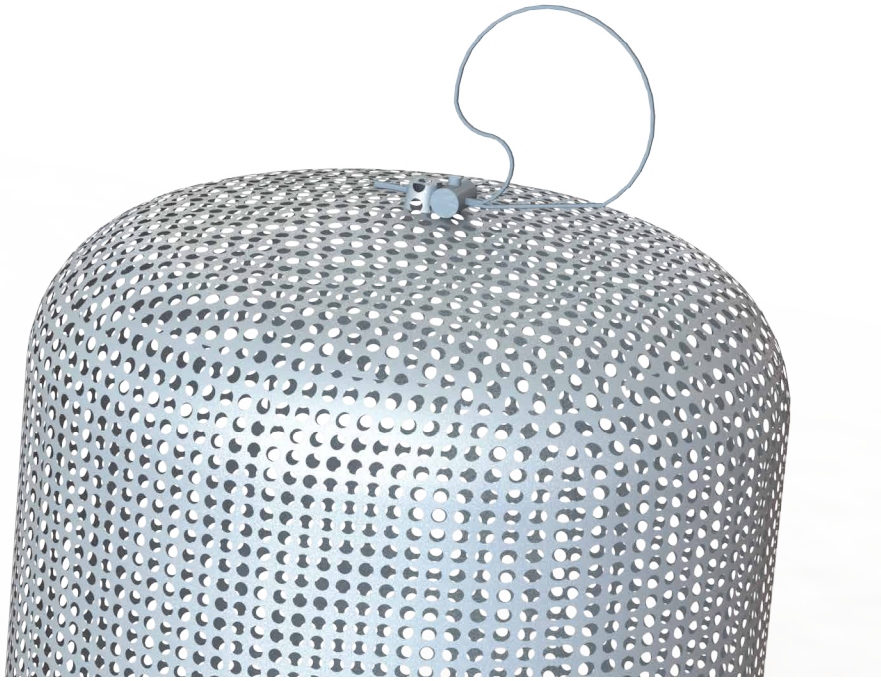


Figure 74

To ensure fuller trust in the effective cleaning of the washing process, and to provide users with more of a sensation of being in control, an extra function is added to the start/finish button. Since the fabric type can no longer be selected using the NFC scanner, the user now selects either “Cotton”, ”Jeans”, ”Synthetics”, ”Delicates”, ”Wool” or ”Intense cleaning” using the start/finish button (Figure 75).

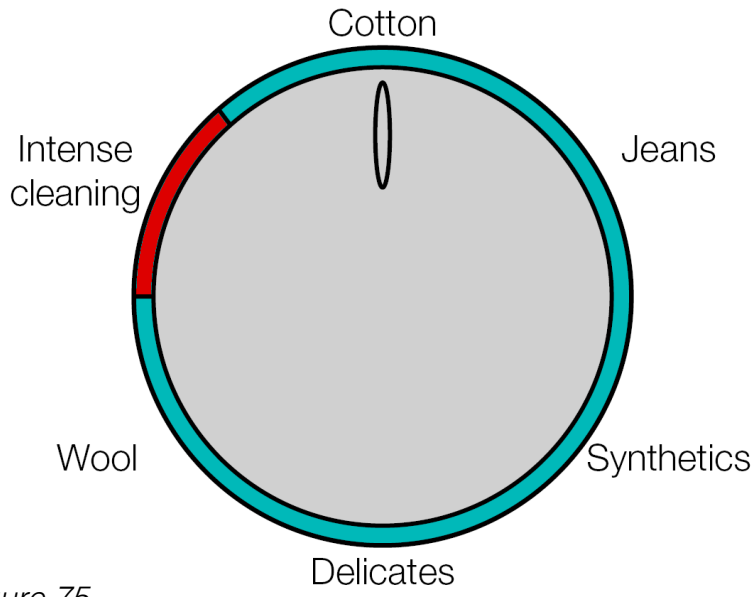


Figure 75

The “Intense cleaning” option lets the user override the machine’s assessment of dirt levels in the water and choose a minimum of 60°C instead.
The other programmes will also reach high temperatures if the washing machine deems it necessary based on its measurements, but the “Intense cleaning” mode ensures the user that the machine will use a hot setting whenever the user chooses this mode.

To discourage constant use of the “Intense cleaning” mode, this setting is the only one that will cost 1.5 times more than the set washing price of €1.31.

Users now have control when they deem it necessary to wash with a minimum temperature of 60°C, but they know that they can save a third of the €1.97 washing price if they let the machine decide whether the high temperature is necessary.

9.6 Validating the effect of the concept adaptations

In order to establish whether the aforementioned changes to the “HOME-run” concept actually serve their purpose and increase the user acceptance of the concept, a second survey was conducted.

The issues the participants had concerning the convenience of the laundry bags is easily solved through practical solutions (Chapter 9.5).

However, it is harder to estimate based on theory at which point users will feel comfortable with the amount of control over their washing process, and when they have enough trust in the effectiveness of the wash.

That is why this second survey focuses on establishing whether users feel comfortable with the amount of control they have over the washing process in the adapted “HOME-run” concept, and whether they trust the concept to produce effective washing results.

9.6.1 Goal

The goal of this second survey (which can be found in Appendix H) is to establish how the adapted concept compares to the original version in terms of user acceptance.

In order to assess the effect of the changes, this survey aims to answer three questions:

- Do participants feel comfortable with the amount of control they have over the adapted concept?
- Do participants trust the adapted concept to wash effectively?
- Do these values show significant improvement compared to the original version of the concept?

9.6.2 Method

The survey first showed a storyboard of the original, unadapted, interaction, followed by several Likert-scale questions:

- Two Likert-scale questions were used to establish whether participants felt comfortable with the amount of control they would have over the washing process.
- Three Likert-scale questions were used to establish whether participants fully trusted the concept to produce effective cleaning results.

The same questions were then repeated for the second, adapted, interaction.

The survey was spread through social media, and was filled out by 67 participants, ages ranging from 17 to 80 (with an average age of 32.5), with 55% female and 45% male participants.

For both question groups, the averages of the Likert scale questions were taken to give an overall score for that subject. The scores for both versions of the concept were then compared using a dependent T-test in SPSS, in order to establish whether the values differed significantly between the two concept versions.

9.6.3 Results

Comfort with level of control

Participants gave both interactions positive scores on how comfortable they felt with the level of control they would have over the washing process. The adapted interaction produced a significantly higher value than the original interaction though, with a mean of M=5.22, compared to the original concept's M=4.43. The difference between the two versions of the concept proved statistically significant in the dependent T-test, with a significance value of Sig.=0.000 (below 0.05 can be considered statistically significant).

Trust in effective washing result

For the second criterion, the participants gave positive scores to both versions of the concept as well. The adapted interaction produced a mean value of M=5.12, the original interaction scored lower with a mean value of M=4.50. The difference between the two means was once again statistically significant with a significance value of Sig.=0.000.

9.6.4 Conclusion

Implementing the changes in the design (discussed in Chapter 9.5) significantly improves both the trust in the washing result, and the acceptance of the level of control the user will have over the washing process.

Since the trust in the washing results is one of the most important user needs (see Chapter 6), and the user acceptance is an essential factor in making the implementation of design interventions centred around product-led use decisions successful (see Chapter 2.2.3), the changes to the concept are valuable in making the concept a success.

One issue that the changes present is that users might now still misuse the product and use the “Intense cleaning“ more often than is actually needed. The large price difference between the “Intense cleaning“ setting and the rest of the programmes is intended to combat this effect. However, if laundry is dirty enough to actually warrant a high washing temperature, using the setting would not actually create a higher environmental impact, since the machine would have chosen a high temperature based on the level of dirt.

10 Conclusion

This chapter looks back at the outcomes presented in this report, and provides answers to the research questions that were established in the Problem Definition (Chapter 1.2).

Research questions

The goal of this project was to generate answers to the following two research questions:

- RQ1: To what extent is HOMIE already creating sustainable customer behaviour through the currently implemented design interventions? How does the environmental impact compare to average washing machine use, and what level of change is reached through the current interventions?
- RQ2: Which design solutions can provide the best results in terms of environmental impact, customer satisfaction and business viability in the envisioned intervention steps? Which design and business model solutions can provide the best results for creating the sustainable customer behaviour interventions?

10.1 Research Question 1 HOMIE's current effect on customer behaviour

Understanding sustainability for washing machines

The Literature review (Chapter 2) revealed that the environmental impact of washing machines mostly takes place during the use phase, and is largely influenced by the way consumers use the product. There are five main factors which should be taken into account when assessing the environmental impact of washing machines, and these are:

- Increasing the wash load
- Decreasing wash frequency
- Reducing the amount of detergent used
- Using low temperature settings
- Making optimal use of the machine's parts (through sharing, proper maintenance and recycling)

(Bourrier at al., 2011) (Koerner et al., 2011)

Concerning these points, there is no data available on the amount of laundry HOMIE's customers wash per load or on how much detergent HOMIE's customers use. The other aspects are discussed in the following section, based on the analysis from Chapter 5.1 and 5.2.

HOMIE's current influence on washing behaviour

Although there is no data available concerning HOMIE's effect on wash load sizes and detergent use, the current business model does have a statistically significant positive effect on both the wash frequency and the washing temperature. Both HOMIE's average wash frequency and wash temperature have significantly lower values than the Dutch average (see Chapter 5.1 and 5.2).

The only statistically significant difference in wash frequency between different months of washing at HOMIE, takes place in the month of free washing. The free washing month creates a spike in the wash frequency data, but there are no significant differences between other months and no significant differences between the temperatures throughout the months.

This suggests that the monthly feedback mailings to HOMIE's customers have no significant effect on the customer behaviour (since that would result in more significant differences between the different months), whereas the payment model does have a significant influence on the washing behaviour (which is shown by the overall effect on wash frequency and temperature, and the significant rise in frequency during the free month).

10.2 Research Question 2
Design and business model solutions for sustainable customer behaviour interventions

New design intervention solutions were developed to provide the best results possible in terms of environmental impact, customer satisfaction and business viability.

Improving the environmental impact of washing behaviour

The HOME-run concept (Chapter 8.3) utilises design interventions centred around product/service led use decisions (Tang, 2010), in order to provide a high degree of certainty that it can influence customer behaviour to become more sustainable (Tang, 2010) (Wever et al., 2008).

The concept automates several aspects of the wash by regulating the detergent automatically and automating the temperature and washing programme. Although the concept is aimed at motivating users to accept these design interventions by adding value to the established customer needs (Chapter 6), some users did not feel comfortable with the lack of control over the washing process and did not fully trust the concept to always provide effective washing results (Chapter 9).

As a result, in order to increase the user acceptance, the final version of the concept provides a single override function in the washing machine's control, to provide users with both a degree of control and more trust in good washing results.

The high degree of certainty offered by product/service-led decisions, combined with a regard for user acceptance, are major factors in creating behavioural change towards sustainable washing (Chapter 2.2.3).

Additionally, the concept lets users gather laundry in separated bags in order to facilitate washing with full loads of laundry, and it provides the user with the option to share the washing machine with others, in order to make more efficient use of the resources.

Customer satisfaction

The concept targets the main customer satisfaction criteria (Chapter 6) in the following ways:

- Having an apparent influence on the environmental impact: The concept guarantees that it will always use the most efficient settings possible in terms of water, energy and detergent, as long as the user does not use the override option. Additionally, the concept facilitates both washing with fuller loads, as well as the sharing of washing machines with others, in order to make more efficient use of the resources that are being used.
- Convenience: The concept facilitates the laundry gathering process by providing separate bags in which laundry can be separated

already while gathering it. Additionally, by automating detergent use and temperature/programme selection, the user will spend less time and effort on the laundry process.

- Assurance of effective washing results: By measuring the amount of laundry, the colour of the laundry and the amount of dirt, the concept automatically adapts the necessary amounts of water, energy and detergent levels to clean the wash effectively. Additionally, the override function was added to give the user an extra way to be assured of effective cleaning results.

Business opportunity

The concept presents value based on both the competitor analysis (Chapter 4.1) and the SWOT analysis (Chapter 4.2).

Both the values of convenience and sustainability (main values of the concept, as discussed in the previous paragraph), were established to offer potential to differentiate from the current competitors in the market.

An analysis of HOMIE's strengths and weaknesses, and the washing machine industry's opportunities and threats, indicated convenience (reducing time and effort) and sustainability as areas to focus on in regard to the current strategic environment of HOMIE. Furthermore there is a need to focus on providing for various washing needs and dealing with a lack of trust in cold washes.

How the HOME-run concept targets the sustainability and convenience (which includes time and effort) aspects, was already discussed in the previous two paragraphs.

In regard to the various washing needs and lack of trust in cold washes: the concept will automatically adapt to different types of washes, and the lack of trust in cold washes is circumvented in this concept by not letting the user make decisions concerning cold washes. The machine will only use a cold setting if that particular laundry load allows for it, but the user will not be aware of the particular temperature the wash is run on.

Overall value of the concepts

Although the HOME-run concept provides a lot of opportunity related to reducing the environmental impact, offering value to the user and differentiating from competition, it requires a lot of change to HOMIE's business model, as well as a higher investment than the other concepts.

As a result, the short-term solutions presented in the HOMIE+ concept (Chapter 8.1) were also chosen to be implemented in this project's proposed solution, since the concept provides solutions which are easier to implement in HOMIE's current business model.

The HOMIE+ concept lacks the amount of benefit that the HOME-run concept presents in terms of sustainability, user satisfaction and competitive advantage, but it provides short-term, actionable solutions which could already be implemented during the development period of the HOME-run concept.

11 Discussion

11.1 Next steps

The next steps to be taken to further develop this project would include several aspects. On a design level, there has to be a detail design step, looking deeper into developing the concept on a technical level and fully testing its functionality. Specifics on material and production aspects would also need to be taken into account.

Linked to customer behaviour, further research is necessary to more fully understand the user acceptance of various degrees of design interventions related to the washing machine interaction. Which motivations exactly prompt users' need to feel in control of certain washing decisions?
This knowledge would be necessary to establish how an optimal balance could be reached between creating more certain behavioural change and still keeping the user motivated to accept the design interventions. User testing would be needed to establish what exact barrier is sufficient to deter users from overusing an override function in an otherwise automated interaction.
In the current solution, the price becomes 50% higher when the user chooses the override option, but no research was taken into account on what exact price difference would be efficient to demotivate overuse.

In the case of washing machines, changes in the product design offer great value since so much of the environmental impact is decided by which choices the user makes while starting the machine. However, product design changes currently fall completely outside of HOMIE's scope, and establishing the right kind of partnership with a home appliance manufacturer would be essential for the implementation of the HOME-run concept.

11.2 Relation to other research

The insights from this project add to the existing research on creating sustainable customer behaviour through design interventions. The project adds industry-specific insights relevant in reaching a fuller understanding of what has to be taken into account in the development of design interventions aimed at creating sustainable behaviour in the washing machine industry. The project also adds to research on understanding customer habits, and introduces industry-specific insights related to habit development in washing machine use.

11.3 Limitations

In this project, several factors can be identified that form limitations to the relevance of the outcomes

- For the competitive analysis, only a very limited number of competitors was taken into account. As a result, the impact of more classic washing machine manufacturers to the competitive landscape has been ignored.
- Some of the user data taken into account to establish Dutch and European washing values, were based on surveys conducted in 2011, whereas the average washing habits may have changed significantly in the meantime.
- All the data on Dutch and European washing habits were based on self-reported values from participants. This method of data collection might present more inaccuracies than actual measured data.
- Within the HOMIE customer data, most of the data was based on recorded washing behaviour, but the values for the customers' pre-HOMIE washing was based on self-reported data, which means

that the comparison of pre-HOMIE to at-HOMIE washing may have presented inaccurate results.

- Although both detergent use and wash loads were established to be important environmental impact factors, they are not taken into account in the comparison of HOMIE customers' washing habits and nationwide washing habits, due to the fact that there was no data available on these subjects. However, both the average wash load and detergent use may have a significant influence on the complete environmental impact of washing machine use.
- For the interviews, only nine participants were used, which could result in this research not taking into account relevant cues, scripts and experienced outcomes of washing habits that were not present among this particular sample of participants.
- To fully understand the actual effects the concepts have on sustainable washing behaviour, user tests of the concepts would have been necessary. Preferably, these would be conducted over the course of multiple months to be able to assess statistical differences between normal HOMIE customer washing behaviour and the washing behaviour that occurs when using the new concept. Now the assessment of changes in washing behaviour for all three of the developed concepts were based on assumptions from literature, the interviews and the surveys.

References

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. Journal of environmental psychology, 25(3), 273-291.

Agarwal, T. (n.d.). Photodiode working principle applications. Retrieved from ELPROCUS: https://www.elprocus.com/photodiode-working-principle-applications/

Ajzen, I. (1991). The theory of planned behavior. Organizational behavior and human decision processes, 50(2), 179-211.

Aldred, J. (2008, March 7). Tread lightly: Keep your kettle in check. Retrieved from The Guardian: https://www.theguardian.com/environment/ethicallivingblog/2008/mar/07/keepyourkettleincheck

Alibaba. (2017). Retrieved from Alibaba: https://www.alibaba.com/

Amazon. (2017). Metaltex. Retrieved from Amazon: https://www.amazon.co.uk/Metaltex-Protective-Laundry-Bag-White/dp/B00K8TB97G

American Fiber Manufacturers Association, Inc. (2017). Nylon. Retrieved from American Fiber Manufacturers Association, Inc.: http://www.fibersource.com/fiber-products/nylon-fiber/

Appspecialisten. (2017). Mijn MKB app. Retrieved from Appspecialisten: https://www.appspecialisten.nl/app-ontwikkelaars/mijnmkbapp

Baus, C. (2015, July 30). What do consumers look for in a washing machine? Retrieved from Euromonitor International: http://blog.euromonitor.com/2015/07/what-do-consumers-look-for-in-a-washing-machine.html

Bocken, N. (2017). Business-led sustainable consumption initiatives: impacts and lessons learned. Journal of Management Development, 36(1).

Bocken, N. M. P., & Short, S. W. (2016). Towards a sufficiency-driven business model: Experiences and opportunities. Environmental Innovation and Societal Transitions, 18, 41-61.

Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. Journal of cleaner production, 65, 42-56.

Bourrier, C., Corsini, F., Danthurebandara, M., Fuchs, K., Olloz, S., Poulikidou, S., ... & Singh, R. (2011). Washing Machine. ETH Sustainability Summer School.

Bruens, G. (2007). Form/Color Anatomy. The Hague: Eleven International Publishing.

Bundles. (2017). Bundles - We love laundry. Retrieved from https://www.bundles.nl/

Drukwerkdeal. (2017). Stickers. Retrieved from Drukwerkdeal: https://www.drukwerkdeal.nl/nl/producten/stickers/stickers-klein-formaat

Valencia Cardona, A. M., Mugge, R., Schoormans, J. P. L., & Schifferstein, H. N. J. (2014). Challenges in the design of smart product-service systems (PSSs): Experiences from practitioners. In Proceedings of the 19th DMI: Academic Design Management Conference. Design

Management in an Era of Disruption, London, UK, September 2-4, 2014. Design Management Institute.

Energy Saving Trust. (2013). At Home with Water.

EPA. (2017). Greenhouse Gases Equivalencies Calculator - Calculations and References. Retrieved from https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

European Union. (2017). Energy efficient products. Retrieved from European Commission: https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficient-products

Flown. (2017). Flown. Retrieved from Flown: http://www.flown.nl/

Froehlich, J. (2009). Promoting energy efficient behaviors in the home through feedback: The role of human-computer interaction. In Proc. HCIC Workshop (Vol. 9, pp. 1-11).

Gorenje. (2017, August). Washing Machines. Retrieved from Gorenje: http://www.gorenje.co.uk/products/laundry/models/washing-machines

Guppyfriend. (2017). Questions and answers. Retrieved from Guppyfriend: http://guppyfriend.com/en/testseite/warum-funktionierts-erklaerungen/anwendung/was-muss-ich-noch-ueber-die-benutzung-des-guppyfriends-wissen

Hatagar, S., & Halase, S. V. (2015). Three Input–One Output Fuzzy logic control of Washing Machine. vol, 4, 57-62.

Home-Tech. (2016, October 13). Home-Tech. Retrieved from Washing Machine Laundry Detergent Dispensing: https://www.home-tech.com/8350/washing-machine-laundry-detergent-dispensing/

HOMIE B.V. (2017). HOMIE Pay-per-use home appliances. Retrieved from https://www.homiepayperuse.com/

I Prefer 30°. (2013). The Case for the “A.I.S.E. Low Temperature Washing” Initiative.

Jager, W. (2003). Breaking bad habits: a dynamical perspective on habit formation and change. Human Decision-Making and Environmental Perception–Understanding and Assisting Human Decision-Making in Real Life Settings. Libor Amicorum for Charles Vlek, Groningen: University of Groningen.

Kinney, T. (2001, September 1). Proximity Sensors Compared: Inductive, Capacitive, Photoelectric, and Ultrasonic. Retrieved from Machine Design: Proximity Sensors Compared: Inductive, Capacitive, Photoelectric, and Ultrasonic

Kobus, C. B., Mugge, R., & Schoormans, J. P. (2013). Washing when the sun is shining! How users interact with a household energy management system. Ergonomics, 56(3), 451-462.

Koerner, M., Schulz, M., Powell, S., & Ercolani, M. (2011). The life cycle assessment of clothes washing options for city west water’s residential customer. In ALCAS Aust. Life Cycle Assess. Soc. Conf.

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior?. Environmental education research, 8(3), 239-260.

Lally, P., Van Jaarsveld, C. H., Potts, H. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. European journal of social psychology, 40(6), 998-1009.

Lilley, D. (2009). Design for sustainable behaviour: strategies and perceptions. Design Studies, 30(6), 704-720.

Lockton, D., Harrison, D., & Stanton, N. A. (2010). The Design with Intent Method: A design tool for influencing user behaviour. Applied ergonomics, 41(3), 382-392.

Mansouri, I., Newborough, M., & Probert, D. (1996). Energy consumption in UK households: impact of domestic electrical appliances. Applied Energy, 54(3), 211-285.

MacArthur, E. (2013). Towards the circular economy. J. Ind. Ecol.

Meo Lease. (2017). Retrieved from Meo Lease: http://meolease.nl/

Nielsen. (2016). The Dirt on Cleaning: Home cleaning/laundry attitudes and trends around the world. Nielsen.

Samsung. (2017A, Januari 11). What is Fuzzy Logic in a Washing Machine? Retrieved from Samsung: http://www.samsung.com/in/support/skp/faq/138486

Samsung. (2017B, August). WW9000 Washing Machine with ecobubble, 10kg. Retrieved from Samsung: http://www.samsung.com/uk/laundry/washer-ww10h9600ew/

Selvefors, A., Pedersen, K. B., & Rahe, U. (2011, June). Design for sustainable consumption behaviour: systematising the use of behavioural intervention strategies. In Proceedings of the 2011 Conference on Designing Pleasurable Products and Interfaces (p. 3). ACM.

ShopNFC. (2017). Laundry Tag. Retrieved from ShopNFC: https://www.shopnfc.it/en/nfc-asset-tags/117-laundry-tag-ntag213-22mm.html

Skala. (2017). Skala. Retrieved from Skala.nl: https://www.skala.nl/

Söderlund, M. (1990). Energy conservation by changing energy consumer behaviour. In Proceedings of ACEEE (pp. 131-139).

Splash. (2017). Splash. Retrieved from Splash lease: https://www.splash.nl/

Tang, T. (2010). Towards sustainable use: design behaviour intervention to reduce household environment impact (Doctoral dissertation, © Tang Tang).

Tromp, N., Hekkert, P., & Verbeek, P. P. (2011). Design for socially responsible behavior: a classification of influence based on intended user experience. Design Issues, 27(3), 3-19.

Tukker, A. (2004). Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet. Business strategy and the

environment, 13(4), 246-260.

uk whitegoods. (2016, August 1). Washing Machine Cost Breakdown. Retrieved from uk whitegoods: http://www.ukwhitegoods.co.uk/help/buying-advice/washing-machine/3502-washing-machine-cost-breakdown

Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. Journal of Public Policy & Marketing, 25(1), 90-103.

Wever, R., Van Kuijk, J., & Boks, C. (2008). User-centred design for sustainable behaviour. International journal of sustainable engineering, 1(1), 9-20.

Zanussi. (2017A). ZWF71443W. Retrieved from Zanussi: http://www.zanussi.nl/laundry/laundry/washing-machines/front-loader-washing-machine/zwf71443w/

Zanussi. (2017B). ZWF81663W. Retrieved from Zanussi: http://www.zanussi.nl/laundry/laundry/washing-machines/front-loader-washing-machine/zwf81663w/

ZipNFC. (2017). 20mm NFC Laundry Tag NXP NTAG213. Retrieved from ZipNFC: http://zipnfc.com/nfc-laundry-tag-20mm-pps-plastic.html

Images:

Aliexpress [Image] (2017). Retrieved October 3, 2017, from https://ae01.alicdn.com/kf/HTB17pCwSFXXXXaZXpXXq6xXFXXXp/High-Quality-Double-font-b-Laundry-b-font-font-b-Bag-b-font-font-b-Printing.jpg

Miele [Image] (2017). Retrieved August 10, 2017, from https://www.miele.nl/pmedia/06/Z13/20000101285-000-00_20000101285.jpg

Walmart [Image] (2017). Retrieved October 9, 2017, from https://www.walmart.com/ip/Whitmor-6154-111-White-Mesh-Laundry-Bag/23501897

Whirlpool [Image} (2017). Retrieved October 9, 2017, from https://www.whirlpool.com/is/image/content/dam/brand/whirlpool/en-us/feature/images/set-talent-p160064-1z.tif

Zanussi [Image] (2017). Retrieved August 10, 2017, from http://emea.electroluxmedia.com/assets/derivates/16/001/420/000/DEV_WS_PN_PSSZWM140P000098.png

Appendix

A Mailings

Mailing 1:

Beste *|FNAME|* ,

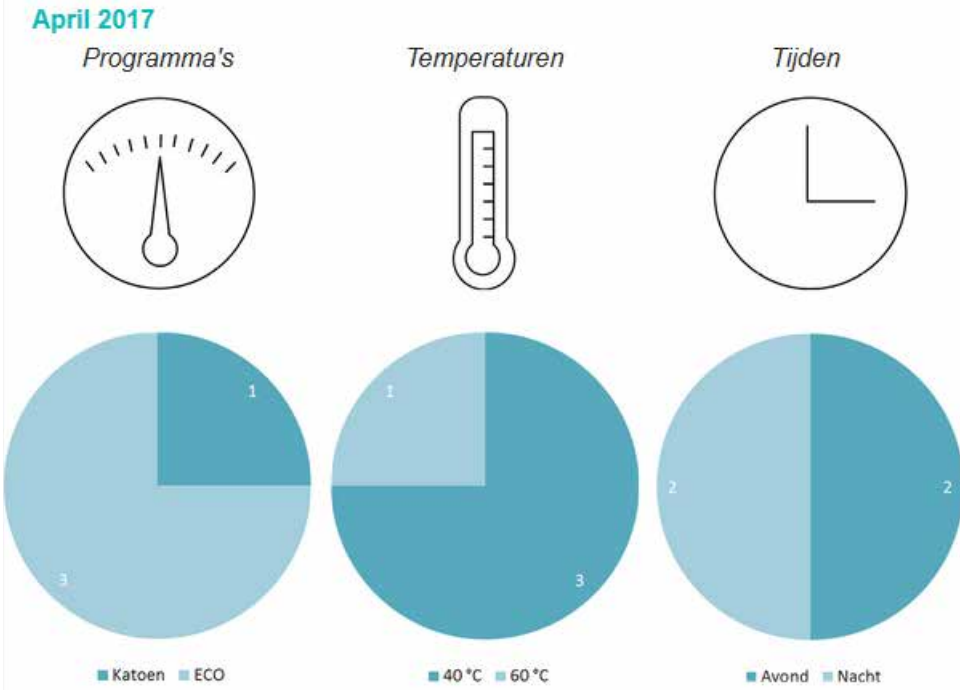
Hier bij HOMIE hopen we dat alles goed gaat met jou, én je Zanussi wasmachine. Vanaf vandaag zullen wij maandelijks een *persoonlijke gebruikersupdate* versturen met informatie over het gebruik van de wasmachine, aangezien wij graag onze klanten beter inzicht zouden willen geven in de manier waarop zij wassen.

Deze gebruikersupdate zal *alle wasdata in maand april* behandelen. Het doel van deze gebruikersupdate is inzicht te geven in de volgende 5 punten:

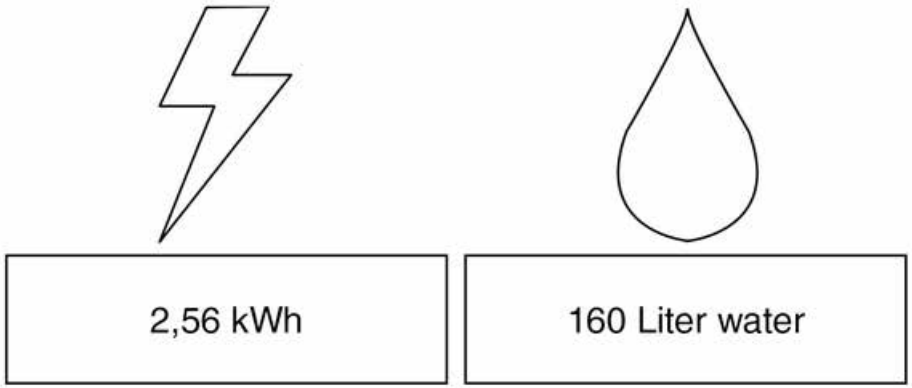
1. Je wasgedrag van afgelopen maand
2. Efficiënt wassen
3. Compensatie voor water- en energieverbruik
4. Tip: Meerdere e-mailadressen linken
5. Verdien extra wastegoed!

1. Wasgedrag van afgelopen maand

De volgende informatie is gebaseerd op onze data van de [...] wassen die je gedraaid hebt in de maand april:



Totaal verbruik april



Gebaseerd op deze informatie hebben wij enkele adviezen gegenereerd over hoe u de efficiëntie van de wasmachine zou kunnen verhogen.

2. Efficiënt wassen

We zien dat je al gebruik gemaakt hebt van het ECO-wasprogramma, goed bezig! *Het ECO programma kan namelijk tot 23% van de gebruikte energie besparen bij een 40 ºC was.* Dit komt doordat het ECO-programma niet gebruik maakt van hogere temperaturen, maar van langere inwerktijden om een effectieve wassessie te garanderen. Hierdoor kan de machine energie besparen bij het opwarmen van het water.

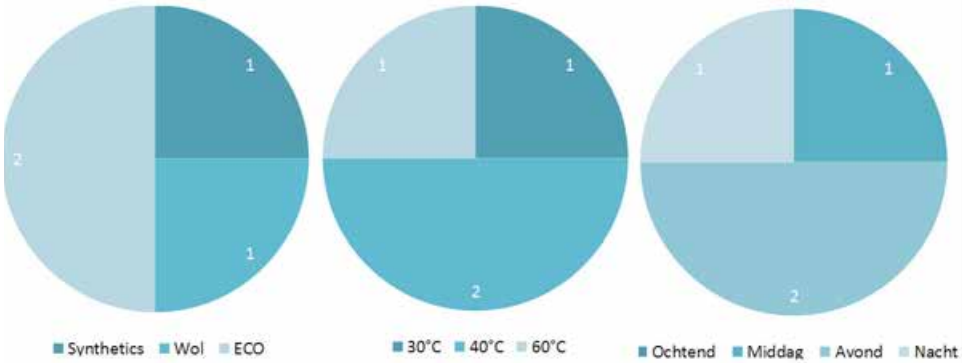
Wassen op koudere temperaturen kan aanzienlijk schelen in het energieverbruik van de wasmachine. Wist je dat je met ons koude wasprogramma nog eens *25% kan besparen ten opzichte van een 30 ºC was?*

Mailing 2:

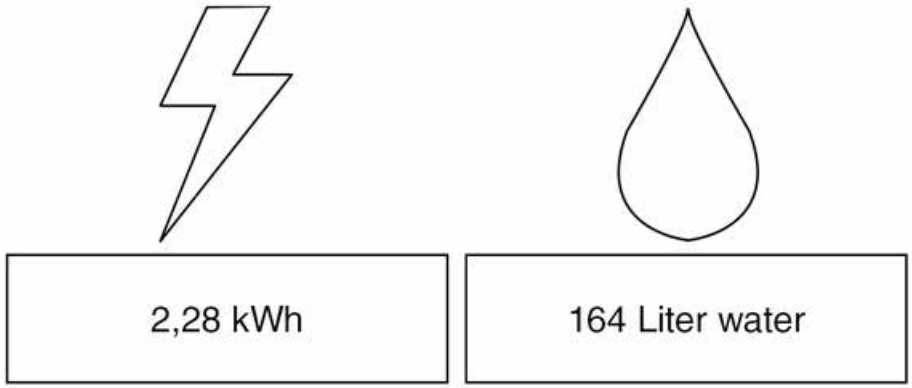
2. Wasgedrag van afgelopen maand

De volgende informatie is gebaseerd op onze data van de [...] wassen die je gedraaid hebt in de maand juli. Ter vergelijking staat je wasdata van de voorgaande maand er ook bij:

Juli 2017



Totaal verbruik juli



3. Efficiënt wassen

We zien dat je al gebruik hebt gemaakt van het ECO-wasprogramma, goed bezig! *Het ECO programma kan namelijk tot 23% van de gebruikte energie besparen bij een 40 ºC was.* Dit komt doordat het ECO-programma niet gebruik maakt van hogere temperaturen, maar van langere inwerktijden om een effectieve wassessie te garanderen. Hierdoor kan de machine energie besparen bij het opwarmen van het water.

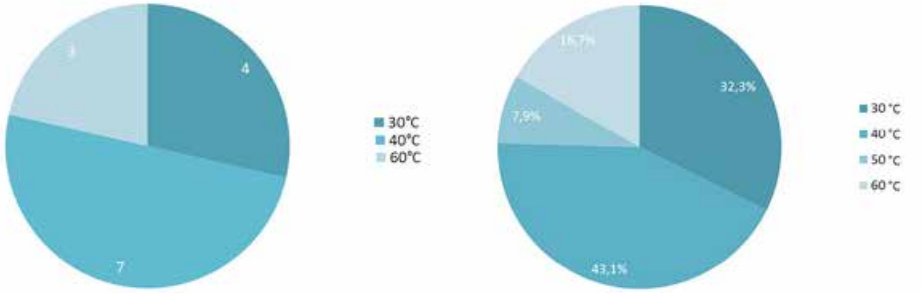
Wassen op koudere temperaturen kan aanzienlijk schelen in het energieverbruik van de wasmachine. Wist je dat een 30 ºC was al 25% goedkoper is in energieverbruik dan een 40 ºC was, en dat je *met ons koude wasprogramma nog eens 25% kan besparen ten opzichte van een 30 ºC was?*

Mailing 3:

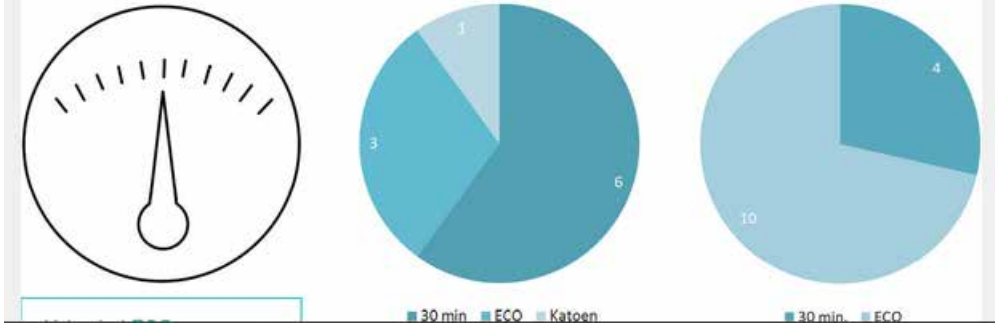
A. Gemiddelde gebruiker

Hieronder tonen we een kort overzicht van jouw waardes, én de waardes die gelden voor een gemiddeld Nederlands gezin van vier personen, gevolgd door een uitgebreider overzicht van jouw wasinformatie:

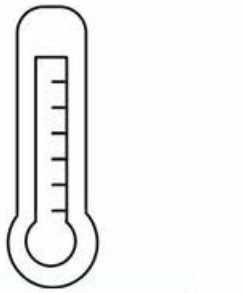
Jouw data		*Gemiddeld 4-persoonsgezin*	
14 wasbeurten/maand		31 wasbeurten/maand	
7,17 kWh energie	475 Liter water	14,5 kWh energie	1548 Liter water



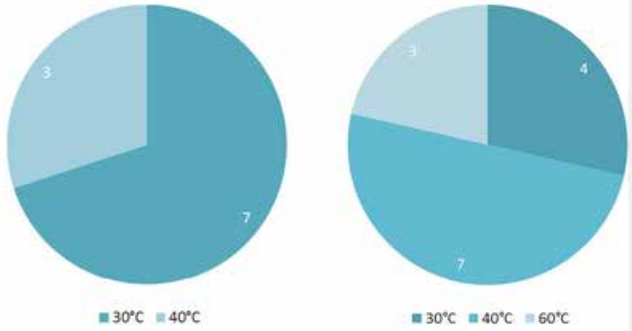
B. Programma



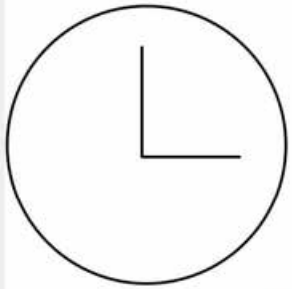
C. Temperatuur



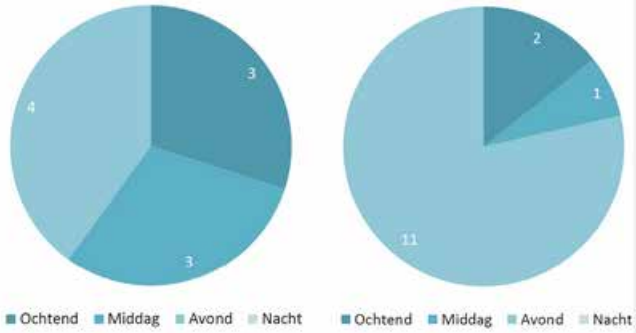
warme wassen gestegen



D. Tijden



niet 's nachts gewassen



E. Totaal verbruik

Mailing 4:

1. Duurzaam wasdoel

Bij HOMIE willen we jou graag helpen met nog duurzamer worden in hoe jij je wassen draait!

Daarom stellen we voor om een duurzaam doel te stellen voor de komende maand. Als je hieraan mee wilt doen zullen wij je wekelijks helpen met tips en terugkoppeling afgesteld op jouw wasgedrag.
Ons voorstel is om 20% minder wassen te draaien in de komende maand, maar je kunt zelf uiteraard ook andere opties aangeven.

Geef dus graag hieronder kort aan of je mee wilt doen met een duurzaam doel stellen of niet!

Vul in de Google Form in of je wel of niet een doel wil stellen voor duurzamer wassen in de komende maand.

Mailing 5:

Jouw meest gebruikte programma

Om je inzicht te geven in de wassen die je draait, hebben we hier wat informatie over jouw meest gebruikte wasprogramma:

0,66 kWh

62 L water

3:14 uur

Ter vergelijking, een lagere temperatuur heeft de volgende waardes:

0,35 kWh

44 L water

2:51 uur

B Advertising

C User survey

1	Persoonlijke gegevens
a	* Naam:
b	* Geslacht:
c	* Leeftijd:
d	Nationaliteit:
e	Hoogste voltooide opleiding:
f	* Indeling huishouden:
g	Wat voor werk doe je?
h	Wat is jullie gedeelde salaris?
i	* Ben je:
j	Kwam je huis gemeubileerd (inclusief wasmachine)?

2	Je huidige wasmachine
a	Waar staat je wasmachine?
b	Is je huidige wasmachine een los model of een inbouwmodel?
c	Hoe oud is je huidige wasmachine?
d	Van welk merk is je wasmachine? En welk model is het?
e	Heeft je machine ook een droogfunctie?
f	Hoe groot is het volume van je wastrommel?
g	Wie is de eigenaar van de wasmachine, en wie heeft de machine gekozen en/of betaald?
h	Wat zijn de 3 beste functies/eigenschappen van je huidige wasmachine?
i	Mis je nog iets bij je huidige machine? Welke functionaliteit had je graag gehad/zou je willen dat bestond?

3	Wasgedrag	
	a	Wie doet de was in het huishouden?
	b	* Hoe ziet een reguliere "wasweek" er voor jou uit? Hoeveel wassen draai je gemiddeld per week?
	c	* En op welke dagen meestal/hoe laat?
	d	* Wat voor een wassen draai je doorgaans? (wit/gekleurd/beddengoed/sportkleding/anders)
	e	Met wat voor een wasmiddel was je (merk, type), en hoeveel gebruik je dan? Gebruik je nog andere wasmiddelen?
	f	* Op wat voor een temperaturen was je meestal? Welke instellingen gebruik je dan?
	g	Wat vind je op het moment het lastigste/vervelendste aan de was doen?
	h	Heb je wel eens nagedacht over de volgende gebruikskosten van je wasmachine? (denk aan: kosten voor water, energieverbruik, afschrijvingskosten etc.
	i	Wat denk je dat 1 wasbeurt zou kosten, alles meegerekend? (Dus inclusief water, elektriciteit, wasmiddel en afschrijvingskosten)

4	Ervaringen met kapotte wasmachines	
	a	Heb je ooit problemen ondervonden met je wasmachine? En wat gebeurde er toen?
	b	Hoe was dat/hoe voelde jij je daarbij?
	c	Wat heb je toen gedaan? (bijv. monteur gebeld/laten repareren onder garantie/gelijk vervangen) Waarom?
		Drag & drop sub-questions here
5	Ervaring met het kopen van een wasmachine	
	a	Heb je ooit een nieuwe wasmachine gekocht? (Indien nee, ga naar vraag 5f)
	b	Hoe en waarom heb je je vorige wasmachine gekozen?
	c	Heb je toen de wasmachine gekocht die je wilde hebben? Heb je ook andere wasmachines overwogen, en waarom heb je die niet gekozen?
	d	Hoeveel heb je toen ongeveer betaald voor je wasmachine?
	e	Heb je nog andere mogelijkheden overwogen zoals leasen, de wassalon of nog andere opties?
	f	Wat zijn voor jou de 3 belangrijkste factoren bij het kopen van een wasmachine?

D Washing programme impact

Programme	Temperature	Actual Duration	Actual Energy usage (kWh)	Actual Water Usage (M3)
Cotton	Cold	118	0,19	0,054
Cotton	30°	129,5	0,35	0,044
Cotton	40°	191	0,66	0,062
Cotton	60°	150	0,99	0,042
Cotton	90°	194	1,71	0,066
Cotton ECO	40°	198	0,51	0,029
Cotton ECO	60°	249	0,88	0,040
Synthetics	Cold			
Synthetics	30°			
Synthetics	40°	135	0,54	0,051
Synthetics	60°			
Delicates	Cold			
Delicates	30°			
Delicates	40°	85	0,49	0,049
Wool Handwash	Cold			
Wool Handwash	30°			
Wool Handwash	40°			
Dark clothes	40°	195	0,47	0,028
Mix 20°	Cold	194	0,21	0,048
Rinse	Rinse/Spoelen			
Drain	Drain		0,06	0,000
Spin	Spin	14	0,06	0,000
Easy Iron	Cold			
Easy Iron	30°			
Easy Iron	40°			
Easy Iron	60°			
Refresh 20 min	30°			
Jeans	Cold			
Jeans	30°			
Jeans	40°	169	0,59	0,053
Jeans	60°			
30° 30min	30°	35	0,24	0,038

E Interview guide

Interview Guide

- Privacy etc.
- Recording
- No wrong answers
- Duration

Topic 1: Wasgewoontes

Openingsvraag:

- Zou je je gebruikelijke proces kunnen omschrijven waar je doorheen gaat als je je kleding gaat wassen?

Deelvragen:

- Wanneer draai je doorgaans je wassen? Na hoeveel tijd?
- Hoe vol gooi je de machine doorgaans? Varieert dit?
- Wat voor een wassen draai je dan? Bepaalde wassen op verschillende programma's? En waarom die programma's?
- Wat voor een wasmiddel? Hoeveel? Waarom?

Topic 2: Motivaties achter gewoontes

Openingsvraag:

- Hoe ben je je huidige wasgewoontes begonnen?

Deelvragen:

- Wat voor een dingen vind je belangrijk bij het doen van de was?
- Wat wil je bereiken? Of juist vermijden?
- Heb je de manier waarop je de was doet wel eens veranderd? Hoe? Waarom wel/niet?
- Heb je wel eens overwogen om op een andere manier te wassen?

Topic 3: Kennis over duurzaam wassen/intenties

Openingsvraag:

- In hoeverre denk je normaal gesproken na over de milieu-impact van de was doen?
- Hoe is dit veranderd sinds je bij HOMIE wast?

Deelvragen:

- Denk je dat je zelf de milieu-impact van de was doen kunt beïnvloeden? En op welke manier?
- Wat voor een dingen spelen een rol in de milieu-impact van je wassen?
- Wat speelt de belangrijkste rol? En waarom?
- Heb je het gevoel dat je al duurzaam wast of niet? En waarom?
- Heeft u het gevoel dat er vanuit andere mensen verwachtingen zijn over hoe duurzaam u wast? Van mensen in het algemeen, of mensen om u heen?
- Bent u zelf tevreden over hoe duurzaam u wast, of zou u er nog verandering in willen brengen?

F Interview summaries

Participant 1 (HOMIE). Category: sustainability

Priorities:

- Cleanliness
- Fresh smell
- **As efficient as possible**
- Clothes should not be dripping wet
- Clothes have to be taken out quickly, to prevent bad smell

Environmental impact factors (knowledge):

- **Temperature**
- Rotation speed
- Duration
- Amount of water

Social view on sustainability:
She doesn't think most people think about the impact and just wash the way they want to wash. She herself thinks cosciously about the impact when doing laundry.

Gathering the laundry

Clothes are worn for 2-3 days, jeans for longer

Laundry is gathered in a basket

Preparing the wash

When there is enough laundry to fill the machine, it's time for laundry

Laundry happens once a week, roughly

The machine is filled to maximum capacity, but not crammed full

Eco-detergent is used, sometimes fluid, sometimes powder **and is measured intuitively**

Starting the wash

Towels and dishclothes are washed at **60 degrees, because of hygiene**

Other laundry is washed at 30 or **40 degrees**, because it is not as dirty and it will show less wear

Never uses cold setting, thinks it doesn't clean as well, but doesn't actually now this for certain

During the wash

After the wash

Participant 2. Category: sustainability

Priorities:

- Clothes have to be clean
- Clothes have to have a fresh smell

Environmental impact factors (knowledge)

- Energy use/Water use
- **Temperature, because heating water requires a lot of energy**
- **Duration**
- Rotation speed
- Production of machine

Social view on sustainability:
People in general do not think about the impact, because it is an automated process where people are not actively engaged during the process itself. He feels that he himself doesn't wash sustainably, because the process requires a lot of energy.

Gathering the laundry

Gathers clothes in basket

Preparing the wash

When basket is full, or clothes are needed, he will start doing laundry

Loads close to maximum capacity, leaves a little space, because he then doesn't have to do laundry as often

1,5 cup of detergent is used, because he thinks that does the job. Sometimes uses extra for fresh smell

Starting the wash

Most clothes are washed at 40 degrees, he feels that the laundry is cleaned better than at lower temperatures

Towels and bed are washed at 60 degrees, because they require extra cleaning

During the wash

After the wash

Participant 3. Category: Short stay

Priorities:

- Good smell
- Any stains need to be cleaned

Environmental impact factors (knowledge):

- Lower temperature
- Eco-friendly detergent

Social view on sustainability:
He is uncertain about the most important factor, because he feels that it depends on other factors, like how the used energy is generated.
Since laundry is a basic human activity, he feels that people cannot do too much about it. He knows that low temperatures work well, **but thinks people in general think that higher teperatures work better.**

He could improve if he had enough clothes with him to do certain washes at lower temperature settings.

Gathering the laundry

Gathers laundry in a basket

Preparing the wash

Once a week he will do laundry

He doesn't want to spend too much extra money on eco-friendly detergents, and thinks these are necessary for effective low temperature washing

All laundry is put in the machine together, because he has few clothes with him and wants to fill the machine fully

Starting the wash

The laundry is done at a "warm" temperature, because he wants to do some laundry at warmer temperatures, some at colder

Back home, he used 40 degree programmes, because he didn't want to spend money on more expensive detergent suited for low temperatures

During the wash

After the wash

Some laundry is hung to dry, some is put in a dryer, **because he has little space to hang the laundry**

Participant 4. Category: Low-cost

Priorities:

- Laundry has to be clean
- The smell of the laundry has to be neutral, doesn't require an added smell

Environmental impact factors (knowledge):

- Temperature
- Amount of detergent used
- Whether fabric softener is used

Social view on sustainability:
He doesn't really think about the impact when doing laundry. If he were to input the washing setting himself, he feels he would pay more attention to the environmental impact and would actually take it into account in the way he washes

Gathering the laundry

He gathers the clothes and separates white laundry from colours.

He has a set time (the weekend) when he does laundry

Preparing the wash

He does laundry once a week, and loads the machine fully, but not so full that it doesn't clean well anymore, by combining his and his parents laundry it is possible to load fully

He measures the detergent with a cup

Starting the wash

He does not know what type of programme he uses, since he uses the settings that are already dialed in by his mother (whose machine it is)

During the wash

After the wash

Doesn't use a dryer, just hangs the laundry

Participant 5. Category: Short stay

Priorities:

- Clean clothes
- No loss of colour
- A fresh smell, but not too overwhelming

Environmental impact factors (knowledge):

- Electricity**/Water consumption**
- Water pollution
- Whether a dryer is used

Social views on sustainability:
She did not use to care about the impact when she was still living with her parents, then she just wanted to be done as quickly as possible. Now she consciously wants to live sustainably.
She thinks whether people in general think about it depends on education and on income (people with a higher income would care less).
She thinks 50% of people would require a financial incentive to start washing more sustainably.

Gathering the laundry

She starts doing laundry when the basket is full, and separates whites, light colours, dark colours and black clothes

She loads the machine as fully as possible without cramming, because she finds half-loaded washes wasteful (of both water and energy, as well as her own effort)

Preparing the wash

Detergent is measured by cup and uses less than prescribed because she doesn't feel she needs more, and soda is added to white clothing

Jeans are sealed in a bag and put in the freezer, because they start to lose colour quickly and show wear when they're machine washed, sometimes vodka is sprayed on them for fresh smell

Bras and panties are put in special protective bags to prevent damage during the wash

Starting the wash

She doesn't use a pre-wash cycle, unless it concerns sports clothing

Towels, linnen, and dishclothes are washed at high temperatures (90 degrees) for disinfection

Normally she uses 30/40 degrees

For skinny jeans she uses the lowest temperature settings to retain the stretching function of the fabric

During the wash

For woolen clothes and linnen she sometimes washes by hand

New jeans are also washed by hand first to ensure that they retain their colour well (she was taught this by her mother)

After the wash

Clothes are hung to dry

Participant 6 (HOMIE): Short stay

Priorities:

- The laundry has to be really clean
- The cycle should not take too long, she prefers short washing durations

Environmental impact factors (knowledge):

- Fully loading the machine

Social views on sustainability:
Before she joined HOMIE, she didn't think a lot about the environmental impact, but has now become more aware of it and would adapt her washing habits if her child didn't create a necessity for her current way of washing

Gathering the laundry

She now gathers a lot of laundry because of her new-born baby.

Preparing the wash

She loads the machine fully, and probably reaches the 7kg mark.

She measures her detergent by cup

Starting the wash

She washes at 30/40 degrees (because she is familiar with those temperatures), with extra spinning at the end. She does the extra spinning to get the hard water out.

She never uses higher temperatures

During the wash

After the wash

Clothes are hung to dry

Participant 7 (HOMIE). Category: Low cost

Priorities:

- Prevent creases
- Clothing has to be clean

Environmental impact factors (knowledge):

- Efficiency (frequency, **energy for heating,** water, effort)
- Type of detergent used
- Once every while a warm cycle is needed to keep the machine clean

Social views on sustainability:
Since she's at HOMIE, she's more aware of her impact, and was shocked by the amount of water that she used.
She feels there's a **trade-off between sustainable behaviour and convenience**, and wouldn't change her planning to be able to use the ECO-programme for example.
She thinks people in general don't really know or care much about their impact during washing. It's an automated activity that they don't think too consciously about.

Gathering the laundry

She uses two laundry bags to gather white and coloured laundry

She'll do laundry when she needs clothes

She's not always at home, and does laundry during the weekend as a result

Jeans are almost never washed because they wear quickly

Preparing the wash

The machine is mostly loaded at half capacity, except when she can add bed linnen

She consciously doesn't use fabric softener anymore to prevent pollution

She used to measure detergent by gut feeling (and go through bottles quickly)
Now she uses half a cup

Starting the wash

She mostly uses 30/40 degree programmes (because they work well and are not as wasteful as higher settings), 60 when there are stains in her clothes
ECO-programmes take up too much time

During the wash

She likes to be present when the machine is washing

After the wash

Clothes are hung to dry

Participant 8. Category: Sustainability

Priorities:

- The laundry has to be really clean and smell fresh
- The colours have to be retained very well
- She doesn't like to waste water, and her machine adapts the programme to how much laundry there is in the machine

Environmental impact factors (knowledge):

- Amount of water and detergent used
- Duration of programme
- Wash frequency
- Lifespan of the machine

Social views on sustainability:
She thinks people in general don't think about the environmental impact at all, and just wash based on convenience.

Gathering the laundry

On Tuesdays she has time to do laundry, and then does 3 washes normally: white, coloured and dark

Preparing the wash

She almost always fully loads the machine

She measures 50ml of detergent

For some stains she first soaks the cloth in Vanish Oxi Action, and uses it in abundance then

Starting the wash

She washes everything at 40 degrees, because at lower settings the laundry doesn't smell fresh yet

An extra wash for the dog's blanket is done at 60 degrees to properly clean them

During the wash

After the wash

Clothes are always hung to dry

Participant 9. Category: Low-cost

Priorities:
- The laundry has to be fresh and clean
- Stains have to be cleaned, but are not an issue most of the time
- The laundry shouldn't shrink

Environmental impact factors (knowledge):

- Wash load/frequency
- Temperature
- Lifespan of machines

Social views on sustainability:
He feels like it's possible to improve the sustainability of his own behaviour, but wouldn't know how to.
He thinks people in general don't care and don't know about what the environmental impact of laundry washing entails.

Gathering the laundry

He separates his laundry by whether he puts it in the dryer or not.

White laundry is also separated, and washed together with his housemates' white laundry because he doesn't have a lot of it

He does laundry twice a week

Preparing the wash

He fully loads the washing machine and crams, right up to the point where it sometimes doesn't wash his clothes properly

He measures detergent with a cup, and sometimes adds a little extra when clothes are dirty

His old machine required fabric softener to prevent unpleasant smells

Starting the wash

He washes at the lowest temperature setting to save energy, but doesn't know for sure whether that matters a lot

He also uses a short cycle because his housemate indicated it works as well as a full cycle

During the wash

After the wash

Shirts and pants are hung to dry, to prevent shrinking

Towels and bed linnen are put in the dryer

G Cost estimations

Concept 1						
Costs (per customer)			*Costs w/o margin*	*Month 0*	*Month 1*	*Month 25*
	Washing machine	Based on current washing machine price		€ 335,00		
	Delivery costs	Rough estimate		€ 50,00		
	Laundry bag (4x)	Based on price from Amazon (2017)		€ 16,00		
	Sticker	Based on price from Drukwerkdeal (2017)		€ 0,37		
	App (/number of customers)	Based on €10000,- price for app development from App-specialisten (2017), then divided by an envisioned number of 300 customers (for comparison: HOMIE aims to reach 100 customers before the end of 2017)		€ 33,33		
	Total investment costs per machine			€ 434,70	€ 434,70	€ 434,70
Revenue (per customer)	Washing fee	Using a 13,29 average number of washes per month, for a 40°C wash (€1,31)			€ 17,42	€ 435,58
	Balance	Revenue-Costs			-€ 417,58	€ 0,58

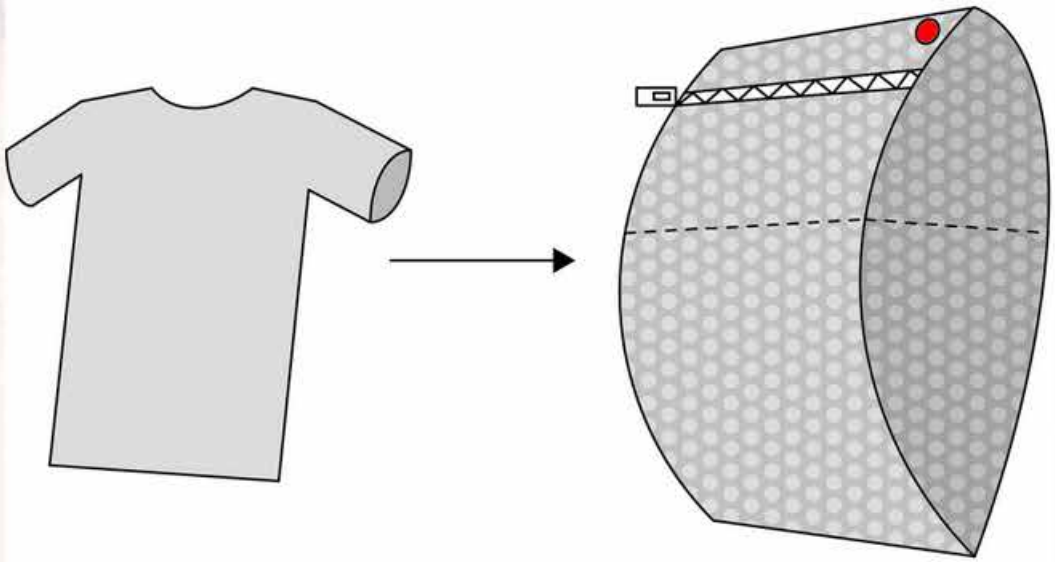
Concept 2						
Costs (per customer)			*Costs w/o margin*		*Month 0*	*Month 1*	*Month 28*
	Washing machine	Based on current washing machine price			€ 335,00		
	Circuit board	Based on price from Alibaba (2017)	€ 4,00		€ 10,00		
	LCD screen	Based on price from Alibaba (2017)	€ 10,00		€ 25,00		
	Detergent tray	Rough estimate, not much structural change is needed	€ 5,00		€ 12,50		
	Distance sensor	Based on price from Ebay (2017)	€ 7,00		€ 17,50		
	LED lights	Based on price from Alibaba (2017)	€ 3,00		€ 7,50		
	Fragrance release	Based on price from Alibaba (2017)	€ 10,00		€ 25,00		
	Delivery costs	Rough estimate			€ 50,00		
	Total investment costs per machine				€ 482,50	€ 482,50	€ 482,50
Revenue (per customer)	Washing fee	Using a 13,29 average number of washes per month, for a 40°C wash (€1,31)				€ 17,42	€ 487,84
	Balance	Revenue-Costs				-€ 465,08	€ 5,34

Concept 3						
Costs (per customer)			*Costs w/o margin*	*Month 0*	*Month 1*	*Month 33*
	Washing machine	Based on current washing machine price		€ 335,00		
	Laundry bag (4x)	Based on price from Amazon (2017)		€ 16,00		
	NFC (4x)	Based on price from ShopNFC (2017)	€ 6,00	€ 15,00		
	NFC reader	Based on price from Alibaba (2017)	€ 20,00	€ 50,00		
	Weight sensor	Based on price from Alibaba (2017)	€ 4,50	€ 11,25		
	Photodiode	Based on price from Alibaba (2017)	€ 6,50	€ 16,25		
	LED	Based on price from Alibaba (2017)	€ 1,50	€ 3,75		
	Optical sensor	LED+Photodiode price	€ 8,00	€ 20,00		
	Circuit board	Based on price from Alibaba (2017A)	€ 4,00	€ 10,00		
	Detergent regulation	Rough estimate for adapted tray with three separate valves	€ 10,00	€ 25,00		
	Delivery costs	Rough estimate		€ 50,00		
	App (/number of customers)	Based on €10000,- price for app development from App-specialisten (2017), then divided by an envisioned number of 300 customers (for comparison: HOMIE aims to reach 100 customers before the end of 2017)		€ 33,33		
	Total investment costs per machine			€ 585,58	€ 585,58	€ 585,58
Revenue (per customer)	Washing fee	Using a 13,29 average number of washes per month, for a 40°C wash (€1,31)			€ 18,09	€ 596,90
	Balance	Revenue-Costs			-€ 566,91	€ 11,90

H Surveys

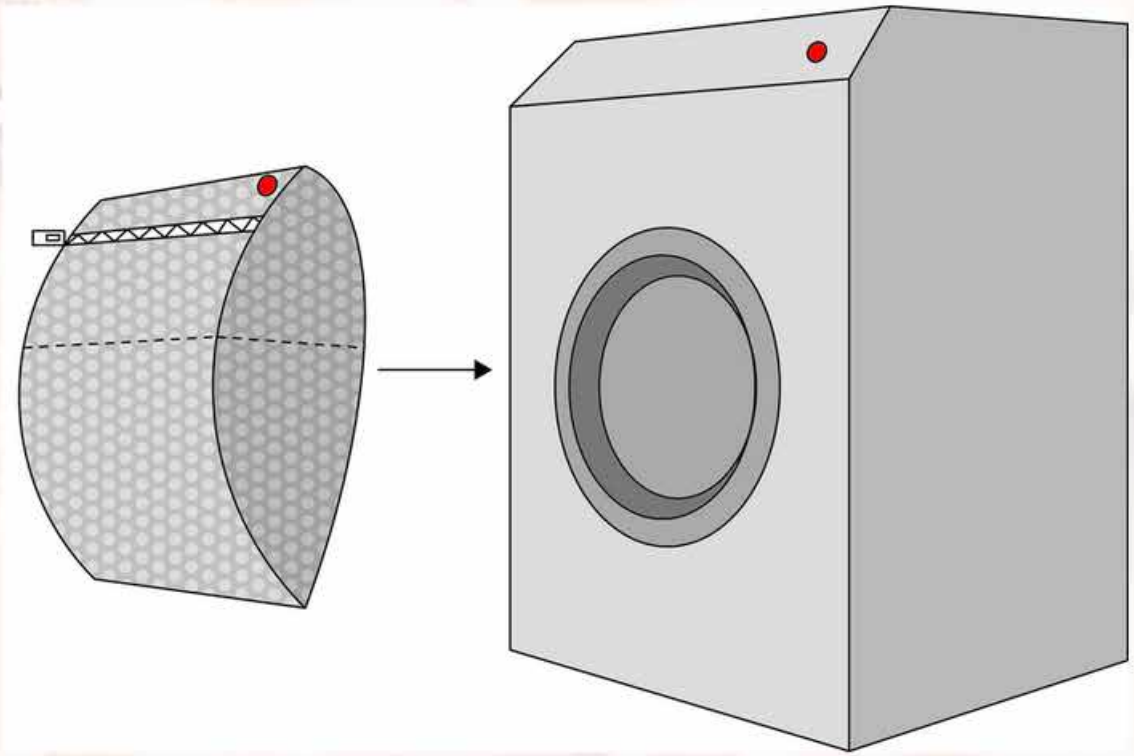
“ 1. The user gathers laundry inside several nylon mesh bags, separated by colours.

Once the laundry reaches the indicator line on the bag, the amount of laundry is big enough to fill the washing machine.



“ 2. The full laundry bag can be taken to the washing machine. The complete bag can be put into the machine, and can be washed with the laundry inside.

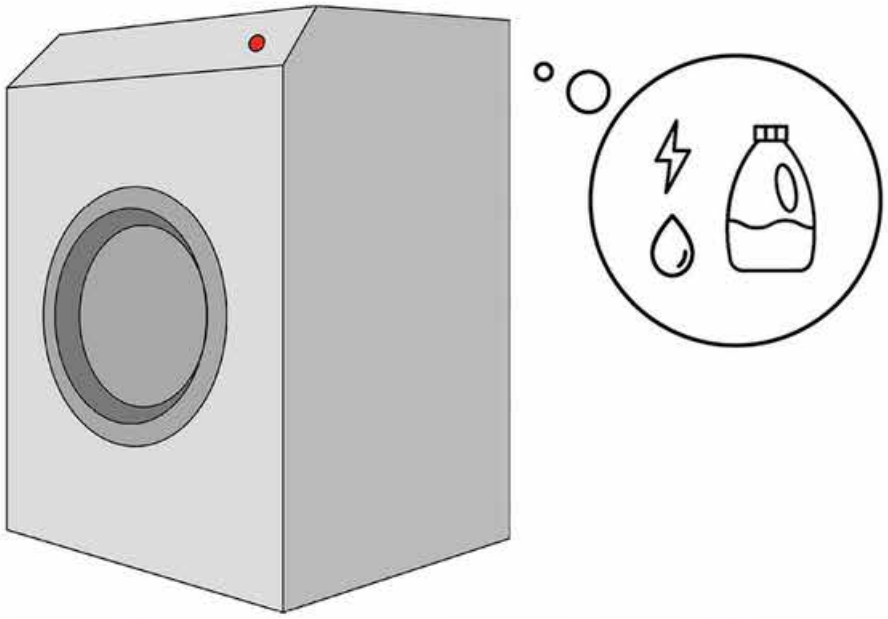
The red tag on the bag can be scanned by the machine to select a specific type of fabric that will be washed.



“ 3. The only thing the user has to do is to start the wash with a single push of a button.

The washing machine can tell the colour of the laundry, weigh the amount of laundry in the machine, and can tell how much dirt there is in the water.

Using this information, the machine will automatically choose the temperature, the amount of water, and automatically adds an appropriate amount of laundry detergent.



1 → **Overall attitude**

a. What is your overall attitude towards this automated washing process?

1	2	3	4	5	6	7

Unfavourable Favourable

b. Would you like to use this automated washing process?

1	2	3	4	5	6	7

Not at all — Very much so

c. Could you list reasons why you would want to use such a concept?

SHIFT + ENTER to make a line break

d. Could you list reasons why you would not want to use such a concept?

SHIFT + ENTER to make a line break

2 → Convenience

a. Compared to a regular washing process, how much time would washing with this concept take?

1	2	3	4	5	6	7

Much less time — Much more time

b. Compared to a regular washing process, how much effort would washing with this concept take?

1	2	3	4	5	6	7

A lot less effort — A lot more effort

c. Compared to a regular washing process, this concept would be:

1	2	3	4	5	6	7

A lot more difficult to use — A lot easier to use

3 → Effective cleaning

a. Compared to a regular washing process, how good would this concept be at making the laundry clean?

1	2	3	4	5	6	7

Much worse — Much better

b. Compared to a regular washing process, how good would this concept be at removing stains?

1	2	3	4	5	6	7

Much worse — Much better

c. Compared to a regular washing process, how good would this concept be at cleaning different types of laundry?

1	2	3	4	5	6	7

Much worse — Much better

4 → Sustainable washing

a. Compared to a regular washing process, how much energy would this concept use?

1	2	3	4	5	6	7

Much less energy — Much more energy

b. Compared to a regular washing process, how much water would this concept use?

1	2	3	4	5	6	7

Much less water — Much more water

c. Compared to a regular washing process, how much laundry detergent would this concept use?

1	2	3	4	5	6	7

Much less detergent — Much more detergent

d. Compared to a regular washing process, how big do you think the environmental impact of the concept is?

1	2	3	4	5	6	7

Much smaller environmental impact — Much larger enviromental impact

5 → General questions

a. What is your age?

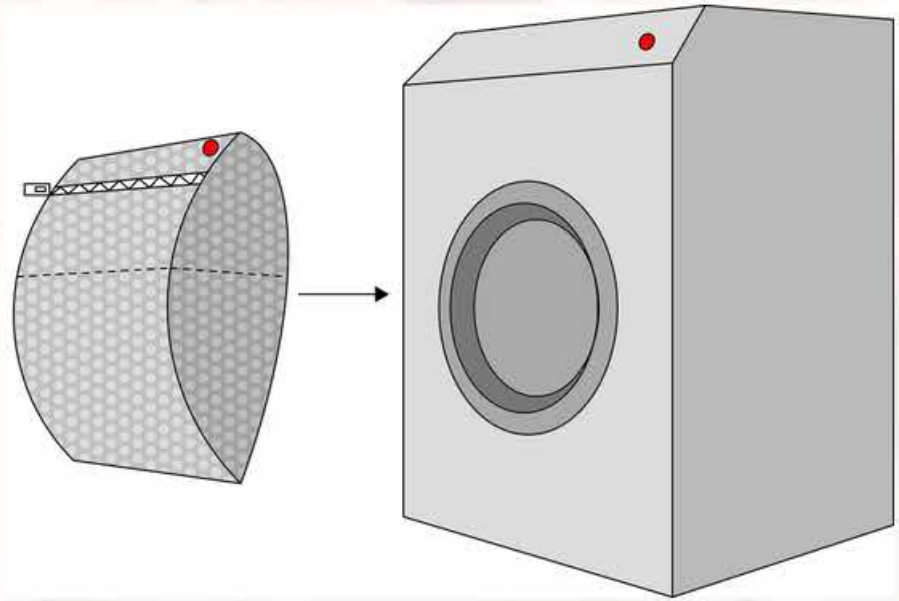
d. How long have you been doing laundry?

Option 1

In this first interaction, you start by gathering laundry in a nylon mesh bag that can be washed along with the laundry.

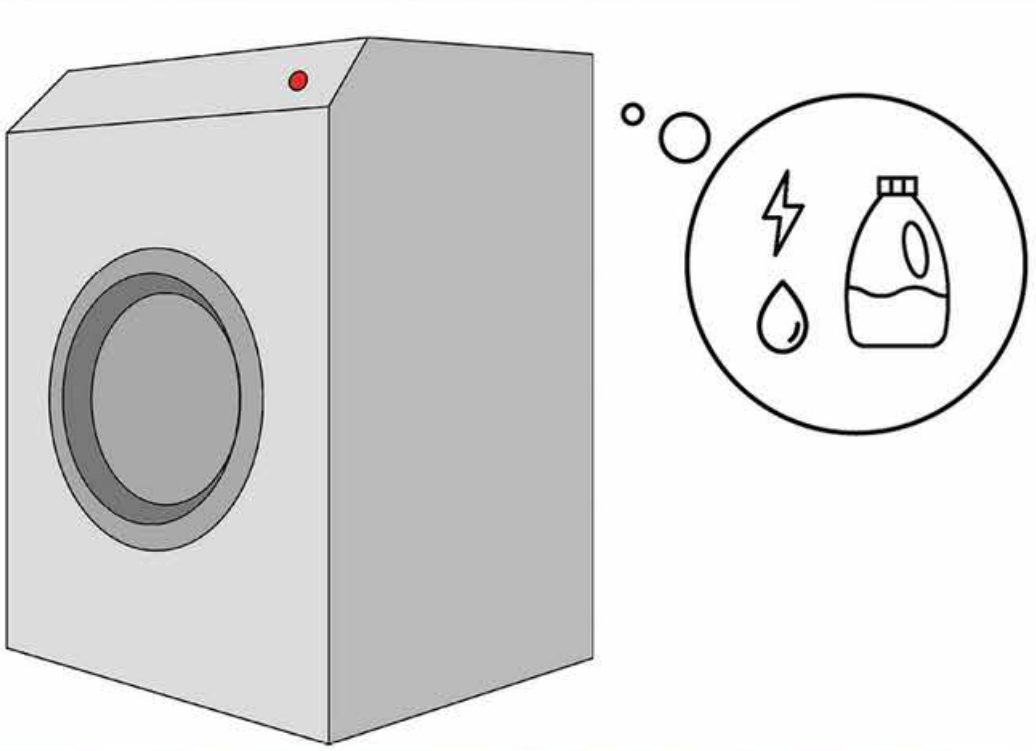
When starting the wash, you scan a tag on the washing bag to select the type of fabric you will be washing:

- Jeans
- Synthetic
- Delicates
- Wool



“ The washing machine can tell the colour of the laundry, weigh the amount of laundry in the machine, and can tell how much dirt there is in the water.

Using this information, the machine will automatically choose the temperature, the amount of water, and automatically adds an appropriate amount of laundry detergent.



1 → Control over the washing process

a. Do you feel like you are in control of this washing process?

1	2	3	4	5	6	7

No control at all — Completely in control

b. Do you feel like you have enough control over this washing process?

1	2	3	4	5	6	7

No, I want more control — Yes, I have enough control

c. How comfortable would you be with the amount of control you have over this washing process?

1	2	3	4	5	6	7

Very uncomfortable — Very comfortable

2 → Effective cleaning

a. Would you trust this concept to clean your laundry effectively?

1	2	3	4	5	6	7

Not at all — I completely trust it

b. Would you trust this concept to clean stains effectively?

1	2	3	4	5	6	7

Not at all — I completely trust it

c. Would you trust this concept to be able to clean different types of laundry?

1	2	3	4	5	6	7

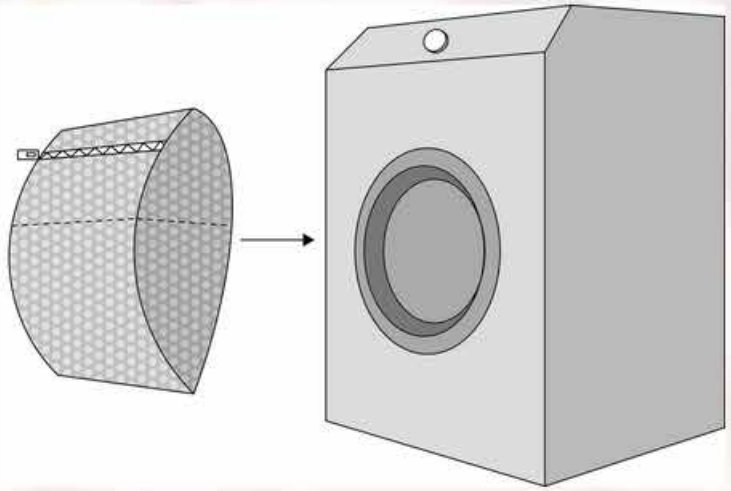
Not at all — I completely trust it

Option 2

With the second interaction, once again you first gather the laundry in the bag that can be washed along with the laundry.

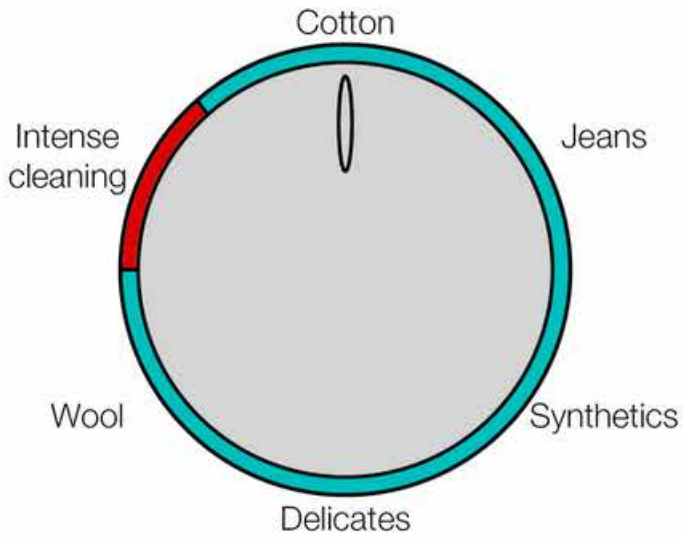
This time, you don't scan anything, but the machine features a button with the following options:

- Cotton
- Jeans
- Synthetics
- Delicates
- Wool
- Intense cleaning



“ Once again, the machine will automatically choose the temperature, the amount of water, and automatically adds an appropriate amount of laundry detergent.

However, choosing the “intense cleaning” option allows you to override the machine’s automatic choices, and will guarantee a hot wash.



1 → Control over the washing process

a. Do you feel like you are in control of this washing process?

1	2	3	4	5	6	7

No control at all — Completely in control

b. Do you feel like you have enough control over this washing process?

1	2	3	4	5	6	7

No, I want more control — Yes, I have enough control

c. How comfortable would you be with the amount of control you have over this washing process?

1	2	3	4	5	6	7

Very uncomfortable — Very comfortable

2 → Effective cleaning

a. Would you trust this concept to clean your laundry effectively?

1	2	3	4	5	6	7

Not at all — I completely trust it

b. Would you trust this concept to clean stains effectively?

1	2	3	4	5	6	7

Not at all — I completely trust it

c. Would you trust this concept to be able to clean different types of laundry?

1	2	3	4	5	6	7

Not at all — I completely trust it