

RE: SOURCE

Final Report

Innovative Circular Business Model for Houdini Sportswear

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Preface

This project has been supported by Re:Source and financed by Swedish Energy Agency and made in collaboration with PlanMiljø. We want to thank the users of the subscription service who has given us invaluable feedback on the business model as well as other partners such as Move by Bike and Boba who have contributed to a successful project.

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Summary

The consumption of textile products causes significant environmental impacts along the lifecycle. The negative effects can be reduced through extending the active lifetimes of garments and thus reducing demand for new textiles. This does not necessarily mean reduced profit for businesses. A subscription system is a business model that allows unwished for clothing to be constantly recirculated to new users instead of sitting idle or being trashed, raising money for the subscription company in the process.

A subscription system was launched with the goal to be profitable, attractive to users and reduce environmental impacts by at least 40%. A pilot ran for 6 months with 85 test subscribers in Stockholm. The 85 signed up to one of three packages. Under two of these, they could borrow 4 items from the subscription wardrobe at any one time for a fixed monthly fee. Under the third, subscribers paid a fee per borrowed item. In the first period, all exchanges were made personally at Houdini Sportswear's HQ in Stockholm, to allow personalized service and information exchange. Later a beta level online ordering system was offered, and a bicycle delivery-and-return at the door service was tested.

Three evaluations of the pilot system were carried out

- **Is the system attractive to users?** Through satisfaction surveys
- **Is it profitable?** Through economic modelling
- **Does it provide environmental benefits compared to ownership?** Through an LCA

The LCA found that the baseline future subscription system would reduce climate impacts by 35% compared to traditional ownership systems for Houdini products and by 85% compared to ownership of average high-street products.

Environmental advantages are not guaranteed. Key factors in ensuring an environmental beneficial subscription system include:

- **Maximising the technical durability** of items in the system
- Encouraging subscribers **to use a sustainable delivery system and/or public transport/bikes** for exchanges
- Locating exchange shops where they are **readily accessible by public transport**
- Selecting **fossil-free delivery services**
- Encouraging subscribers **not to launder items before returning them** and to **avoid laundering more than necessary**
- Using **eco-labelled professional laundries**
- Encouraging subscribers **to wash at low temperatures and to air dry**

Adopting these measures further reduces the environmental impacts of the service to 56% of those of an ownership system for Houdini products.

It was also found that being part of a subscription system led to broader positive changes in behaviour of the subscribers. The change from transaction to relation with the subscriber allows for the company to nudge and inspire to a change from the habitual consumption driven behaviour.

The system, despite being a pilot, achieved medium to high satisfaction which should increase with a full-scale system.

A upscaled subscription system with 1000 users was found to be profitable over a four-year period, with profitability increasing as the number of users increases.

Careful design of the system is key in ensuring both environmental benefits and economic viability.

Maximising the economic viability requires:

- Scaling up rapidly to **gain a minimum of 500 subscribers**
- **Maximizing the technical durability** of items in the system, identifying the most durable products
- **Maximising the value for money** by for example identifying the products which would be too high financial or social investment to purchase
- **Minimising the idle rate of clothing** in the wardrobe by matching the contents as closely as possible to needs
- **Requires the end user to appreciate accessibility to the limitless wardrobe and the improved experience of each garment** rather than calculated price per item
- **Carefully managing laundering and logistics costs** for delivery
- **Great care in selection of a subscription fee** which will ensure profitability but also be attractive to users. This may **require a range of packages and prices catering for different types of user**



Focus on maximum experience, zero impact and beyond

Sammanfattning

Klädkonsumtionen leder till en betydande miljöpåverkan under dess livscykel. Denna påverkan kan reduceras genom att förlänga den aktiva livstiden på plagg och på så sätt reducera behovet av nya textilier. Det behöver inte nödvändigtvis betyda minskade intäkter. Ett subscriptionsystem är en affärsmodell som tillåter att ej använda plagg konstant kan cirkulera till nya användare istället för att ligga orörda eller kastas, och företagen kan tjäna pengar på cirkulationen.

En subscriptiontjänst lanserades med målet att vara lönsam, attraktiv för användare och minskad miljöpåverkan med minst 40%. Piloten pågick i 6 månader med 85 testpiloter i Stockholm. Piloterna valde ett av tre paket. De två första paketen kunde piloten välja 4 plagg från den tillgängliga garderoben och rotera dessa fritt efter önskemål för en fast månadsavgift. Det sista betalade piloten plagg per plagg, och kunde lägga till fler eller ta bort plagg efter önskemål. För att få ett djupgående informationsutbyte och förståelse för upplevelsen samt erbjuda en personlig service genomfördes initialt alla byten på plats på Houdini Sportswear HK i Stockholm och under pilotens gång infördes en betaversion för online-beställningar och cykelbud med simultan leverans och retur vid dörren testades.

Tre utvärderingar av pilotsystemet genomfördes:

- **Är systemet attraktivt för användaren?** Utvärderades genom kundnöjdhet
- **Är det lönsamt?** Analyserades med ekonomisk modellering
- **Skapar det miljömässiga fördelar jämfört med ägandeskap?** Utvärderades med LCA

Den miljömässiga utvärderingen visade i grundscenariot på en på en 35% minskning i klimatpåverkan jämfört med ett traditionellt ägande av samma Houdiniprodukter. Jämfört med ägandeskap av en genomsnittlig kvalitetsprodukt på marknaden är besparingen istället 85%.

Miljömässiga fördelar är inte garanterade, viktiga faktorer för att säkerställa ett fördelaktigt subscriptionsystem för miljön är:

- **Maximera den tekniska hållbarheten** av plaggen i systemet
- Uppmuntra användaren att **använda hållbar logistikservice och/eller att använda kommunaltrafik/cykel**
- Placera hubbar för byten där de är **lätillgängliga med kommunaltrafik**
- Använda **fossilfria leveranssätt**
- Uppmuntra subscribers att **inte tvätta innan man återlämnar kläderna** och att **inte tvätta mer än nödvändigt**
- Använda **miljöcertifierade tvätterier**
- Uppmuntra subscribers att **tvätta på låga temperaturer och inte torktumla**

Genom att följa dessa råd kan miljöpåverkan av subscription jämfört med av att köpa samma Houdiniplagg minskas med 56%.

Ett resultat av att gå från transaktioner till relationer med subscribern kan tjänsten användas till att påverka och inspirera kunderna att ändra sina invanda beteenden. Det

visade sig att vara del av subscriptionssystemet ledde till flera mer långtgående positiva förändringar i beteendet hos piloterna.

Systemet uppnådde, trots att det var en pilot, medium till hög nöjdhet vilket antas öka med fullskaligt system.

En uppskalad version av systemet med 1000 användare blir lönsamt över en 4-årsperiod med en ökande lönsamhet med ett ökat antal användare.

En mycket genomtänkt design av systemet ligger till grund till både den ekonomiska och den miljömässiga hållbarheten.

Maximal ekonomisk hållbarhet förutsätter:

- Skala upp snabbt till minst **500 prenumeranter**
- **Maximera tekniska hållbarheten** på produkterna i systemet
- **Maximera upplevt värde för kunden** genom att exempelvis identifiera vilka produkter som har en hög ekonomisk eller social risk att köpa.
- **Kräver att kunden uppskattar den obegränsade tillgången till garderoben och den ökade upplevelsen av varje plagg** snarare än den uträknade priset per plagg
- **Minimera oanvända produkter i garderoben** genom att förstå behov och matcha dessa så bra som möjligt
- **Noggrann hantering av tvätt och logistik** för leverans
- **Hitta prispunkten som upplevs fördelaktig** men också säkerställer att det bli ekonomiskt hållbart, detta kan kräva **ett antal olika paket och prisnivåer för att tillfredsställa olika behov och preferenser**

1. Background

1.1 The need for new methods to access clothing

121 000 tonnes of new clothing and household textiles were put on the Swedish market in 2013 (Elander et al, 2014). Globally, clothing production has approximately doubled over the last 15 years driven in part by increased per capita sales in mature economies due to a rise in the 'fast fashion' phenomenon, with rapid turnaround of new styles and collections and falling prices (EMF, 2017).

The consumption of textile products causes significant environmental impacts along the lifecycle. Much of these are caused during the production phase; the production of natural and synthetic fibres, chemical, water and energy inputs to weaving/knitting, dyeing and finishing of fabrics and finally the fabrication of textiles products (JRC, 2014).

Environmental impacts can be reduced directly via cleaner production processes and the selection of greener fibres. However, significant gains can also be made via extending the active lifetimes of garments to reduce the demand for new textiles (Roos et al, 2015; Schmidt et al, 2016; WRAP, 2014;). The longer the active lifetime of garments, the fewer garments need to be produced. This offsets resource use and waste generation and associated environmental impacts. However, trends are moving in the opposite direction; globally the average number of times a garment is worn before it ceases to be used has decreased by 36% compared to 15 years ago (EMF, 2017).

Extending active lifetimes and reducing the quantity of new textiles purchased each year, does not necessarily mean reduced profit for the textile industry. There are many opportunities for business models that derive value via extending the active life of garments either via the same user, or consecutive users. These include production of quality clothing, a wide range of sharing models such as clothing libraries, wardrobe sharing and leasing, as well as resale (of own brand or others) models and repair models (of own brand or others) (Watson et al, 2014; Elander et al 2017).

There are many examples of brands and businesses that have adopted such models, but they remain relatively niche, catering for small numbers of citizens. For the models to become mainstream there is a need for success stories that demonstrate profitability and trailblaze the way for other companies to follow.

1.2 Houdini Sportswear and sustainability

Houdini is well recognised as a progressive outdoor sportswear company that is pushing boundaries of how outdoor clothing is made and used. The company's goal for the future is to move "beyond zero waste and become a positive and regenerative force in society and for the planet".

Houdini is constantly working to transform its business, the activities of its suppliers and the attitudes and behaviour of its customers. At Houdini, circularity is defined as styles that are durable whilst at the same time being designed to be recycled at end-of-life and made from recycled or organic, renewable and biodegradable fibres. After years of innovation

and experimentation, they now have managed to create a collection that is 100% either recycled, recyclable, renewable, biodegradable or Bluesign®-certified.

Long lived products designed to be minimalistic and for versatile performance are part of Houdini's product philosophy. Minimalistic design allows for resource savings, easier construction and swifter repairs, while versatility allows a garment to be used for various types of activities.

Some of Houdini's core products are being used for more than 10 years and some for even more than 15 years. Much of this is due to their durable and aesthetic designs. However, business models that they have put in place also play a fundamental role in extending the life of their products. Houdini offers repair services and product care advice. They also offer second-hand Houdini products through their Reuse program and a rental option as an alternative to buying Houdini products since 2012.

1.3 Houdini subscription service

In 2017, in a wish to challenge the norms on how people gain access to clothing, the brand began the development of a subscription model. By establishing the first outdoor clothing subscription system in Sweden, Houdini aimed to kick-start an entirely new way of gaining access to clothing that drastically reduces idle time for individual garments and gains the most out of the material resources that have been used to produce them. They wanted their users to focus on the experience of nature rather than the act on consumption. Within the business model people would pay to gain access to a wardrobe rather than ownership of clothing.

Subscription models particularly suitable for clothing that is used seasonally, in connection with a particular activity or where the user is growing (i.e. children's clothes). Instead of sitting idle in a wardrobe or being trashed when it no longer fits, a subscription system allows clothing to be constantly recirculated to new users as the need arises. Outdoor clothing seems well-matched to such a system.

The subscription business model that benefit users, businesses and our planet is the direct opposite of the fast fashion business model. In fast fashion, money is made by selling high volumes of low-quality clothing, rapid obsolescence and need for more sales. The model thrives on low quality and fast throughput. In a subscription service, the higher the quality and durability of the clothing, the more money a business can earn from a single article and the lower its costs. Thus, a subscription model thrives on high quality. Houdini only makes high quality, durable clothing, again providing a good match.

The fact that Houdini retains ownership means that they can ensure the garments are repaired as far as possible and at end of life they can be recycled into new products.

1.4 Re:Source pilot/demonstration project

Houdini Sportswear, with the assistance of Danish consultancy PlanMiljø, applied successfully for funding from Swedish Energy Agency through Re:Source, the strategic

innovation programme¹ financed by Vinnova, Swedish Energy Agency and Formas, in 2017 to pilot and demonstrate a subscription service for outdoor clothing. Danish circular economy consultancy PlanMiljø, and LCA consultancy BoBa were included as sub-contractors. PlanMiljø has many years' experience in working with sustainability and textiles and in 2014-2016 assisted in the development and launch of Danish baby clothing subscription brand Vigga.us. BoBa is a Lifecycle Assessment (LCA) consultancy who has subcontracted to PlanMiljø on a range of projects including an LCA of the Vigga.us subscription system.

The goal of the Re:Source funded project *was to research, develop and pilot-test an innovative circular subscription service for a single brand of Swedish outdoor clothing, which is profitable (in the medium term) attractive to users and will reduce environmental impacts/resource use by at least 40% per consumer/garment compared to purchase and ownership models.*

The longer-term goal is that within the first year following a scaled-up launch, the subscription system will have gained 500 subscribers in Sweden, and after 3 years will have gained 5000 subscribers, will have been spread to additional countries where Houdini has presence, and the concept will have been adopted by at least two other Swedish brands.

2. Objectives of this evaluation

The objectives of the project as a whole are described above. The main output of the project has been the subscription pilot and demonstration system. This report is a further output. The objectives of this report are to:

- **Provide an overview for interested brands of the development process for a subscription system and its successes and obstacles**
- **Evaluate the environmental benefits of the pilot and an upscaled system**
- **Evaluate the economic viability of system and internal changes necessary to increase this**
- **Evaluate user satisfaction and how this can be further improved**

The report will be useful both for Houdini itself to improve, scale up and expand the system and for other clothing brands wishing to move away from ownership models, to give both environmental and economic gains.

3. Development of a pilot subscription system

3.1 Goal and target group

The specific goal for this element of the project was to design a small limited subscription system that could serve as a prototype for a scaled-up system, and where various concepts could be trialled and feedback obtained from the trial users, that would allow the company to move forward towards a scaled-up version.

¹ <https://resource-sip.se/om-resource/resource-in-english/>

Active and engaged feedback was an important element of the pilot trial with the main focus on testing and evaluating the design of the subscription service and not on attracting new customers. For this reason, Houdini preferred to engage members who were already actively engaged with brand who were followers on social media or subscribed to Houdini's newsletter. Within this wider group they wished to find potential **Early Adopters**: *outdoor enthusiast who are open to new concepts, new technologies, new ways of accessing goods and services but may not be able to afford Houdini garments.*

3.2 The many facets of a subscription system

There are many ways of designing a subscription system and many variables which need to be considered and selected. These can include:

- **Payment options and pricing levels** – payment per month and/or per exchange and at what price levels
- **Binding period of subscribers** – or none at all
- **Number of articles** that may 'borrowed' by a user at any one time
- **Wardrobe choice** – what range of products, sizes and colours to offer and what is most interesting for subscribers
- **How and when to curate and inspire** on the content of the wardrobe
- **Wear and tear levels** – what threshold should be set for how worn an article can be before no longer fit-for-inclusion in system
- **Wear and tear cascades** – related to bullet above: should there be one quality for all, or should there be different types of packages – one for those who want to have access to latest relatively crisp items and another for those who are happy with older, well-used items (at a lower subscription price)
- **Time frame per product** – related to two bullets above - how long should products stay within the wardrobe – until end of life, or should there be a regular turnover with the 'older' products being sold for reuse
- **Limits to numbers of exchanges** per month or unlimited access
- **Access/logistics options** – physical drop off/pick up, online transactions with drop-off/pick-up at post-kiosk or direct to door
- **Influencing user behaviour** – information, carrots or sticks to prevent misuse, loss, damage of garments
- **Personal vs digital** interfaces for the user, **depending on whether** the customer wants recommendations or wants to pick their garments themselves
- **Peer-to-peer opportunities** should exchanges always pass through Houdini or can there be direct exchanges between subscribers

Often the choice faced by the business will be a balance between meeting the wishes of the user on one hand (and thus increasing user numbers) and the need to keep costs down on the other. For some choices there will be no conflicting forces pulling in each direction. As an example, both provider and user may be interested in the wardrobe being populated by high quality garments. For others the preferences of the user may come at a cost to the provider. For example, a user may wish to have access to the widest range of products

possible. This will increase the costs of filling the wardrobe and the potential idle time of individual items.

One option for the provider is to offer a range of packages that users can select from, to best suit their own needs, rather than a one size fits all. On the other hand, too many packages can complicate communication and complicate the steering system.

Under any circumstances, the first step in the process is to get to know the wishes of the potential user to identify the underlying needs of the customers.

3.3 Profiling methodology for potential subscribers

Houdini and PlanMiljø developed a methodology for profiling these potential users more closely which included the following steps:

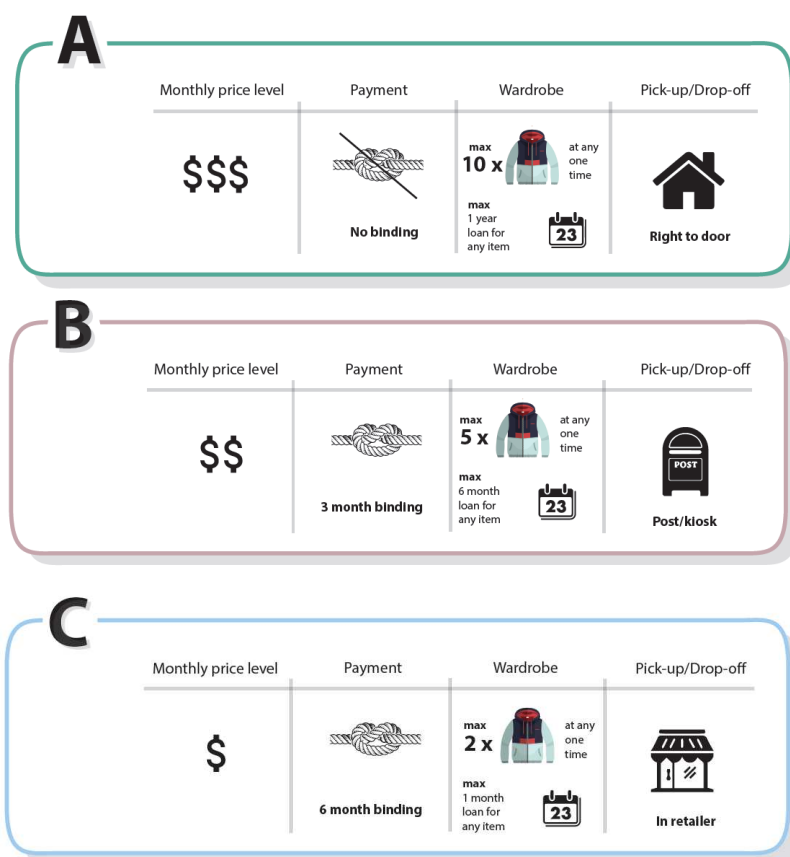
- **Develop profiling questions** for potential users
- **Develop short descriptions** of 3 types of subscription models
- **Connect with, and invite participants** to two focus group workshops in Stockholm, November 2017
- **Facilitating focus groups** to gain answers to the profiling questions and responses to the three subscription models
- **Gathering results** to identify common trends and distinct groupings

Each workshop was attended by approximately 10-12 participants that had been gathered through the extended network of Houdini that includes a wide range of Houdini customers; from students to executives. The workshops were carried out in four phases:

- 1 **Generalised questions** filled out individually by participants concerning their outdoor activities, the outdoor clothing that they already own and use and where they obtained these and knowledge of the Houdini brand
- 2 **Access preferences** - a plenary session where participants answered, explained and discussed more specific questions on preferences concerning gaining access to outdoor clothing and attitudes towards ownership versus sharing
- 3 **Discussion of subscription models** – participants were presented with the three subscription models and gave and discussed their immediate responses
- 4 **Subscription preferences** – participants individually wrote down answers to questions on preferences with respect to the three models and to individual variables of a subscription system. After each participant had expressed their preference in writing to a given question, it was opened for plenary discussion so that the reasons for the preferences could be identified.

The questions under all sessions can be found in Appendix 1.

The three subscription scenarios are visually presented below. Scenario A would be most convenient and flexible for subscribers but would come at a higher monthly payment. Scenario C was the least flexible and convenient for subscribers but with the lowest monthly payment.



3.4 Qualitative results of attitude/profiling

The following key findings emerged from the profiling workshops. The findings are arranged according to the various variables in a subscription system. Although the aim of workshop was to get input on a subscription model, the terminology “rent”, and “lease” was used in the discussions to give the participants something to relate to which they have familiarity with.

Environmental perception

Many perceived it to be particularly important for outdoor wear to be sustainable; anything else would be hypocritical. Participants understood sustainable outdoor clothing to mean: use of eco-labels, good labour conditions in the supply chain; use of natural or recycled materials; high level of durability. Cheap prices were viewed as an indication of non-sustainable production.

Attitudes on ownership versus sharing

Many preferred to own if it was something they use often. Some participants buy second-hand outdoor wear via social media or online auctions. Ownership was less important for less-used items provided they

“I would actually prefer borrowing, but I need to be sure that I can get hold of it when I need it”

can get their hands on it quickly and easily when they do need it.

Many already borrow outdoor wear from friends or family but are less sure about borrowing from strangers due to hygiene/trust. Some have informal sharing groups between family and friends.

"I usually buy, but if its something I won't use regularly I would prefer to borrow it from a friend. Borrowing from a brand would be great, but it needs to feel good."

Some specific situations/groups were identified where a subscription model would be particularly attractive: active people lacking storage space; beginners wanting to try a new activity; active outdoor people wishing to test the latest equipment, going on a unique trip; or needing items for a seasonal activity e.g. hiking or skiing.

Payment options and pricing levels

Almost all participants disliked the concept of a binding period. Some because spontaneity and flexibility were important to them. Others because of the economic consequences.

"When you buy a jacket, you feel like you have to wear it the next 5 year to pay it off"

500-1000 SEK per month was the most typical quoted range for acceptable fixed subscription prices. Pay as you go options were generally preferred to fix monthly payments, however.

All participants expected the borrowing period for individual items to be measured in weeks. The typical desired period for borrowing an item was 1-2 weeks. The maximum mentioned was half a year – after that they would rather own it.

"Flexibility is the key. Subscription models should be based on my current needs"

Wardrobe choice and condition

All participants could see themselves lease a jacket or pants. Many could see themselves lease a fleece, hoodie and gloves. No participants could see themselves lease under-layers – mostly for hygiene reasons.

Most participants expected the leased items to be of high quality and functional. Some participants said they expected to be able to rent items they normally wouldn't be able to afford.

"With better gear I feel like I can do better at the activity I am doing"

On the other hand, most also said that signs of wear are acceptable as long as the clothing is still fully functional, clean and fresh. The users need to be able to fully trust in that the clothing has been cleaned and tested.

Some would like to see a range of prices/qualities. For example, they would lease a 12 years old hoodie they were presented with after seeing the quality, but at a reduced price.

Access points

"I buy in physical stores and yes I prefer that because I buy them mostly for function and fit, which is difficult online"

Most participants would prefer to attain outdoor wear in a shop where they can try items before deciding whether to lease them. Though one or two were restrained in this due to where they live. Many carry out research online first.

At the same time, many expressed a need for flexibility in picking up the items; options of pick-up at store or via a package kiosk or even at home provided they could guarantee they were home at delivery time

Many participants would like to return by post in a pre-paid postage package. Others were happy to deliver to the store they had picked up in.

Influencing user behaviour – carrots and sticks

Some participants indicated that they don't want to worry about how they treat the leased clothing. Most participants would treat the items the same as if they owned it; one worse and two better.

One participant proposed a reward (rather than penalty) system – if the items were returned in a good condition they would receive a discount.

"When you rent a car, you have to check the condition in the beginning and the end – I don't want to deal with this with clothing"

3.5 From profiling to design of the pilot

The profiling work gave Houdini glimpses into the needs and wishes for a subscription system for outdoor clothing as seen from the eyes of the potential user. However, designing a service this different to ownership models would be beyond what the user could imagine it should be. Therefore, a design methodology was selected that allowed the team to adjust the model during the pilot period; shaping and perfecting the model via a trial and error approach and qualitative interviews.

The pilot system should be broad enough in its approach to allow users to express their preferences both during and after the pilot. To validate the design process, and create further depth in the user knowledge, interviews were carried out during the full pilot period.

The focus was on designing a pilot that could be used to test concepts that could be part of a profitable subscription model in the future, rather than a model that in its initial form would already create a profit.

Using the results from the profiling workshops led us to several things that Houdini wished to try out in the pilot. One example of this is that initially almost the whole assortment of Houdini garments was included in the subscription system wardrobe, rather than a curated assortment based on for example sales or initial interviews.

Another was that different packages with different price levels as well as a pay per piece option was introduced, to see which ones they chose in the end. The decision to start with an offline access point (at the Houdini HQ in Nacka, Stockholm) was also because this allowed for a close relationship and communication between the pilot users and the Houdini staff running the pilot allowing for a in depth understanding of all the aspects related to scaling this system in the future. The forward-looking plan was to create a solid basis for a digital-based system with a very user-friendly interface for users in combination with inner city access points.

Another step that was taken to identify how the model should be designed and analysed was to invite several leading individuals and businesses within the sharing economy.

4. Description of the Pilot Subscription System

A pilot system was launched at the beginning of November 2018 and ran until June 2019. The following describes the system and its users and how it further developed during the first 6 months. The economic, environmental and user satisfaction evaluations of the pilot described under subsequent chapters will feed in to the design of a commercial system to be launched later in 2019.

4.1 Users

The goal was to establish a group of roughly 80-90 trial users who would gain access to the system under 'beta' conditions and who would be actively engaged in the testing and evaluation of the system.

Members of the user group were attracted via the extended Houdini community. Houdini sent out a 3-page description of the coming service for potential users, highlighting the potential user and environmental benefits compared to ownership systems. Coming users were offered a 50% reduction in projected future monthly subscription in fees (the reduced prices presented below) in return for active feedback by the group.

Interested users were asked to contact Houdini with a description of themselves, their interests and their motivation to be a part of the pilot. To limit the wardrobe size Houdini filtered the aspiring users to those of average build.

A total 85 users were gathered. These were asked to sign up and paid per month for the full 6-month pilot. A total of 32 signed up to the Essentials, 43 to Adventurers and 10 to Customised packages (see below).

4.2 Packages

The users were offered 3 alternative options. The available wardrobes differed between the packages and are described under wardrobe further down.

Essentials

This curated package included clothes for every day wear - at work, on bike commutes to and from work as well as for our active everyday life, no matter the weather.

Users could borrow 4 garments at any one time from the *Essentials Wardrobe* with free exchanges at the of these at any time during the pilot.

Pilot subscription price: SEK 400

Adventurers

This package catered for those with additional specialised outdoor activities. In addition to having access to the Essentials wardrobe this package offered access to the most innovative and technical products for the more adventurous.

Users could borrow 4 garments at any one time from the *Essentials* wardrobe and the *Adventurers* wardrobe with free exchanges of these at any time during the pilot.

Pilot subscription price: SEK 600

Customized

Here users could select individual items from the full Essentials and Adventurers wardrobes at a given price per month for individual items. The monthly price differed between items ranging from 100 to 300 SEK per item.

4.3 Wardrobe and stock

The Essential and Adventurers wardrobes can be largely categorised by the following product hierarchy: concept, piece, gender, size and colour. The following individual item is an example:

Phantom Zip, Female, greystone purple, small

Phantom is the *concept*, zip is the particularly *piece* referring to a long-sleeved mid-layer zipped blouse, this item is aimed principally at females although many items are unisex, the *colour* is Greystone purple in *size* small.

Initially an unlimited variety of all the products in the assortment - pants, t-shirts, shell layers etc. - was presented for the customer. This was done to identify the consumer behaviour related to what products would serve to fulfil their specific needs related to what activities they do.

The total wardrobe that initially was in the shared wardrobe offered to the consumers contained **117 product types** (not taking account of gender, colour and size differences). Of these **63** of the products were included in the Essentials wardrobe and **54** additional product types in the Adventurers wardrobe.

When colour and size were also taken into account the total aggregated wardrobe that was selected contained **346 unique products**. Some items were only included in a single colour and size. More popular products were included in a range of colours and sizes. For example, 20 distinct colours of Men's Power Houdis were included in the wardrobe, and mostly in

both Medium and Large sizes. Note that the trial users had already been filtered according to size.

Some of the most popular product, colour, size combinations had more than one item represented in the stock. The maximum stock for any unique product, colour, size was 5. The total stock of the wardrobe after the initial choice by the subscribers plus the buffer comprised **529 pieces**.

4.4 Launch and operation of the system

All stock was housed in a curated subscription room at Houdini Sportswear's HQ in Nacka. Users were invited to come to the HQ to select and pick up their first package of clothing during one of four separate launch days during end of October/beginning of November 2018.

Before the visit the subscribers were able to view the summarized contents of the packages online before they came and make a pre-selection of their package (which they could subsequently alter).

At the launch days they received personalized help in choosing garments to maximise the chance of gaining an optimised package of products (in terms of size, colour, end use, activity, layering, temperature) and allowed for feedback and a chance to discuss the use of the system, laundering and any concerns they may have had. For Houdini, this was the first opportunity to understand the needs of the end user related to the products and how their behaviour could potentially be nudged.

Subsequent exchanges were also made via visits to the HQ. Later during the pilot, however, Houdini offered an online order system via a personalised form. This was created to test what minimum information Houdini would need to gather from subscribers to be able to suggest a personalised curated package. Delivery and pick-up were meanwhile tested with a bike courier delivery service. Subscribers were offered this service as an alternative to coming to Houdini HQ themselves at an additional price of 125 SEK per drop-off/pick-up. The idea was to test the attractiveness and functionality of 'last-mile' delivery and pickup solutions.

Items that had been out with a user were inspected for damage/wear and laundered at Houdini HQ before being placed back in stock for the next user. Any items in need of repair were set aside for repair by Houdini's repair services before being placed back.

At the end of the pilot, users were asked to return all their borrowed items for inspection to analyse wear and tear during the 6 months of use.

4.5 Communication with users

Communication with subscribers took place principally via email, phone and physical meetings. The content of communication included:

- A pre-pilot phone call with an introduction to the pilot scheme and how it would operate
- Initial physical kick off with more information and inspiration

- An initial pre-pilot survey questionnaire that the subscribers were asked to fill in
- Information on how to look after clothing
- News on suggested products when there was a change of season
- Information on a new courier delivery option
- Interesting reading on the sharing economy
- A post-pilot survey questionnaire for users

The questionnaires were critical in evaluating user behaviour, user satisfaction and the environmental benefits of the system.

Physical meetings were also key to understand and identify ways and arguments to shift subscribers' habitual consumption behaviour and focus for example on functionality and service rather than on specific products. The suitability of a product relates to not only size, colour but also end use, activity, layering, temperature and so on.

5. Evaluation of the system: methodology

5.1 What do we want to measure?

The goal of this Re:Source funded project was: *to research, develop and pilot-test an innovative circular subscription service for a single brand of Swedish outdoor clothing, which is profitable (in the medium term) attractive to users and will reduce environmental impacts/resource use by at least 40% per consumer/garment compared to purchase and ownership models.*

To evaluate whether these goals have been met we need to evaluate three elements of the pilot system compared to ownership models:

- **Is the system attractive to users?** Evaluation method: user satisfaction surveys and user feedback
- **Is it profitable?** Evaluation method: economic modelling
- **Does it provide environmental benefits compared to ownership?** Evaluation method: Life Cycle Assessment supplemented by qualitative assessments

It is important for the evaluation to consider both the pilot system but also consider the 'full-size' system that will follow on, and which will be different in many aspects. The pilot system was built to test a variety of options and to gain feedback. Some elements of the system have been optimised for data gathering and trials, and taking account of the low numbers of users for the trial, and not for efficiency.

For example, 1) the wardrobe contains a large range of products in order to test user preferences but for a relatively small group of users 2) users have initially been encouraged to make physical exchanges at Houdini HQ to allow more active feedback, rather than online delivery services 3) subscription fees have been at a reduced price to attract a first set of pilot users and reward them for their engagement and feedback 4) service and laundering has been carried out by staff at Houdini HQ rather than using a professional laundry service.

These design elements can have a negative effect on the economics, convenience and environmental benefits of the system. Therefore, in the evaluation we also looked into the future to the 'full-size' rolled out, optimised system.

5.2 User satisfaction methodology

Since a fixed number of pilot users were tied in to the full six-month trial we cannot use flows of customers to and from the system as an indicator of user satisfaction. Instead we rely here on expressed satisfaction via surveys.

Towards the end of the pilot, users were asked several questions on their experiences with the system and their suggestions for improvements. Translations of the questions can be found in Appendix C.

5.3 Economic evaluation methodology

The economic evaluation was based on scenarios for a future system. Three scales of model were modelled: a small (single city ca. 1000 subscribers), medium (1-2 cities, ca. 5000 subscribers) and large (2-3 cities, ca. 25 000 subscribers).

A wide range of cost and income variables were included in the evaluation. When setting values for each variable, the focus has been on the rolled-out 'full-size' system that can be of use to a company rather than just project specific. These values were estimated based on experiences from the pilot system and from investigations of the prices of services such as warehouse storage and handling, professional laundry services, courier services etc.

The values of some variables can be chosen by Houdini as part of the future system design e.g. monthly subscription fee, number of items per person and the average use. The selection of these will have a key impact on another critical variable; number of users. Here the values have been set according to the findings of the user survey at the end of the pilot.

Once the basic economic model was set up, this was analysed to investigate the following:

- 1) Which variables are most critical with respect to profit or loss
- 2) What are the break-even values for these variables
- 3) What is the break-even number of users within the system

5.4 Environmental evaluation methodology

Functional Unit

Unlike the other two evaluations it was important here to compare the environmental impacts of the subscription system with the impacts of an 'equivalent' ownership system. In lifecycle assessment, equivalence is established through the selection of a so-called functional unit which is described in terms of the functional service provided by alternative products and/or services.

We could define this functional unit in terms of access to all outdoor clothing needed by an average Swede or average Houdini customer. However, the scope of the corresponding LCA would be enormous since the lifecycle impacts of the full range of outdoor clothing

available in the subscription wardrobe would need to be constructed, using data from all of Houdini's suppliers of materials and products.

Instead we selected product types from the subscription wardrobe, with similar material content and function. These comprise the Power Houdi, Outright Houdi, Power Jacket and Outright Jacket. These products were used by a majority of the pilot subscribers and made up 20% of the total stock of the subscription wardrobe and therefore are relatively representative. For the remainder of the LCA these are collectively named the 'Houdini hoodie'.

The functional unit (FU) was defined as: *"Having access to a hoodie at average use intensity for a period of 10 years"*.

Note that this definition of the FU does not imply that an average user only owns or wishes to have access to a single hoodie. Perhaps the average user demands 2.3 types and colours of hoodie available in their closet. In that case, the results for the average user can be obtained by multiplying the number of hoodies owned with the result for a single hoodie.

Scenarios

The ideal comparison would be between an ownership model and a subscription model for a Houdini hoodie. However, subscription models by their nature provide access opportunities to products that users may otherwise not be able to afford. This is also the case for much of Houdini's range which is at the higher price end of outdoor wear due to its focus on durability, performance, quality and the triple bottom line with full integration of environmental and social responsibility.

A subscription system opens the door to a whole new set of Houdini customers who have an immediate need for a garment but without a high upfront investment. For these users, the comparable alternatives may be an average purchased mid-range hoodie or a superior quality Houdini hoodie accessed via a subscription service.

To cover both existing Houdini customers and new customers, three different systems for providing the same functional unit were compared using LCA methods; use of an average purchased hoodie 2) use of a purchased Houdini hoodie and 3) access to a Houdini hoodie via the subscription service.

These are described briefly below, and a more detailed description can be found in Appendix D.

System 1 – use of a purchased average hoodie

Under System 1, a user fulfils the functional unit through purchasing successive average quality hoodies, comprising an average fibre mix. If the average hoodie can't survive ten years of average use intensity, or if the user gets tired of the hoodie and wants a different one, subsequent hoodies will need to be purchased.

Each new purchased hoodie is manufactured using a range of raw material inputs and transported to the shop/internet warehouse and finally to the user. The user launders the successive hoodies for ten years according to average laundering rates, using average Swedish washing machines at average temperature etc.

The discarded hoodies are either donated/sold for reuse or discarded in mixed waste for incineration according to the average behaviour of Swedes. If re-used, the hoodie will partially offset the production of a new hoodie, at a share corresponding to the technical lifetime left in the hoodie².

System 2 – use of a purchased Houdini hoodie

Under System 2, a user fulfils the functional unit through purchasing (successive) Houdini hoodies. System 2 is similar to Scenario 1, but some of the parameters will be different. For example, the Houdini hoodie has a higher technical life span, different material composition to the average hoodie etc.

We could expect this scenario to be environmentally superior to System 1 primarily due to the superior technical lifetime of the Houdini hoodie compared to an average hoodie. In order to fulfil the FU, under System 2 the user would need to buy fewer hoodies over the 10-year period compared to System 1.

System 3 – access to a subscription Houdini hoodie

Under System 3, a user fulfils the functional unit through gaining access to Houdini hoodies via the subscription service. She changes the colour and size of the Houdini hoodie an average number of times (for a subscriber) during the ten-year period. Each time she makes an exchange this includes a transport of the hoodie, either by courier/post or via her own transport to make the exchange. At each exchange there is also a professional laundering. Otherwise the home laundering is the same as in System 1 and 2. However, since under a subscription service there is potential for far stronger influence on user behaviour, scenarios were also developed for reduced impact laundering at home.

However, unlike System 1 and 2, each 'discarded' hoodie is made available for a new user until its technical life has come to an end. Hoodies with technical lifetime remaining are *never* incinerated in System 3. Moreover, under the subscription service the technical lifetime is extended through repair services which are an integral part of the system.

A further potential difference allowed by System 3 would be that since the Hoodie is always returned to Houdini these could be recycled end-of-life, instead of incinerated. However, the fibre mix of the Hoodie doesn't allow for recycling using current commercialised recycling technologies so Houdini products as stored or remade.

The hoodie user

All scenarios are built under the assumption that we model the same average user. The behaviour of the average user remains the same in all three scenarios. The behaviour of the average user directly affects the LCA modelling: we need to find out how often they wash the hoodies, how long they keep them and how much of the nominal life span is left in the clothes when they decide to discard them. These parameters will remain constant in all three scenarios. However, since Houdini subscribers are likely to be a different type of

² For example, if the technical life span of the hoodie is 5 use years, and the average user donates it after only 3 use years into re-use, this would lead to offsetting emissions from the production of 2/5 of a new hoodie.

person than the average Swede, we modelled two types of averages: an average Houdini customer as identified through Houdini's surveys (see below) and an average Swede.

5.5 Data collection

Data for the three evaluations was gathered using a range of methods:

- 1) A survey of Houdini customers (September 2018) (see Appendix A)
- 2) A pre-pilot survey of subscribers (October 2018) (see Appendix B)
- 3) Transaction and stock data from the subscription pilot (October 2018 to May 2019)
- 4) Questions asked of pilot subscribers at each transaction (October 2018 to May 2019)
- 5) A post-pilot survey of subscribers (May 2019) (see Appendix C)
- 6) Focus group workshops with a total of 25+ subscribers (Jan 2019 & May 2019)
- 7) Product and service data held by Houdini
- 8) Literature surveys
- 9) Eco-Invent Life Cycle Inventories

Table 1: Overview of data needs and where the data was sourced

Variable	Environmental evaluation (scenario numbers)	Economic evaluation	Data source according to list above
Material composition of an average hoodie	X (1)		1 & 2
Material composition of a Houdini hoodie	X (2 & 3)		7
Production emissions and resource use of a Houdini hoodie	X (2 & 3)		7, 8 & 9
Transport from production to Sweden and emissions	X (all)		7, 8 & 9
No. of Houdini hoodies/hoodies in average personal wardrobe	X (all)		1 & 2
Average use intensity of a Houdini/average hoodie	X (all)		1 & 2
Average number of uses between home laundry cycles	X (all)		1 & 2
Temperature of wash and detergent used in home laundry	X (all)		1, 2 & 9
Drying behaviour in home laundry	X (all)		1, 2 & 9
Location of professional laundry/repair service	X (3)		Assumption
Mode of transport to and from professional laundry	X (3)		Assumption
Water/energy use per Houdini hoodie under professional laundry service	X (3)		Assumption
Detergent used by professional laundry	X		Assumption
Technical life expectancy of a Houdini/average hoodie	X (All)	X	6
Period of ownership of individual Houdini/average hoodie before discard	X (1&2)		1 & 2
Average discard route for unwanted Houdini/average hoodies	X (1&2)		1, 2 & 8
Emissions from incineration and offset energy use	X (All)		8 & 9
Number of subscribers		X	Variable
Monthly subscription fee		X	Variable
Stock of items (idle or in use) per user		X	3
Average production cost per item		X	7
Interest rate for initial investments			7
Accumulated losses of items	X	X	3
Annual replacement rate for items in wardrobe		X	Variable
Average sales price of unused items in stock		X	7
Average sales price for pre-owned items in stock		X	7
No. of exchanges per month for average subscriber	X	X	3

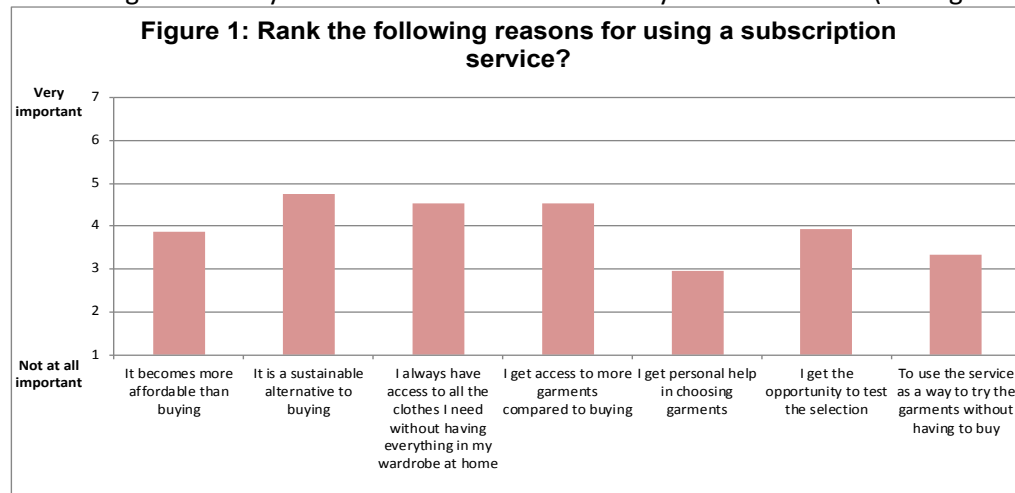
Price charged to subscriber per exchange		X	Variable
Cost of transport per item exchange		X	3
Cost of laundry and repairs per item exchange		X	Assumption
% repair necessary per returned item		X	3
Annual rental cost of warehouse		X	Assumption
Internal staff costs for running system		X	Assumption

6. Evaluation of the system: Results

6.1 The system from the subscriber's perspective

Motivation

Of the 85 subscribers joined the pilot system, when asked on their motivation, no single motivating factor or system benefit stood out markedly from the others (see Figure 1).



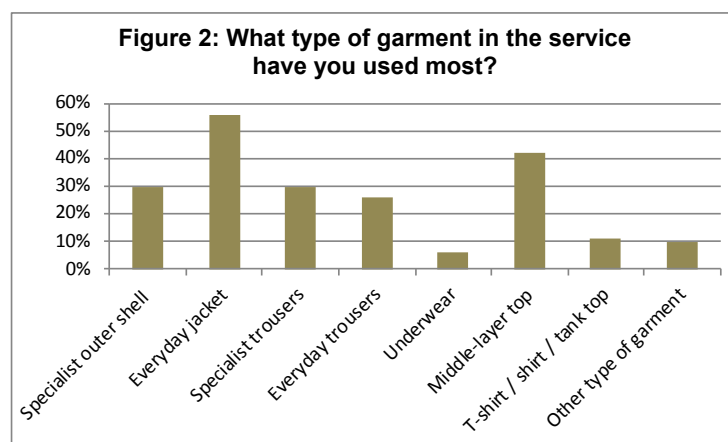
Increased sustainability, having access to more clothing than under ownership options but at the same time not needing to store these garments at home, ranked a little higher than middle.

Usage of the pilot system

Of the 85 subscribers, 32 signed up to the basic Essentials package, 43 to the Adventurers package with the wider wardrobe range and 10 to Customised packages.

Subscribers who signed up to the first two packages borrowed up to their limit e.g. 4 items, for the entire period.

Those in the customised package borrowed on average 2.5 items. This doesn't necessarily



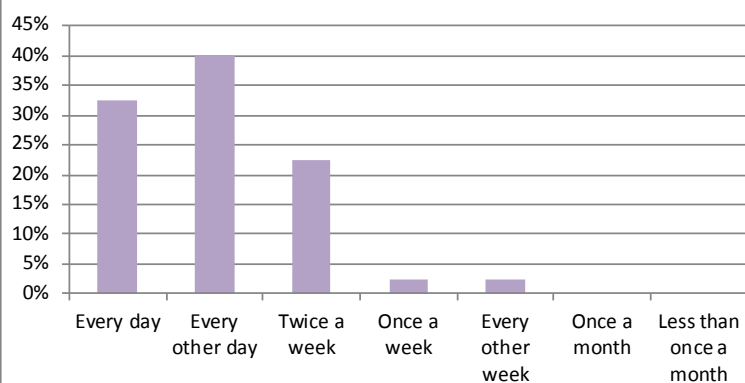
indicate that subscribers will always use up to their limit when paying a fixed price. Knowing that the scheme was only in operation for a short period may have encouraged them to make as much use of it as possible. A future model could also change that behaviour offering both more and less items, and a short time access through a customized option for subscribers with a package.

Fewer exchanges were on average made than might be expected considering the limited time span. During the six months of the pilot the exchange events per user was 1.5, in other words one exchange every 4 months, number of exchanges ranged among the subscribers from 0-11. The average user exchanged a total of 3.9 items over the period.

The most used types of items have been jackets, pants and middle layers (see Figure 2). 31% of the 346 unique product types³ that were initially offered, were never used during the six-month pilot.

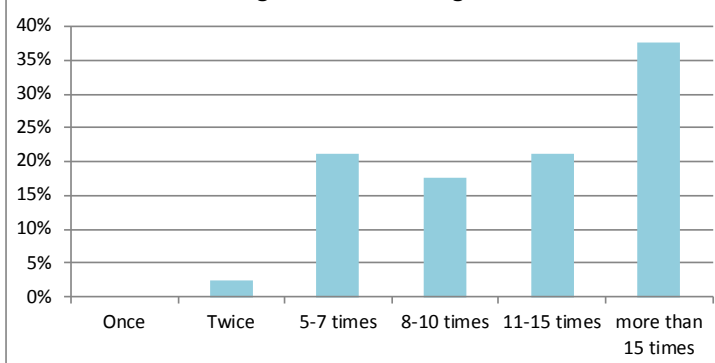
Subscribers were quite clear in preferring not to share items placed next to the body. 57% of subscribers did not consider that underwear should be part of a subscription system with 43% having the same opinion with respect to t-shirts.

Figure 3: How often have you used the garments you have borrowed from the subscription service?



The users made regular use of the garments that they had accessed via the system. Over 70% of subscribers used one or more of the garments at least once every other day (see Figure 3).

Figure 4: How many times have you used them on average before washing them?



Moreover, they used them many times before laundering and, in some cases, returned the items without ever having laundered them. Over a third of subscribers used items over 15 times before laundering (see Figure 4). This can partly be explained by the preference for jackets and pants rather than items close to the body.

³ Also taking account of colour, gender and size

Behavioural changes

However, the many uses before washing is also a conscious decision that has resulted from the subscriber's experiences within the system and the communication they have received from Houdini.

Communication material has been sent on the environmental impacts of ownership compared to sharing, on the impacts of laundering behaviour both on the environment but also on the quality and life expectancy of the garment.

As can be seen in Figure 5, these experiences and information have led to several changes in behaviour.

This demonstrates that inclusion in a subscription system doesn't only have immediate direct environmental benefits but can also lead to wider indirect benefits through behaviour change. The close relationship between the subscriber and the company allows a much stronger use of nudges and communication than purchase systems where the relationship is only transactional.

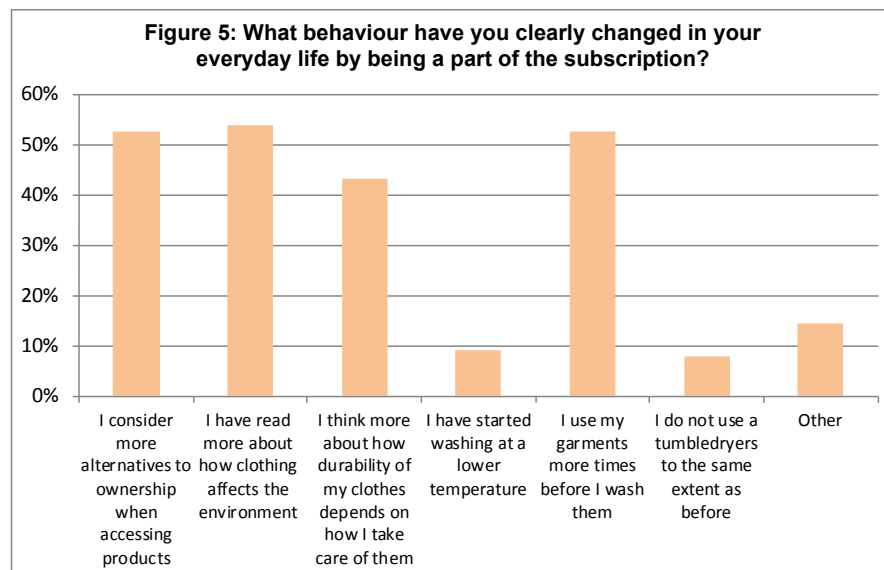
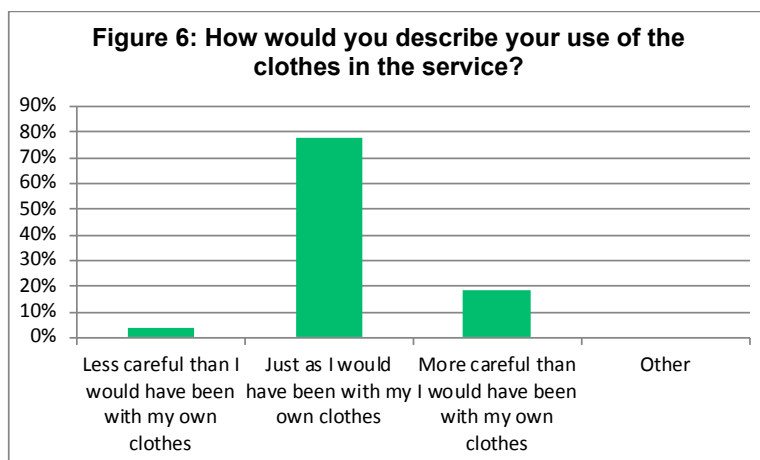


Figure 6 demonstrates that behavioural changes in laundering haven't been caused by the fact that subscribers are aware that they don't own the clothing, but rather demonstrate a broader change in attitudes towards clothing (and other products). Subscribers claim that they don't treat the leased clothing differently than they would their own.

Another behavioural change caused by the system is that subscribers no longer feel the need to purchase garments that they had otherwise planned to do. The average spending



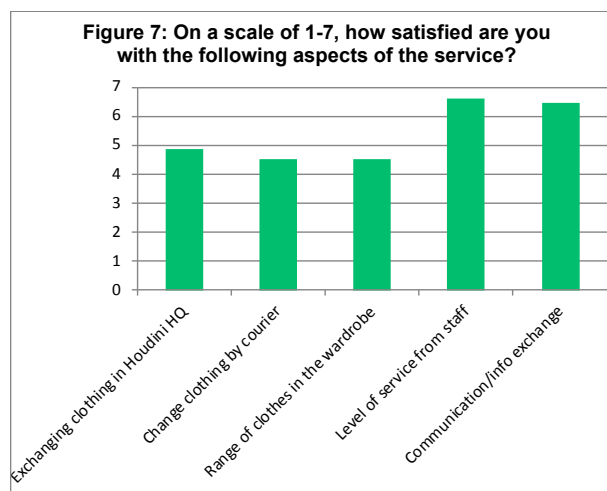
on clothes during the pilot was 31% lower than in the 6 months before the pilot: 5440 SEK compared to 3800 SEK. The number of items purchased reduced from 9 to 6.

This indicates that the subscription service has achieved one of its key goals – to act as a viable and attractive alternative to ownership models.

Satisfaction and value for money

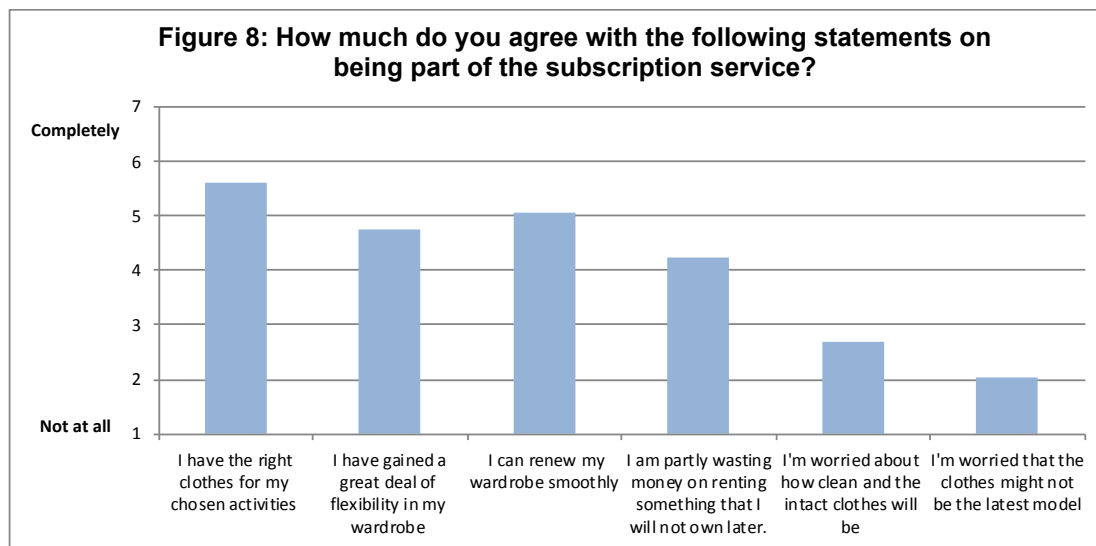
The subscribers report a medium to high level of satisfaction with the pilot system giving the pilot experience 5.3 points out of a possible 7. This bodes well for a future system that is more closely matched to needs.

With respect to individual elements (see Figure 7), the personal interface and communication with the subscribers has paid off with particularly high levels of satisfaction. Perhaps surprisingly, the range of clothing has only achieved middle satisfaction even though almost the entire Houdini range is represented. Thus, can potentially be explained by limitations in the available colours per model.

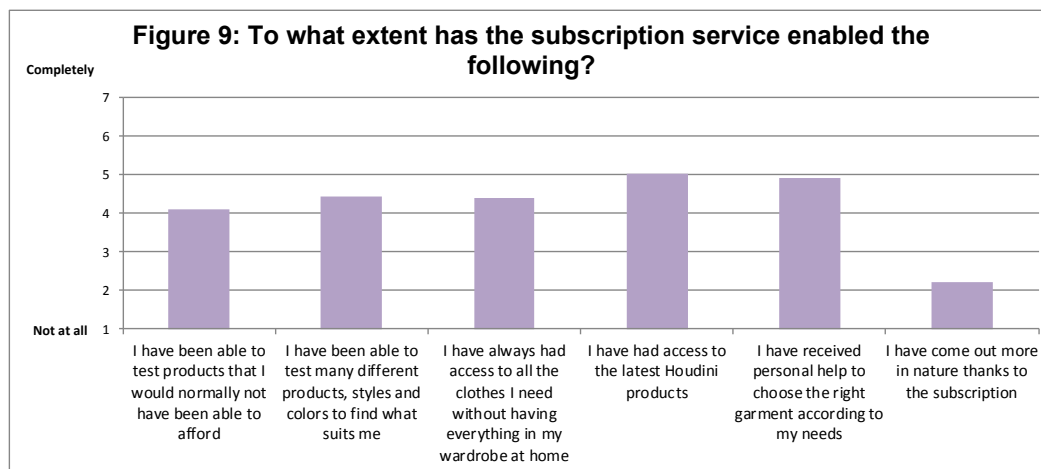


Another clear issue that needs consideration for the future system is the convenience versus cost of access to the wardrobe. Neither coming physically to the Houdini HQ to make exchanges, nor the bicycle delivery service have achieved very high levels of satisfaction. On the one hand the Houdini HQ is perhaps a little too out of the way. On the other hand, subscribers consider the delivery service to be costly (see later). These issues are addressed further later.

The system has provided reasonably well for many needs/wishes of the subscribers (see Figures 8 and 9). Moreover, some of the concerns that subscribers might have had such as the garments not being clean, or not being the latest model have not arisen.



Subscribers feel that they have the right clothing for their activity, have gained flexibility and can make smooth exchanges. There remains a little niggle for some on the fact that they are using money on something they do not own, but this can be considered to be a hangover from ownership systems that might disappear as they become more used to other types of access systems or a better understanding of their current spending behaviour. When asked to add up their spending on new clothing during the six months prior to joining the pilot subscription system, the average spending on clothing was found to be approximately SEK 900 per month.

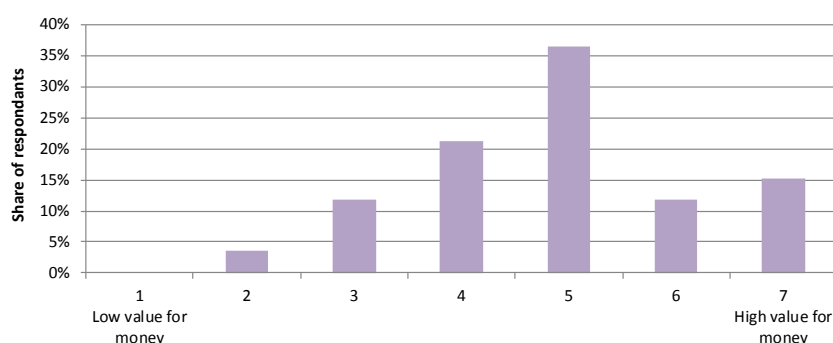


One goal that Houdini did not achieve during the pilot, was to encourage people to experience nature more than they otherwise would have done. This can be explained by the fact that the pilot subscribers have all been selected from the Houdini community who are by definition nature enthusiasts and thus unlikely to further increase their experience of nature.

In general subscribers consider the service to be reasonably good value for money (see Figure 10). Note, however, that subscribers have been paying a reduced monthly fee (as outlined in 4.2) during the pilot.

When asked on the monthly subscription fees that they feel would be reasonable for the service offered under the pilot, the Adventurer subscribers proposed fees from SEK 200 to 1500 with an average of SEK 621 just above the pilot price of SEK 600.

Figure 10: How do you rate the value you have received for the price you paid in the pilot?

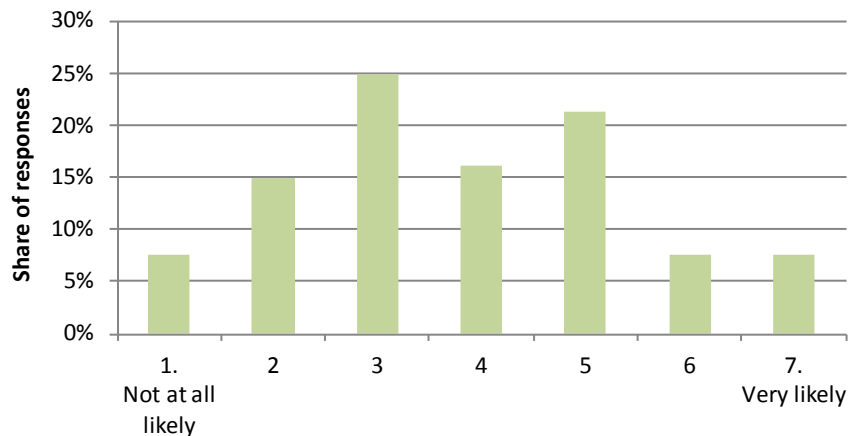


Essentials subscribers proposed fees between SEK 80 and SEK 1550, with an average of SEK 476, a little above the pilot price of SEK 400.

The large range in proposed fees illustrates that Houdini will need to be flexible in the types of packages and price schemes the company offers for the future service, and/or to make subscribers aware of the money that they currently already use on purchasing clothing and outdoor wear as this is often underestimated.

It also may explain why subscribers are mixed when it comes to whether they will join the future system which is similar to the pilot version (see Figure 11) without being specified what the monthly price for the system would be. Around 15% seem likely or very likely to do so, with another 35% reasonably likely. The other half are less sure.

Figure 11: How likely is it that you would subscribe to Houdini's future subscription service?



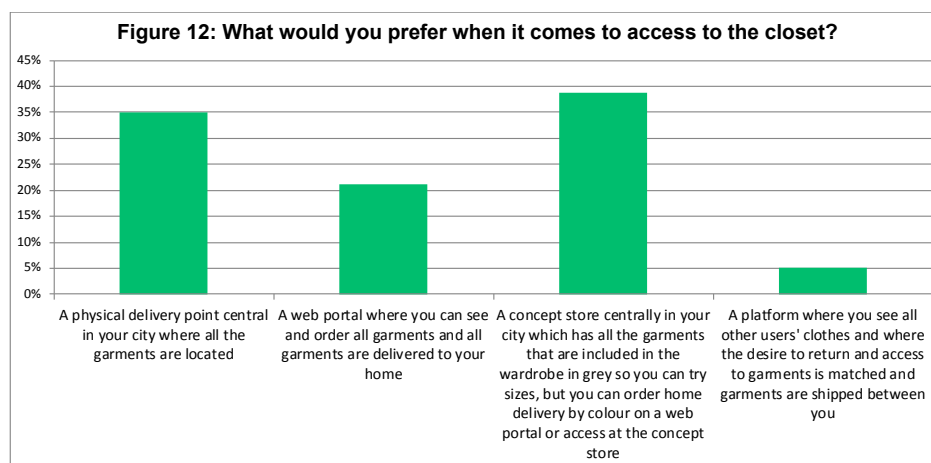
Wishes for a future system

Subscribers were also asked on their thoughts/wishes for the future subscription system both in the questionnaire survey and during the focus group workshops with 25+ subscribers in both January and May.

As mentioned earlier, the issue of how to

access the closet does not give clear results (see Figure 12). It may be that Houdini may need to provide several options, both online and physical to cater for different types of users.

For delivery options (see Figure 13), the results were again mixed with delivery to a postal kiosk most popular but deliver direct to home or workplace also relatively well-wished for.



These issues were also discussed at the half time and post-pilot workshops where many felt that exchange choices should be made online, with a convenient delivery or pick up method. Subscribers understood that not all products are always in stock, and that access to the right function for the activity was the key aspect rather than a specific product. At workshops, subscribers also prioritised the sustainable of exchanges, rather than next day delivery or unlimited number of exchanges per year as part of a package.

“I think you as a brand should make a statement and not offer unlimited exchanges by delivery unless it is by sustainable transport modes”

According to online post-pilot surveys, when selecting wardrobe items online, subscribers would prefer options where they can see all products, or all currently available products rather than curated views (see Figure 14).

This may reflect the fact that the pilot subscribers are outdoor enthusiasts with perhaps a greater knowledge and interest in gear than the average Houdini customer.

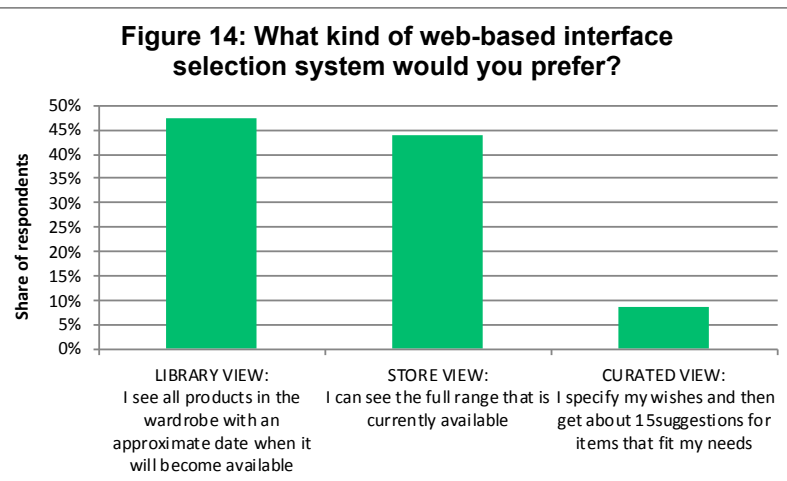
However, the post-pilot Workshops with subscribers told a more nuanced story where a recurring wish from subscribers was for personal curated option. Subscribers wanted to access clothing in a non-traditional way and be inspired with a concluding agreement that through in depth understanding of the customer needs and with machine learning, curation would create a high value in a subscription system.

In workshops, subscribers also expressed a strong wish and acceptance to share details like weight, size, preferences and what they already had in their wardrobe to improve curated suggestions. There was close to no concern regarding sharing this kind of data, although transparency of how it was used and by whom was important.

Finally, there was a relief at not having to look at price tags, and only at the functional need, or emotional connection they had. This was especially apparent regarding colours, where they felt a relief that they could choose colour based on intuition rather than long term planning.

"I am so tired of going to another web shop to buy clothes, just tell me what things I need for the next adventure!"

"It was amazing how quickly I went from wanting a specific product to thinking about what function I needed, without the need to consider a price tag"



6.2 The subscription system from an environmental perspective

Comparing three systems

As described in Chapter 5.4, we took a life cycle approach comparing three alternative means for meeting a service (so-called Functional Unit): *Having access to a hoodie at average use intensity for a period of 10 years*. The Houdini hoodie and similar (material content) products represent 20% of the subscription wardrobe and was used by a majority of the subscribers and therefore was viewed as reasonable representative of the subscription service.

The three alternative systems were:

- System 1) consecutive purchased average brand hoodies
- System 2) consecutive purchased Houdini hoodies
- System 3) consecutive Houdini hoodies accessed via the subscription system.

Variables to fully describe the three systems as accurately as possible were derived from user surveys, Houdini product data, data gathered during the pilot, literature surveys and LCA databases as shown in Table xx earlier. System 3 was modelled on a more mature system than the pilot, with a professional laundry service and access via both delivery and an exchange closet situated in Stockholm city centre. The values used for the variables are described in Appendix D.

The environmental impacts of the three systems were thus compared and the results tested for other values for some key variables to see how robust the results are, but also to identify what Houdini can do to further improve the subscription systems environmental benefits. The report has been limited to using climate impact as the measurement for environmental impact, but it could be assumed that similar results would be found for other critical measurements within the planetary boundaries.

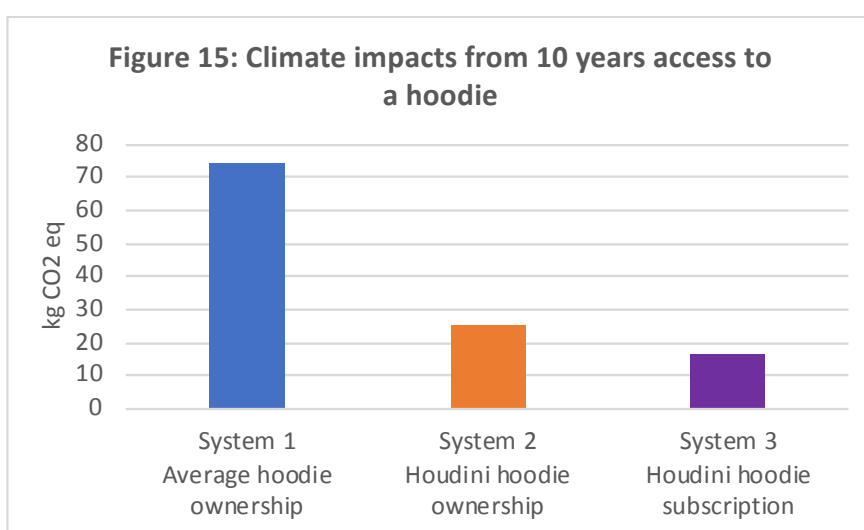
What is a valid comparison?

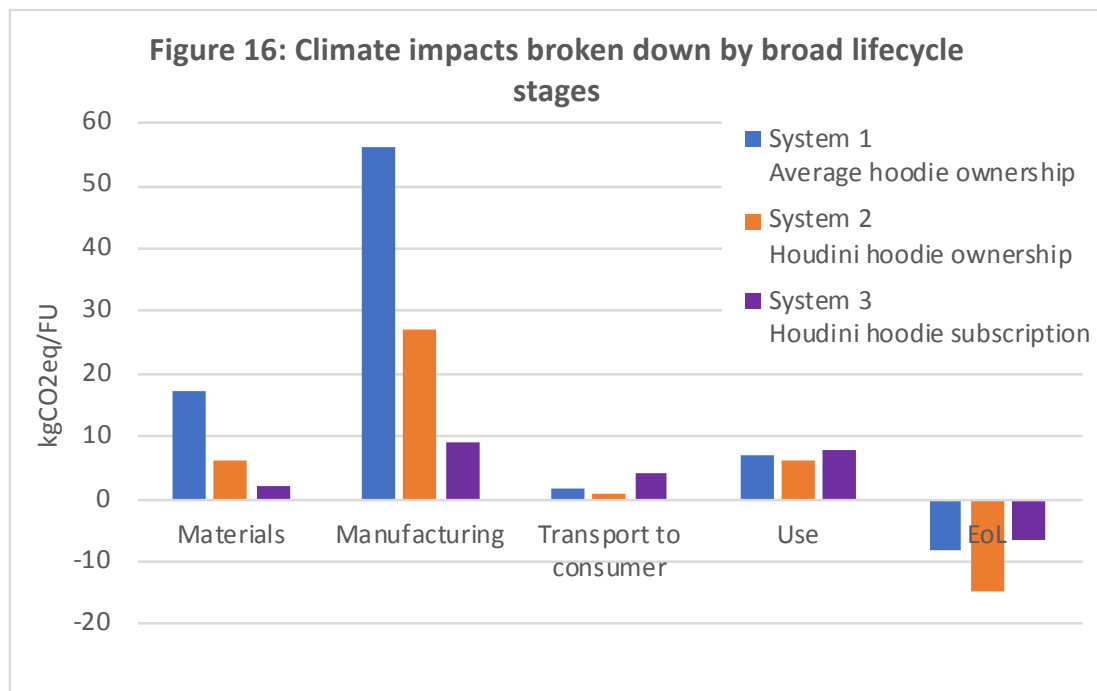
Are the three systems comparable? The most immediately valid comparison is between the ownership and subscription systems for the same product: the Houdini hoodie. However, a subscription system for Houdini hoodies can also be compared to an ownership system for an average lower quality hoodie. Why? Because a subscription system for Houdini products can open the door to use of these products by people that otherwise couldn't afford to buy such high quality, durable goods and are currently forced to buy lower quality hoodies. Thus, a subscription system for Houdini hoodies can also offset purchases of lower quality average hoodies.

The subscription system is greener under core assumptions

Under core assumptions, the Houdini hoodie subscription system (system 3) has 78% lower climate impacts than an ownership system for average hoodies (System 1) and 35% lower climate impacts than an ordinary ownership system for Houdini hoodies (System 2) (see Figure 15).

In both cases, these savings are a result of reductions in production quantities and associated impacts from material production and manufacturing (see Figure 16).





Why are the production quantities different in the three systems? There are two key reasons.

- 1) The central product in Systems 2 and 3 (the Houdini hoodie) **is far more durable** than the central product in System 1 (the average hoodie). The Houdini hoodie has a technical lifetime of 3000 days of use; ten times the technical lifetime than assumed for the average hoodie. A more durable product means much fewer products that need to be produced to fulfil the service (of having a hoodie over a 10-year period.)⁴
- 2) Under ownership systems people **discard their products even before the technical lifetime has been reached**. According to our surveys people on average hold on to their Houdini hoodies (486 days of use) longer than they do their average hoodies (171 day of use). In the subscription system, however, it is assumed that the Houdini hoodies are never discarded from the system while they still have technical life in them. They are simply recirculated to new users.

Under core assumptions (10 uses per month), 7 average hoodies are used over 10 years under system 1, 2.5 Houdini hoodies under system 2 but just 0.4 Houdini hoodies under System 3. Hence the large differences in production impacts (Materials and Manufacturing).

The observant reader will protest that discarded products under System 1 and 2 that still have life left in them, can also be recirculated to new users. Under cores assumptions we have assumed average Swedish systems for recirculation: 25% of discarded clothing is

⁴ In addition, though not modelled here, under the subscription system the functional life of the product is further extended through communication to the subscriber on how best to wash and maintain the product to extend its lifetime as far as possible. We have already seen from Figure 5 earlier that this communication has had an effect.

donated for reuse/recycling while 75% is discarded in mixed waste for incineration (Elander et al, 2016). Thus, we assume 25% recirculation to a new user. The resulting benefits are shown under the end of life (EOL) stage in Figure 16.

The benefits under System 2 are higher than System 1 because the discarded Houdini hoodies have much greater technical life left in them and thus can more completely offset a new product.

Nevertheless, for System 2 the high EOL benefits only partially offset the production impacts and the final result is that System 3 is environmentally advantageous. However, this is not true under all assumptions. This is discussed in more detail below.

A delicate balance

A subscription system has potential environmental costs that at least partially outweigh its benefits. Every time a subscriber exchanges an item with a new item from the Houdini wardrobe this exchange is associated with some transport between the subscriber's home and the exchange shop, and with a professional laundering service.

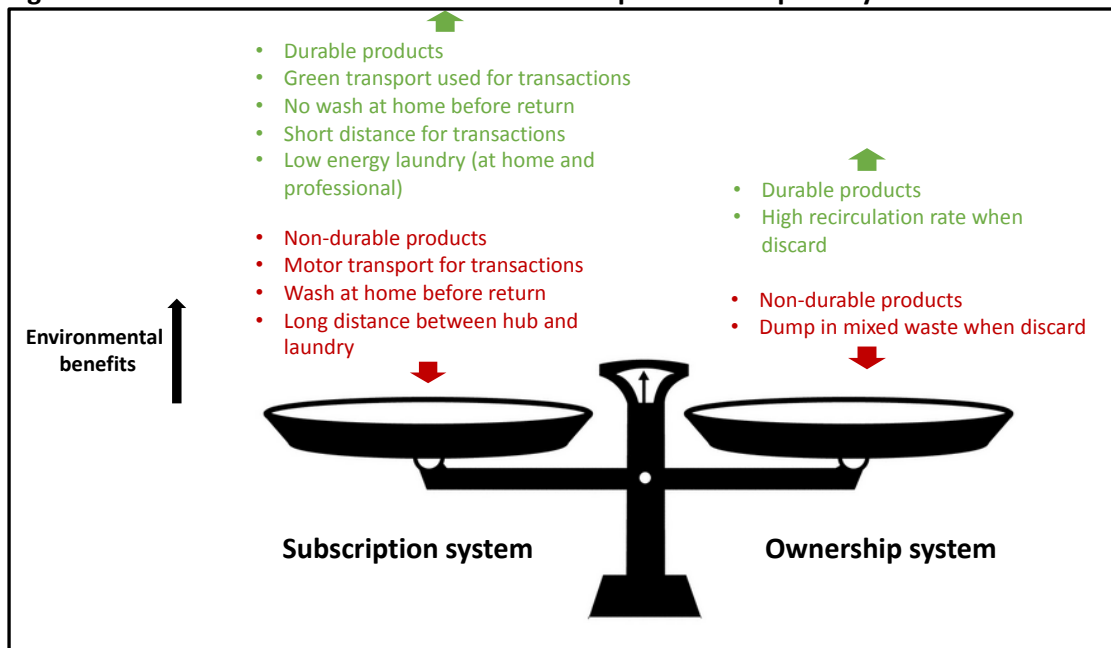
These costs can be heavy or light depending on how the system is designed and on the behaviour of the user.

Heavy: *The subscriber makes very frequent exchanges, she launders each article before she returns it, even though it will be professionally laundered anyway, she travels to the exchange shop by car for each exchange, the laundry is located some distance from the exchange shop and uses high temperatures to launder the item*

Light: *The subscriber makes fewer exchanges, she doesn't launder articles before she returns them, she uses a bicycle delivery service or cycles herself to the exchange shop, travels to the exchange shop, the laundry is located close to the exchange shop and has an environmental label*

Other factors that affect the balance between the ownership and subscription system are the technical lifetime of the Houdini hoodie, and the likelihood that under an ownership system the owner discards an unwanted article in mixed waste or gives it a new life. The balance is illustrated in Figure 17.

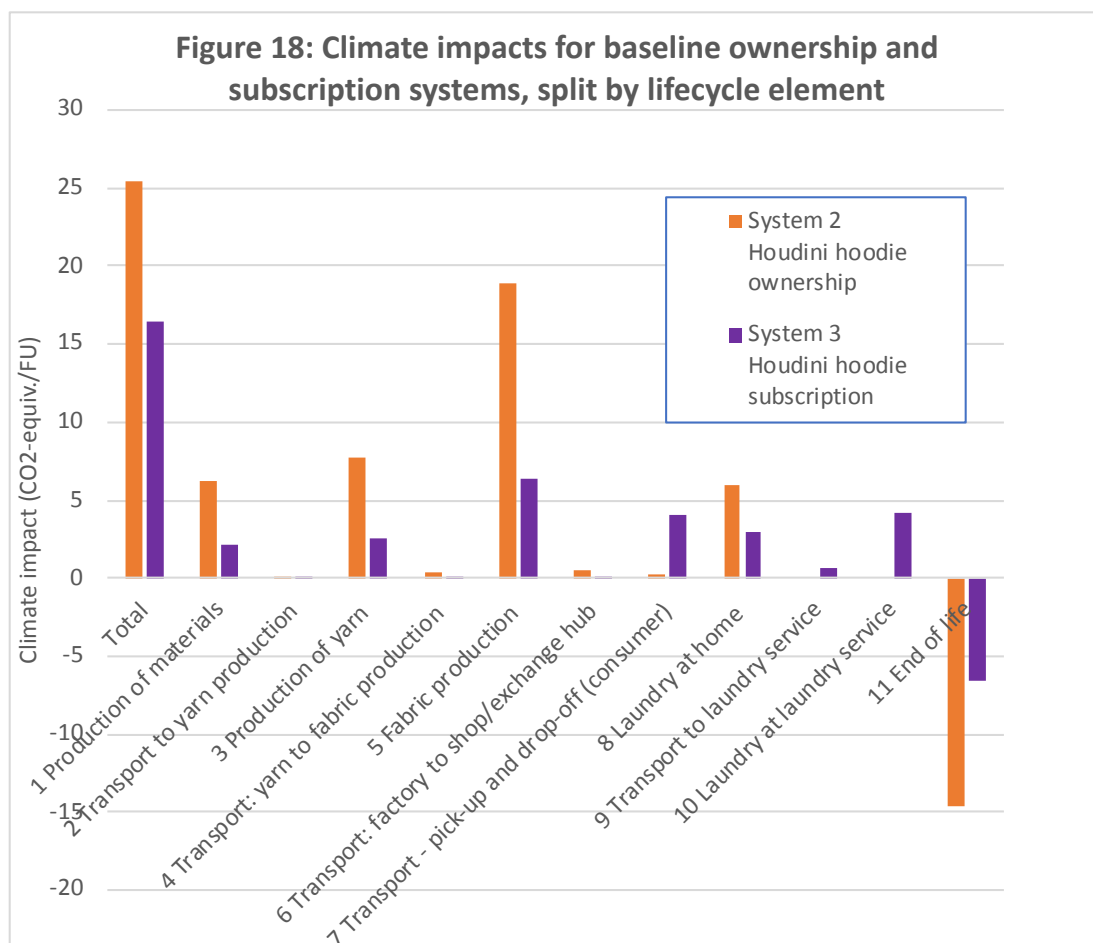
Figure 17: The delicate balance between ownership and subscription systems



The *core assumptions* for the models for System 2 and 3 were mixed with respect to this balance (see also Figure 18).

On the plus side for the subscription system we had a high durability for the Houdini hoodie (3000 days of use as tested by the company), assumed no wash at home prior to returning items, and assumed an eco-labelled professional laundry, a short distance between exchange hub and customer (5 km), and a relatively low rate of clothing swaps (once every 3 months based on behaviour during the pilot). Moreover, a low recirculation for discarded Houdini hoodies in the ownership system was assumed (25% based on Swedish average for all textiles).

On the minus side for the subscription system we assumed that half of article swaps via the exchange hub are made by car (based on actual behaviour of pilot users), that the laundry is positioned some distance from the exchange hub (10 km) and that the laundry made use of tumble-dryers rather than air drying.



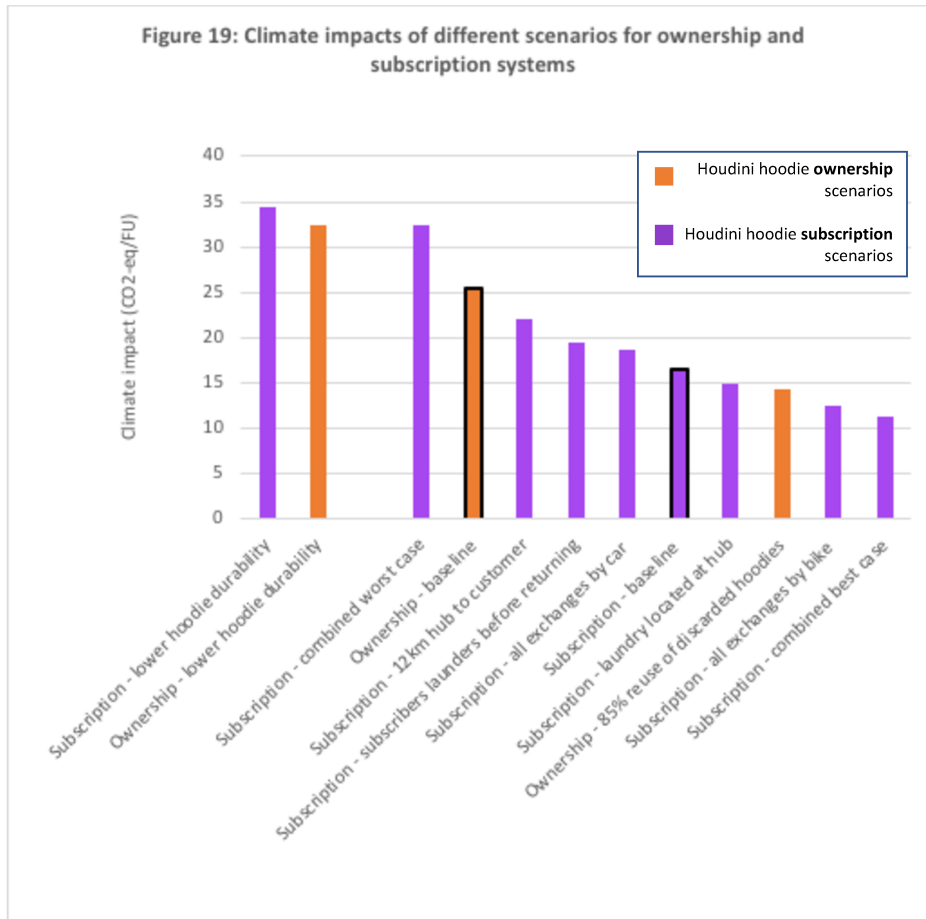
This latter point is almost unavoidable for a professional laundry due to space issues. Therefore, even when assuming identical numbers of washes (sum of home washes plus professional laundry wash) for Systems 2 and 3, the total impact from laundering is higher under System 2.

Figure 19 shows how the balance can shift with changes in the design and use of the system. In the two left bars it can be seen how a significant reduction of the durability of the Houdini hoodie from 3000 to 600 days of use, shifts the climate balance in favour of ownership (System 2).

While individually, less eco-friendly design variables of the subscription system don't shift the environmental balance, when combined in a single system in a worst-case (third bar from left in Figure 9) the subscription system becomes environmentally less favourable than the baseline ownership system (fourth bar from the left in Figure 19).

Moreover, if we assume that 85% of Houdini hoodie owners sell or donate their hoodies when they no longer wish for them (as reported in surveys) then the subscription system can only compete environmentally with the ownership system if *all* transport between exchange hub and the user is made by bike or some other CO₂-neutral transport system.

When all eco-friendly design and use aspects of the subscription system are combined, this would give a carbon footprint for 10 years of access to a Houdini hoodie as low as 11 kg CO₂-equiv. (extreme right-hand bar in Figure 19).



Designing an environmentally optimised subscription system

The analysis above demonstrates that the way that Houdini, or any other subscription service provider, designs a subscription system and the way it is used are critical in determining whether the system is environmentally beneficial or detrimental compared to an ownership system.

Houdini can ensure environmental benefits of the system by:

- **Maximising the technical durability** of items in the system
- Encouraging subscribers **to use a delivery system and/or public transport/bikes** for exchanges
- Locating exchange shops where they are **readily accessible by public transport**
- Selecting **fossil-free delivery services**
- Encouraging subscribers **not to launder items before returning them** and to **avoid laundering more than necessary**
- Using **eco-labelled professional laundries**
- Encouraging subscribers **to wash at low temperatures and to air dry**

6.3 The subscription system from a business perspective

As already described in Section 5.3, the economics analysis was based on scenarios for a future system but using variables based on findings from the pilot system. Three scales of model were modelled: a small (single city ca. 1000 subscribers), medium (1-2 cities, ca. 5000 subscribers) and large (2-3 cities, ca. 25 000 subscribers).

The three scales of the subscription service potentially represent different three snapshots of a business under development. The gradual growth in the numbers of users will naturally require the injection of new clothing into the wardrobe. This also allows for the injection of new improved products into the system as they are developed by Houdini's design team without the need to replace any of the existing wardrobe. As such there would be no conflict between the wish to develop new products and the key sustainability wish to keep products within the system until they reach the end of their technical lifetime.

It also allows for a range of package options for users, where those who are keen to have access to latest models pay a premium to have access to those as they enter the system, while those who are less bothered about having the latest model pay a lower price and have access only to items that have already been within the system for a while.

During the pilot subscribers have expressed different expectations of what is deemed to be a garment that is fit for the system. Different packages can therefore be created depending on what level wear and tear different subscribers accept. Some do not care if there is significant wear and tear, while others want the garment to "feel like it could be new", crisp.

In the system below the number of days that an average garment is "fit for use" in a system with crisp clothes are, through results from workshops, around 730 days. This was used to with regards to the goal offer an alternative to consuming new clothes. There is also an opportunity to create a model that uses the on wear and tear for other uses, however not modelled below.

Core assumptions for variables within the system are provided in Table 2. These were based in part on experiences with the pilot system and in part on additional research. All prices are ex-VAT.

Table 2: Core assumptions for variables in the economic models

	Small	Medium	Large
Location:	1 large city	1-2 large cities	2-3 large cities
Numbers of exchange hubs:	1	2	3
Digital Subscription platform:	External platform (customized)	External platform (customized)	External platform (customized)
Number of users:	1000	5000	25000
Average monthly fee per user	640	640	640
Number of items per user (fixed or average):	4	4	4
Idle rate (number of additional items in wardrobe per item with subscribers):	2	1,7	1,5
Pieces of Houdini clothes included in the Subscription wardrobe:	8 000	34 000	150 000

Average production cost per item:	700	700	700
Avg. "fit for service" days:	730	730	730
Avg. "fit for service" years in the system:	4	3,4	3
Average exchanges per year / user (4 exchanges included in the fee):	4	4	4
Average pieces changed at each exchange:	2,5	2,5	2,5
Exchange via HUB (face to face)	40%	20%	10%
Exchange via Delivery (web)	60%	80%	90%
Logistics:	Outsourced	Outsourced	Outsourced
Logistics costs between hub and user (each way):	56	45	35
% repairs per year of total number of clothes (year 1&2)	5%	5%	5%
% repairs per year of total number of clothes (year 3 and more)	10%	10%	10%
Average repair costs per item	150	125	100
Laundering between users:	Outsourced	Outsourced	Outsourced
Cost of laundering per item:	30	25	20
Number of full-time staff:	2,5	10	31,25

As can be seen in Table 2, some of the factors are affected by economies of scale in the system. For example, the *idle factor* (the total number of items in the hub wardrobe per item demanded users) will reduce as the numbers of users increase: it becomes gradually more efficient to provide a full range of items as numbers increase. To take an extreme case, for a single subscriber the idle factor could be over 100 (if he was to have access to the full range of clothing offered by Houdini).

Other factors that experience an economy of scale are: *average repair costs per item*, *logistics costs per item* and *laundering costs per item*.

Calculations were made of total costs versus income making use of the variables in Table 2. The key cost lines concerned: *initial investments in purchasing the wardrobe*, *space rental for the hub*, *personnel costs*, *total outsourcing costs for logistics and the professional laundry and repairs*, *IT running costs* and *interest rates on initial investments*. A 15% overhead cost was also assumed for head office, product development etc.

Costs versus income was modelled for a four-year period following the launch of the system, to allow for developments in wear and tear of the articles in the wardrobe. Each snapshot (small, medium and large) was analysed in isolation since it isn't possible to this stage to determine how quickly or slowly the business will grow. In other words, the economics of the small system was followed for 4 years after launch assuming a fixed number of users.

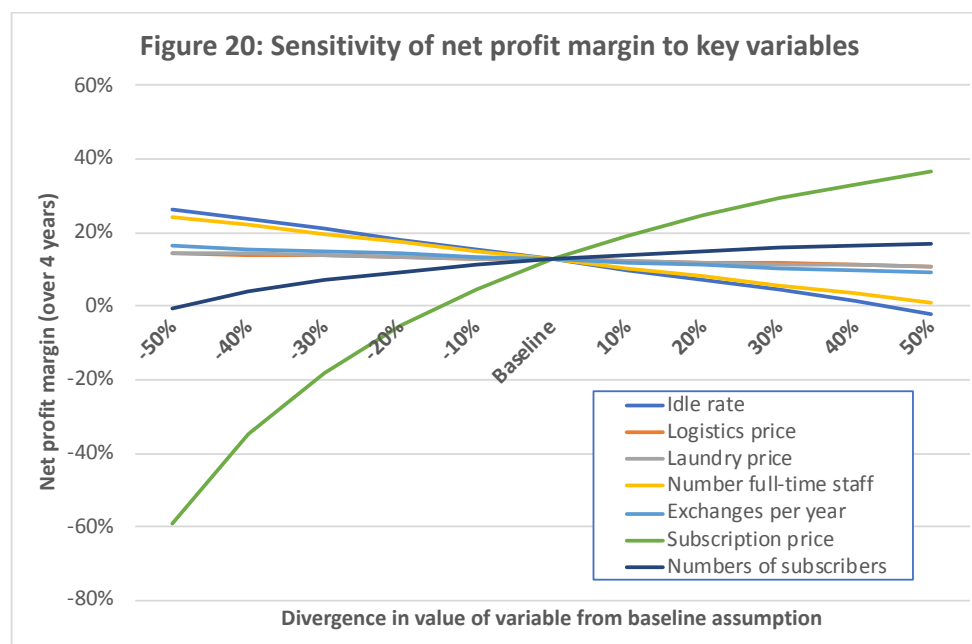
The four-year results (in SEK) for the small system for core assumptions are given in Table 3.

Table 3: Net profit over 4-year period following launch of the small system (1000 users)

	Year 1	Year 2	Year 3	Year 4	Accumulated (over 4 years)
Subscription income	7 680 000	7 680 000	7 680 000	7 680 000	30 720 000
Cost of wardrobe	2 800 000	2 520 000	1 960 000	560 000	7 840 000
Operating & costs	3 498 800	3 645 600	3 663 600	3 565 600	14 373 600
Operating profit	1 381 200	1 514 400	2 056 400	3 554 400	8 506 400
Overhead costs	1 152 000	1 152 000	1 152 000	1 152 000	4 608 000
Net profit	229 200	362 400	904 400	2 402 400	3 898 400

This demonstrates that even the small system with 1000 users is profitable with returns around 13% average net profit margin.

Analysing the various factors in whether the system makes a profit or not identified the following variables as being relevant for further analysis: *idle rate, subscription fee, number of full-time staff, numbers of exchanges per year, costs of logistics and costs of laundering*. The effects of changing each of these factors, all other things being equal, on the net profit margin is presented in Figure 20.



As can be seen, the net profit margin is by far the most sensitive to subscription price. A 100 SEK reduction in subscription price from 640 SEK per month to 540 SEK entirely removes any profit over the 4 years, while an increase of 100 SEK more than doubles the profit from 3.9 mil. to 7.9 mil. SEK (note that these prices are ex-VAT).

Medium changes in the numbers of subscribers, the idle rate and the number of full-time staff can also significantly reduce profit margins. A halving in numbers of subscribers from 1000 to 500 or an increase in full time staff numbers from 2.5 to 3.8 would remove all profits from the system. The same is true if the idle rate of clothing increased from 2 to 3 (i.e. only 1/3 of clothing in the wardrobe actively out with subscribers at any one time).

The sensitivity to the Idle Rate means that Houdini needs to be particularly careful in managing the wardrobe's contents (e.g. which sizes and colours to include for less popular items) to match demand as closely as possible. This may mean a system where not all items are available for immediate delivery to the subscriber on demand. This can be managed for example by only showing subscribers items that are currently available as discussed earlier. Houdini will have the advantage of running a shop (including new and second-hand sales) and subscription service in parallel. This allows for flexibility by enabling sales of unused items from the subscription service and vice versa for rapid inclusion of new items in the wardrobe.

The profit margin's sensitivity, on the one hand to subscription price and on the other hand, to numbers of subscribers, is typical of any product. Houdini needs to be very careful in selecting the subscription price to a level that can attract subscribers but at the same time still raise a profit. The high sensitivity would suggest the use of a range of package and price options that can attract different types of users to the system.

The profit margin is less sensitive to the costs/per exchange of logistics and laundering (both costs assumed to be included in the price) than the other variables. These costs can increase by 50% while keeping a relatively healthy profit margin. The same is true of numbers of exchanges per year; these could be increased to 6 per year without unduly challenging profits. However, it should be noted that we have assumed a fairly balanced mix between exchanges by external logistics and direct exchanges by users at the hub in the baseline. If the share of exchanges made by external delivery increases (as the larger system suggest) the sensitivity of the profit margin to delivery price costs and to number of exchanges would also increase.

7. Conclusions and Next Steps

Designing an environmentally advantageous and economically viable system

The development and running of the pilot subscription service has given Houdini a wealth of information, which it can use to develop an upscaled subscription service in the near future.

The outcome of the pilot is generally positive, with a medium to high level of satisfaction amongst users, which would be expected to increase for a more mature system with a fully developed digital interface, a wardrobe which closely fits needs and even more curated personal service.

The life cycle assessment that was built upon data from behaviour within the pilot, qualitative and quantitative data from the users and generic textiles production data for the materials for the Houdini hoodie found that a subscription system with a medium level of green design would reduce climate impacts by 35% compared to traditional ownership system for the same products. This could be increased to 56% with careful design of the subscription system.

The high durability of Houdini products is a strong factor in the environmental benefits of the subscription system. When compared to a traditional ownership system of an average hoodie with its significantly lower durability, the average subscription system for Houdini

products has 78% lower climate impacts; increasing to 85% savings with careful environmental design of the subscription service.

A upscaled subscription system with 1000 users were also found to be profitable with profits increasing as the number of users increases. An even larger user base (ex. +5000 users) has potential to result in a doubles net profit margin, but the uncertainty in the different input factors increases as well. Thus, it is difficult to predict exact, but this is certainly a system well suited for a large user base as both the quality of the service and the margins increases with the number of users.

Careful design of the system is key in ensuring both environmental benefits and economic viability.

The **key factors in ensuring an environmental beneficial system** are:

- **Maximising the technical durability** of items in the system
- Encouraging subscribers (with economic incentives, communication etc.) **to use a delivery system and/or to use public transport/bikes** to travel to an exchange shop/post kiosk
- Locating exchange shops where they are **readily accessible by public transport**
- Selecting **fossil-free delivery services** (delivery by bike, electric vehicle, other) both between home and exchange shop and between exchange shop and professional laundry
- Encouraging subscribers (through careful communication) **not to launder items before returning them** and to **avoid laundering items more than necessary**
- Using **eco-labelled professional laundries**
- Encouraging subscribers **to wash at low temperatures and to air dry** when laundering at home

Managing these issues, and in particular, **ensuring green transport for exchanges of clothing between the exchange hub and the subscriber** is absolutely essential in ensuring environmental advantages of the subscription system compared to ownership systems for the same products. **Subscription businesses need to be aware that environmental advantages are not guaranteed.** A lack of close management can risk a subscription system which is environmentally disadvantage, despite offering a better service for users.

Managing the behaviour of subscribers is a key element in the management.

Fortunately, the **close relationship between the subscriber and the company allows a much stronger use of nudges** and communication than purchase systems where the relationship is more distant. This close relationship is a key advantage of a subscription system that should be utilised to its limit.

It was also found that **being part of a subscription system can also lead to broader changes in behaviour** of the subscribers including an increased openness to sharing rather than ownership for a wide range of other goods, and an increased awareness of the environmental impacts of consumption.

Maximising the economic viability, meanwhile, requires:

Maximising the economic viability requires:

- Scaling up rapidly to **gain a minimum of 500 subscribers**

- **Maximising the technical durability** of items in the system, identifying the most durable products
- **Maximising the value for money** by for example identifying the products which would be too high financial or social investment to purchase
- **Minimising the idle rate of clothing** in the wardrobe by matching the contents as closely as possible to needs
- **Requires the end user to appreciate accessibility to the limitless wardrobe and the improved experience of each garment** rather than calculated price per item
- **Carefully managing laundering and logistics costs** for delivery
- **Great care in selection of a subscription fee** which will ensure profitability but also be attractive to users. This may **require a range of packages and prices catering for different types of user.**

These findings are equally valid for the developers of other subscription systems for clothing.

Further messages for developers of subscription services are as follows:

- **Get to know your users** – this is an essential element for designing an attractive, viable and environmentally advantageous system. This can be carried out by surveys but also through discussions through focus groups.
- **Experiment and make iterative changes to the system** – don't try to get it right first time, nor make large investments in online systems, wardrobes before you have tested the concept with users. Your subscribers needs and wishes may surprise you. Make sure those surprises lead to improvements in the system and not to failures.
- It is **easier for a business that designs and sells clothing to set out on a subscription pathway** since the parallel business models allow greater flexibility in what is included in a wardrobe without risk of large financial losses. Products can be transferred fluidly between the sales and subscription models.
- **Challenge and inspire your subscribers** – this will require two-way communication where it is a learning process for both. Most people aren't used to subscription systems and they needed to be guided into the system and encouraged to drop habits of assumed but not real needs formed by ownership. At the same listening to the subscriber can ensure a service that fits to their developing needs.
- **Focus on quality** - the main positive aspect from product-as-a-service is the combination of incentives for businesses to create truly qualitative products and the improved ways for a larger group of users to get access to them. This will be good for the profit margins, for the user experience and for the planet.
- **Make it easy to try** - when people get the chance to experience the service they will most likely change their behaviour. Let the users be part of co-creating the system step by step. We need to see more businesses doing this and the market seems ready for it.

Next steps

Houdini Sportswear will use the findings of this pilot to develop and roll-out an upscaled more mature subscription system, building on the current beta (See Appendix E). Part of the development will be development of an online ordering and management system for subscribers.

As mentioned earlier, to scale this up to a larger system will involve high initial investments in setting up the digital solution and creating a seamless system for users and Houdini as a company. It also involves building up extra stock for a company; higher costs but also higher risk of short-term market movements. On the positive side, a company will keep owning the products and the resources (vs. selling this to the customer) in this new system. The financial industry and all the questions related to that area within this new system (product-as-a-service) will have to be solved. Some financial firms are focusing on this area right now and this development should be followed closely. Also, it will be important that the transformation for an individual business includes all surrounded partners in order to create maximum impact.

Expansion of the subscription system to new users will mean a need for an expansion in the central wardrobe, allowing a natural flow of new more sustainable designs into the subscription system as they arise, without a need to phase out still usable older garments.

Final note - Aiming for longevity

A critical question for Houdini has been how they can develop new, more sustainable and circular products, while not undermining a core aim of the subscription system which is to ensure that garments are used within the system until they reach the end of their technical lifetime, which for Houdini easily could be 10 year. Only looking at the industry which designs and produces for short time with planned aging, there might be a concern what happens when products are not the latest model. However, this is not the case for Houdini who strives to design for longevity. This means that Houdini products are durable enough to withstand the hard use within a subscription model and still offer the same experience during the whole durability for end users. The goal for Houdini products is not to be the latest news, but rather to never become old.

8. Project communication

Initial results of the project has been shared through presentations and seminars. These include, but are not limited to, ITMA, Mistra Future Fashion Outlook Days, Circular Economy focused seminar with 100 people from the industry and Re:Source result days. It has also been a part of presentations for Vinnova, Ohio State University & Stockholm School of Economics students and Houdini sales meeting with all external partners. Workshops and meetings with other actors within the outdoor and general industry. The insights from project has also been mentioned when Houdini Sportswear has been featured in Forbes, DI Weekend and Market. Additionally, marketing campaigns has been conducted through all channels with both still and video footage.

9. References

Elander, M., Sörme, L., Dun, O., Stare, M., Allerup, J. (2014) Konsumtion och återanvändning av textilier. SMED report nr. 149. Commissioned by Naturvårdsverket, Stockholm <http://www.smed.se/wp-content/uploads/2014/06/Slutrapport.pdf>

Elander, M., Watson, D. & Gylling, A.C (2017) Evaluation of business models for increased reuse, collective use and prolonged life time of textiles. Report for Mistra Future Fashion. <http://mistrafuturefashion.com/wp-content/uploads/2017/11/Mistra-report-D3.3.3.1.-Evaluation-of-business-models.pdf>

Ellen Macarthur Foundation (2017) A New Textiles Economy: Redesigning Fashion's Future. <https://www.ellenmacarthurfoundation.org/publications/a-new-textiles-economy-redesigning-fashions-future>

JRC 2014, Environmental Improvement Potential of textiles (IMPRO Textiles) http://publications.jrc.ec.europa.eu/repository/bitstream/JRC85895/impro%20textiles_fina%20report%20edited_pubsy%20web.pdf

Roos, S., Sandin, G., Zamani, B., Peters, G., (2015) Environmental assessment of Swedish fashion consumption: Five garments – sustainable futures. Mistra Future Fashion report, deliverable number D2.6

Schmidt, A., Watson, D., Roos, S., Askham, C. & Brunn Poulsen, P. (2016) Gaining Benefits from Discarded Textiles: Life Cycle Assessment (LCA) of different treatment pathways. TemaNord 2016:537, Nordic Council of Ministers

Watson, D., Kiørboe, N., Palm, D., Tekie, H., Ekvall, T., Lindhqvist, T., Tojo, N., Salmenperä, H., Hanssen, O.J., Rubach, S., Lyng, K. & Gíslason, S., (2015). EPR-systems and new business models. Part II: Policy packages. Report for Nordic Council of Ministers.

WRAP, 2014. Valuing Our Clothes: the True Cost of How we Design, Use and Dispose of our Clothing in the UK. Summary of a technical report commissioned by WRAP.

Appendix A: Pre-pilot Survey of Houdini Customers (non-subscribers)

Questions on your ownership and use of Power Houdis/Power Jackets

1. Do you own, or have you ever owned a Power Houdi or a Power Jacket?

Yes No

2. How many Power Houdis/Jackets do you own right now?

0, 1, 2, 3-4, More than 4

3. How long have you had your oldest Power Houdi/Jacket

Less than 1 year; 1-2 years; 3-4 years; 5-7 years; 8-10 years; Longer than 10 years

4. How often do you wear a Power Houdi/Jacket?

Every day; Almost every day; 1-2 times per week; 1-2 times per month; Every second month
1-2 times per years; Almost never

5. How many times do you wear an individual Power Houdi/Jacket before you wash it?

Once; twice; 3-4 times; 5-7 times; 8-10 times; 10-20 times; More than 20 times

6. At what temperature do you wash your hoodies?

20 °C (cold wash); 30 °C; 40-45 °C; 60 °C; Warmer than 60 °C

7. What detergent do you use?

8. Do you use fabric softener?

Yes/No

9. How often do you use a tumble dryer when you wash your Power Houdi/Jacket(s)

Never; Sometimes (25% of the time); Half the time; Often (75% of the time); Always

10. Have you ever had a Power Houdi/Jacket that you got rid of?

Yes/No

11. How long did you own it before you got rid of it?

Less than 1 year; 1-2 years; 3-4 years; 5-7 years; 8-10 years; Longer than 10 years

12. How did you dispose of it?

Sold it; Donated it (e.g. to family, friends, clothing collection, charity); Threw it in the trash;
Other

Now we will ask you about OTHER hoodies, not Houdini hoodies (e.g. Power Houdi/Jacket)

13. Do you own, or have you owned any other hoodies?

Yes/No

14. How many other hoodies do you own right now? (reminder, not Houdini hoodies)

0; 1; 2; 3-4; 5-6; 7-10; More than 10

15. What fabrics is your newest hoodie made from?

Cotton; Cotton/polyester blend; Polyester; Wool; Acrylic; Nylon or nylon blend; Other

16. Last time you disposed a hoodie, how long did you own it before you got rid of it?

I have not got rid of a hoodie; Less than a year; 1-2 years; 3-4 years; 5-7 years; 8-10 years;
Longer than 10 years

17. How did you dispose of it?

Sold it; Donated it (e.g. to family, friends, clothing collection, charity); Threw it in the trash;
Other

18. How often do you wear a hoodie? (reminder, not a Houdini hoodie)

Every day; Almost every day; 1-2 times per week; 1-2 times per month; Every second month
1-2 times per years; Almost never

19. How many times do you wear an individual hoodie before you wash it?

Once; twice; 3-4 times; 5-7 times; 8-10 times; 10-20 times; More than 20 times

20. At what temperature do you wash your hoodies?

20 °C (cold wash); 30 °C; 40-45 °C; 60 °C; Warmer than 60 °C

21. What detergent do you use?

22. Do you use fabric softener?

Yes /No

23. How often do you use a tumble dryer when you wash your hoodies?

Never; Sometimes (25% of the time); Half the time; Often (75% of the time); Always

* 26. To what extent do you associate Houdini's products with the following aspects?

7. Agree completely

[illegible]

* 27. What do you think of not owning your own clothes?

	1	2	3	4	5	6	7
1. Does not like at all /	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Like very much							
1. Not at all interesting /	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7 Very interesting							
1. Not at all appealing / 7.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very appealing							
1. Not at all nice/ 7. Very	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
nice							
1. Not at all beneficial /	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Very beneficial							

* 28. How do you feel like regarding the following aspects?

[illegible]

* 29. How many pieces of clothes have you bought in the last 6 months?

* 30. How much would you estimate that you have spent on clothes the last 6 months?

* 31. How much would you estimate that you have spent on clothes FROM HOUDINI the last 6 months?

* 32. Efter piloten, och om tjänsten finns tillgänglig, hur troligt är det att du kommer fortsätta prenumerera på tjänsten från Houdini?

Inte alls troligt Mycket troligt

A horizontal Likert scale consisting of six empty circles arranged in a row, representing a range from 'Inte alls troligt' (Not at all likely) on the left to 'Mycket troligt' (Very likely) on the right.

Appendix C: Post-pilot survey of subscribers

Part 1

* 5. On a scale 1-7, hur satisfied are you with the subscription service as a whole?

1. Very dissatisfied 2 3 4 5 6 7. Very satisfied

* 6. How well did the service meet the description of the service you got initially?

1. Not at all 2 3 4 5 6 7. Completely

* 7. On a scale 1-7, how satisfied are you with the follow aspects of the service?

[illegible]

7. Anything you want to add regarding your satisfaction?

* 9. How do you perceive the value you have received compared to the price you have paid in the service?

1. Not at all
beneficial

2

3

4

5

6

7. Very beneficial

☐ ☐ ☐ ☐ ☐ ☐ ☐

* 10. How much would you be willing to pay per month to continue the subscription you have had today for the same package?

SEK 0kr/month

SEK 2000kr/month

11. If customized, what product(s) are you referring to above?

12. Anything you want to add regarding your willingness to pay?

* 13. How would you describe yourself?

1. Not at all

7. Completely

[illegible]

* 14. What do you think of not owning your own clothes?

[illegible]

15. What would be the most important reason for you to use a service like this? 1. most important, 7. least important.

- ☐ Better value for the money compared to buying
- ☐ That it is a sustainable alternative to buying
- ☐ That I have access to all the products I need without having to keep them in my own wardrobe.
- ☐ That I get access to more products compared to buying
- ☐ That I get personalized help in choosing my products
- ☐ That I get the opportunity to try out the assortment
- ☐ That I can try the clothes without having to buy them

16. Anything else that is important for you regarding the service?

* 17. How do you feel like regarding the following aspects?

[illegible]

18. Anything else you want to add regarding your experience?

* 19. Of the product you have used the most in the pilot, how often have you used them?

- ☐ Every day
- ☐ Almost every day
- ☐ Every second day
- ☐ 2 times per week
- ☐ 1 time per week
- ☐ Every second week
- ☐ 2 times per month
- ☐ 1 time per month

20. Was there anything in the washing instructions that changed your behavior?

* 21. Have you used the transportation service?

- ☐ Yes
- ☐ No

* 22. What was the main reason why you wanted to get delivery

* 23. What did you think of it?

* 24. Why have you not tried it?

Have not had the time to do it

It was too expensive

I was situated outside of the delivery zone of Move By Bike

It was too complicated to order

I prefer coming to the store to try the products in real life

I prefer the face to face personal service I get in the store

Any other reason?

* 25. How many garments have you purchased during the last 6 months?

* 26. How much would you estimate that you have spent on clothes the last 6 months?

* 27. How much would you estimate that you have spent on clothes **from Houdini** the last 6 months?

28. How

Part 2

* 1. How likely is it that you would have continued the subscription if it would have been the same offer as today?

- ☐ 1. Not likely at all
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7. Very likely

* 2. To what extent has the subscription service allowed for the following aspects?

1. Not at all 2 3 4 5 6 7. Completely

○ ○ ○ ○ ○ ○ ○

would not afford to buy

I have been able to try many different models, styles and colors to

○ ○ ○ ○ ○ ○

identify my own personal style

○ ○ ○ ○ ○ ○ ○

I have had access to the latest Houdini products

○ ○ ○ ○ ○ ○ ○

○ ○ ○ ○ ○ ○ ○

I have experienced more of the nature thanks to ☐ subscription

☐ ☐ ☐ ☐ ☐ ☐

3. What if anything in your behavior have changed significantly in your everyday life by being a part of the subscription?

I have looked into other alternatives to not owning my own things

I have started washing at lower temperatures

I have read more about how clothes are affection the environment and nature

I use my products more times before I wash them

I have become more aware that dependent on how I treat the clothes will affect the life span of i

I do not used my tumble dryer to the same extent as before

Is there anything else that has changed?

* 4. How many Houdini products did you own before the pilot started?

* 5. Have you purchased any of the products that you have had in the service?

- ☐ No
- ☐ 1 product
- ☐ 2 products
- ☐ 3 products
- ☐ 4-5 products
- ☐ More than 5 products

* 6. Are you planning on buying any of the products that you have tried in the service?

- ☐ No
- ☐ Yes - 1 product
- ☐ Yes - 2 products
- ☐ Yes - 3 products
- ☐ Yes - 4 products
- ☐ Yes - 5 products

* 7. Would you make more or fewer exchanges if the store was located in the middle of the city instead of the current location.

Much fewer Same Much more

☐ ☐

* 8. What would you prefer regarding accessing the clothes

- ☐ Only a physical store where all the products in the wardrobe is available
- ☐ Only a platform where you can see and order all the products and get it delivered
- ☐ Have a concept store in the city that you live, where all products are available in a grey scale so you can try the sizes, but a platform where you order the products and you can get delivery or pick it up in the store
- ☐ Have a platform where you can see all the users products and through a matching process the garments are sent between you

* 9. What's your reasoning for the cost of delivery

- ☐ Pay for every delivery, approx 150 SEK with return
- ☐ Pay SEK 25 per month to change 4 times per year
- ☐ Pay SEK 50 per month to change 8 times per year
- ☐ Pay SEK 100 per month to change 12 times per year

* 10. Regarding delivery, what would you prefer?

- ☐ Delivery and return at my door
- ☐ Delivery and return at a box which is located at a place which I pass every day
- ☐ Delivery and return at my local pick up place

* 11. On average, how often have you used one or more garments in the service?

- ☐ Every day
- ☐ Every second day
- ☐ Twice a week
- ☐ 1 time per week
- ☐ Every second week
- ☐ Twice a month
- ☐ 1 time per month
- ☐ Fewer

* 12. How many times have you in average used them before washing?

- ☐ 1 time
- ☐ 2 times
- ☐ 5-7 times
- ☐ 8-10 times
- ☐ 11-15 times
- ☐ more than 15 times

* 13. What type of garment have you used the most?

- | | |
|-----------------------|--------------------|
| Jacket for activity | Base layer |
| Everyday jacket | Mid-layer upper |
| Pants to activity | T-shirt/Shirt/Tank |
| Everyday pants | |
| Other type of garment | |

14. Is there any type of garment in our assortment that you DO NOT think should be included in a subscription service?

- | | |
|---------------------|--------------------|
| Jacket for activity | Base layer |
| Everyday jacket | Mid-layer upper |
| Pants to activity | T-shirt/Shirt/Tank |
| Everyday pants | |
| Other garment | |

15. Anything to add?

14. Is there any type of garment in our assortment that you STRONGLY think should be included in a subscription service?

Jacket for activity

Base layer

Everyday jacket

Mid-layer upper

Pants to activity

T-shirt/Shirt/Tank

Everyday pants

Other:

15. Why?

* 18. Have you found a favorite garment that you would have prefer to keep and notexchange for another garment?

☐ Yes

☐ No

* 19. How would you have preferred to keep this product (still within the subscription service)

☐ Buy it for a slightly limited price

☐ Lease it until I have paid off the full value of the product

☐ Lease it for a low monthly cost and then return the product

☐ Extend my package so that I have 5 products instead of 4

☐ Annan (var god ange)

* 20. To what extent have you felt that you own the garments in the service?

1. Not at all

2

3

4

5

6

7. Very much

☐
☐
☐
☐
☐
☐
☐

21. What is your opinion on ownership of clothes?

21. How would you describe your use of the clothes in the service?

- ☐ Less careful than with my own clothes
- ☐ just as careful as my own clothes
- ☐ More careful than with my own clothes
- ☐ Other

22. How would you consider the following options regarding tear and wear that needs to be repaired?

- ☐ I would like to buy an insurance so I don't have to think about it
- ☐ I rather take responsibility of my products and makes sure that they do not have any extensive damages and pay for it if they do
- ☐ Other way

23. Anything you want to comment on?

* 25. What do you think of the following concepts?

[illegible]

26. Any comments?

* 27. Regarding the assortment and stock, how do you agree with the following statements?

	1. Do not agree at all	2	3	4	5	6	7. Completely agree
want	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I rather pay less to be able to get the right functionality, rather than the exact color	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

* 28. For a web based solution, how would you want it to be designed?

- ☐ Like a library where you can see everything, in stock and not, where there is a waiting list and a proximate data I will get it.
- ☐ More curated, where I enter my preferences and gets a curated suggestion of 15 garments based on my needs
- ☐ Like a store where I see the products that are available in the wardrobe right now

29. Would you want more products or services to be included in a concept like this?

30. What products and services?

31. Is there anything that you have been thinking about that you want to tell us about?

Appendix D: The Lifecycle Assessment Methodology



The Functional Unit

In this study the functional unit is defined as: "To have one hoodie available to wear for a period of 10 years".

The functional unit describes the primary function of the system that is evaluated. The FU is especially relevant for conducting LCA work that involves comparisons of different systems. The FU in that case needs to ensure fairness for all systems under comparison: it is the unit that the environmental performance is measured against.

In this exercise, the FU reflects the need for the hoodie's availability over a specific period of time. We cannot define the FU based on the product itself, since we would not capture the differences in quality, life time etc of the different systems to be compared. Instead the FU is defined based on the service the product delivers to the user. This service is then common for all systems and scenarios under comparison.

Note: This definition of FU is not to imply that an average user only owns 1 hoodie. Maybe the average user wants to have 2.3 hoodies available in the closet. In that case, we could define the FU accordingly, on the basis of 2.3 hoodies, but the results of the comparison among the three scenarios wouldn't change. In any case, results for the average user can be obtained by multiplying the number of hoodies owned on average with the results per FU as we have defined here.

The hoodie user

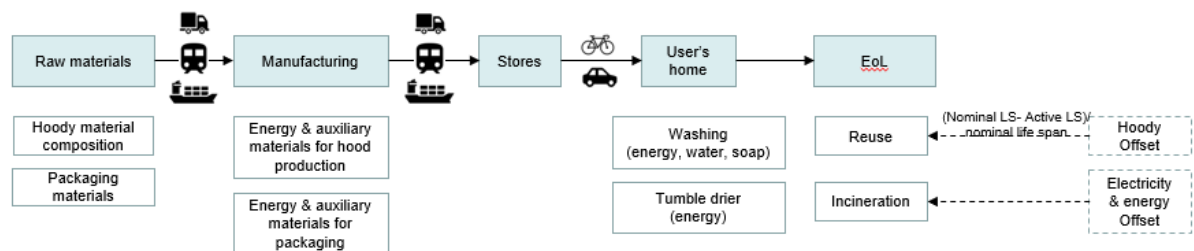
All scenarios are built under the assumption that we model the same average user. The behaviour of the average user remains the same in all three scenarios. This is not entirely accurate, as there are indications that the Houdini buyers are more environmentally aware than the buyers of an average hoodie. However, we need to assume the same user in all scenarios for comparability purposes. We need, in the end, to be able to support claims such as "switching from system A to B makes an x% difference in carbon emissions".

The behaviour of the average user directly affects the LCA modelling: we need to find out how often they wash the hoodies, how long they keep them and how much of the nominal life span is left in the clothes when they decide to discard them. These parameters will remain constant in all three scenarios.

Alternative systems to be compared

Here, the three systems to be modelled and eventually compared are described. The figure below shows the life cycle stages and the system aspects that are common for the Systems 1 and 2.

The details for each process are scenario-specific as it is discussed in the scenario descriptions right below. The aspects that have an effect on the environmental performance are highlighted in bold.



System 1

Under System 1, a user decides to fulfil the FU (or the need to have one hoodie available to wear for a period of 10 years) through buying an average quality, average material hoodie. Depending on the active life span $LS_{\text{active, average hoodie}}$ (how long one keeps the hoodie on average), the user would need to buy $10 / LS_{\text{active, average hoodie}}$ hoodies over the FU-defined period of 10 years.

The life cycle of each hoodie starts with **raw material** extraction. Depending on the material composition of the average hoodie, the manufacturer needs to source the relevant materials in appropriate quantities. The manufacturer then manufactures the hoodie by using **energy** (electricity and heat), **auxiliary materials** (chemicals, etc.) and **packages** it. The clothes are then distributed to retailers through **trucks/ships** and reach the stores. The user then buys the hoodie while visiting the store with their bike/car. During the use phase, the clothes are **washed** regularly and sometimes **tumble dried**. After the active life span $LS_{\text{active, average hoodie}}$ has passed, the user discards the hoodie, which is then 25% re-used and 75% **incinerated**. The re-use will **offset** the production of a new, identical hoodie, but this offset does not refer to the entire hoodie, but only a part of it, corresponding to the life left in the hoodie. For example, if the nominal life span of the hoodie is 5 years, and the average user discards it after only 3 years into re-use, this would lead to offsetting emissions from the production of 2/5 of a new hoodie (which is then multiplied with 24 % which is the reuse rate of clothes in Sweden).

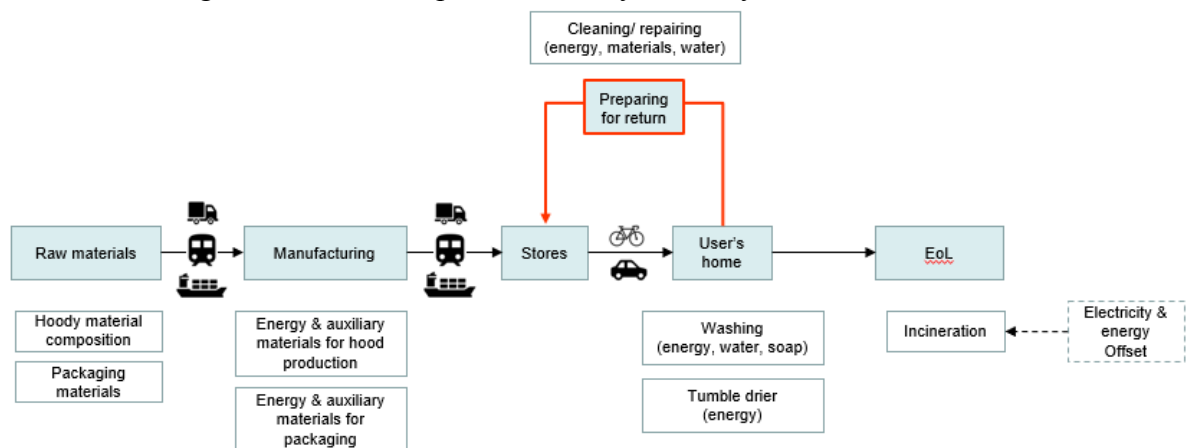
System 2

Under System 2, the same average user decides to buy a Houdini hoodie. Therefore, System 2 is identical to System 1, but the relevant parameters change. For example, the Houdini solution has higher nominal life span, different material composition etc.

We expect this system to be environmentally superior to System 1. This benefit would occur because of the better quality of the Houdini hoodie, reflected on the increased nominal life span. We don't expect the raw material extraction and manufacturing phases to be significantly different than System 1 and we also assume the same user behaviour during the use phase. We also assume the same ratio of end-of-life options as in System 1. However, the nominal life span of the Houdini hoodie is higher meaning that, in order to fulfil the FU, under system 2 the user would need to buy less hoodies over the 10 year period. This is translated in less production of materials, manufacturing and transport.

System 3

Under the last system, we model the new Houdini service of subscribing hoodies to the users. The figure below corresponds to the System 3 system.



We plan on modelling System 3 in exactly the same manner as System 2. However, the end-of-life options change: while under System 2, a part of the discarded clothes is incinerated, under this system, there is only re-use as an end-of-life option (through the service's recirculation of clothes). This means that the offsetting of emissions, because of re-use is 100%. In practice, this means that the benefit of System 3 compared to the others is that the nominal life span of the hoodie is exhausted, while in the other systems, clothes are incinerated although they still have some life span left. Of course, System 3 involves more transport due to the take-back scheme of Houdini, but the impacts from that are not high enough to match the benefit from exhausting the hoodie's life span.

One might think that System 3 might lead to a user exchanging hoodies a lot and that could have some additional environmental impacts. However, if we assume that the hoodies' life spans are only affected by use, then we can model on the basis that the change of user has no effect on the hoodie and thus on the environment. To put it simply, in LCA terms, it does not matter how many owners a hoodie changes over its life span, as long as in the end, its life span is exhausted. Of course, in some extreme cases, where a hoodie changes too many owners over its life, the impacts of transport during the owner changes might become significant.

LCA modelling

How many Hoodies?

System 1: the user uses the average hoodie 171 times before he/she discards it. The user uses the hoodie 10 times per month. So the user discards 1 hoodie after $171/10=17.1$ months so after 1.4 calendar years. This means that in 10 calendar years the user has used $10/1.4=7$ hoodies

System 2: the user uses the Houdini hoodie 486 times before he/she discards it. The user uses the hoodie 10 times per month. So the user discards 1 hoodie after $486/10=48.6$ months, so after 4.05 calendar years. This means that in 10 calendar years the user has used 3 Houdini hoodies: 2 of them have been discarded and the 3rd has been used almost half of the expected time (so 50% of the 486 days). This means that the last hoodie has only been used for 243 days so $243/3000=8\%$ of its lifetime (this is the 'devaluation' rate).

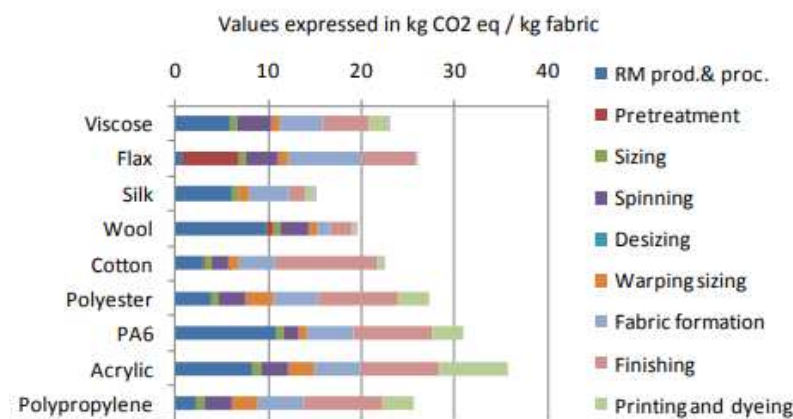
System 3: For the case of the new product service system the user could keep the hoodie for 3000 days before he/she discards it. The user uses the Houdini hoodie 10 times per month. So the user would normally discard 1 hoodie after $3000/10=300$ months, so after 25 calendar years. In 10 calendar years the user has used 40% of the hoodie's life time, so the Houdini hoodie has been devaluated by 40%.

1) Raw materials

	System 1	System 2	System 3
Product	Total weight Female (kg)	POWER HOUDI average weight male/female(kg)	POWER HOUDI average weight male/female(kg)
kg	0.45kg	0.38	0.38
Material Composition	%	%	%
Polyester	40	57	57
Polyamide	1	33	33
Elastane	1	10	10
Cotton	34.5		
Wool	16.5		
Nylon	1		

Data for fabric production are taken from the JRC scientific and policy report Environmental Improvement Potential of Textiles (IMPRO-Textiles) by Beton et.al. (2014)⁵

Beton et al cover the production or extraction of raw materials (e.g. cultivation of fibre-producing crops), leading to the processing of the fibre, followed by the confection of yarn and fabric, and finally the finishing, cutting and sewing steps needed to make a complete end product. Specifically, for the potential impact of different fabrics to climate change, the following figure (found in the aforementioned report) was used.



Impact on climate change due to the production of fabric from different fibre types

Transport of raw material to yarn production facility

All systems Same assumption 500 km transport by truck to the yarn production facility

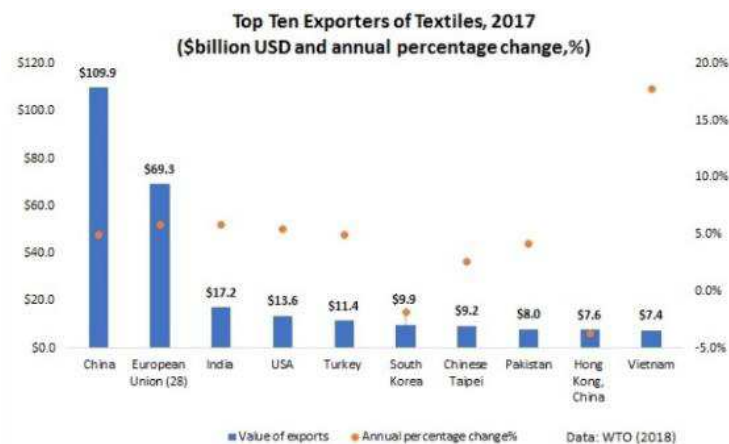
Yarn production

All systems: For the yarn production the data from the Figure above has been used (for yarn production we have accounted for the processes: pre-treatment, sizing, spinning, desizing, warping sizing). As for the production location, this differs for the different systems:

System 1: production location based on average global export data for apparel According to the newly released World Trade Statistical Review 2018 by the World Trade Organization (WTO)⁶

⁵ Beton A., Dias D., Farrant L., Gibon T., le Guern Y., Desaxce M., Perwuelz A., Boufateh I., Editors: Wolf O., Kougoulis J., Cordella M., Dodd N., 2014, Environmental Improvement Potential of Textiles (IMPRO-Textiles), European Commission Joint Research Centre Institute for Prospective Technological Studies (IPTS)

⁶ <https://shenglufashion.com/2018/08/16/wto-reports-world-textile-and-apparel-trade-in-2017/> based on https://www.wto.org/english/res_e/statis_e/wts2018_e/wts18_toc_e.htm



System 2 and System 3 Yarn production in China

Transport to fabric production

System 1: assumption is that fabric production takes place at the same 'average location' as the yarn production, so there is no such transport

Systems 2 and 3: Knit/weave factory /Fabric production: in Italy

Assumptions: Transport distances have been estimated for road to be 450 km within China (googlemaps) and sea 10000 nautical miles)18520Km from Shangai to Ancona (sea-distances.org) transport

Fabric production

All systems: we have accounted for the processes fabric formation, finishing, printing and dyeing, from the figure presented in section 3.1

Transport from fabric production location to Sweden (the product reaches the shop/warehouse)

System 1: A transport distance from the 'average location' to Stockholm is assumed. Road transport approx. 900 km, sea transport 16500 km. An additional 20km distance to the shop/warehouse is assumed

System 2 and System 3: A transport distance from Italy to Stockholm is assumed. An additional 20km distance to the warehouse is assumed

Transport to consumer (the consumer buys the product and takes/receives it at home)

System 1 and 2. The share of internet sales versus shop sales in Sweden is 34% web and 66% shop.

For web: Road transport by van for a distance of 5 km is assumed.

For shop: 5 km distance by different modes based on the pilot: 49% car, 17% bus/train, 16% boat, 9% bike, 10% on foot. (for the passenger car we have only accounted for 25% of the 49% since only 25% of the consumers did the journey just for this purpose)

System 3: The average distance between the pilot participants' home and Houdini HQ is assumed 5km and the transport mode distribution is: 49% car, 17% bus/train, 16% boat, 9% bike, 10% on foot. (for the passenger car we have only accounted for 25% of the 49% since only 25% of the consumers did the journey just for this purpose). This type of transport occurs every time there is an exchange. For the 6 month period of the pilot, the user went 1.56 times to the shop to exchange. We have assumed that there is approx. 1 exchange per 3 months so in total 10years*4months=40 exchanges

Keeping at home (the product is used by the consumer)

Systems 1 and 2: Regarding electricity consumption we assume 0.21 kWh/kg which is typical in the EU for 40 deg C based on the studies prepared for the EU ecodesign directive (2009/125/EC) (the assumption is close to reality: according to the data given by Houdini Washing temperature is 38 deg C based on 86 survey responses). There is an additional need for electricity related to tumble drying (9.3% of consumers dry in tumble dryer based on 86 responses). Regarding detergent use it is assumed to be 18.2 ml/kg clothes, based on the Revision of European Ecolabel Criteria for Laundry Detergents. Regarding washing frequency Based on surveys of non-pilots and pilot surveys laundry takes place once every 14 days use (based on 154 survey responses). According to the pre-pilot survey and non-pilots an individual Hoodie is used on average 10 times a month. Therefore normally the hoodie would be washed every 1.5 months. Therefore the hoodie is washed at home $12/1.5=8$ times per year. For a period of 10 years the hoodie is washed 80 times.

System 3: Regarding washing frequency we assume that the user will not wash the hoodie before taking it back to the shop neither when he/she received it. So the frequency is half than in Systems 1 and 2 (the user washes at home 1 every 3 months)

Transport to professional laundry service

Only for System 3: For the 6 month period of the pilot, the user went 1.56 times to the shop to exchange. We have therefore assumed that there is approx. 1 exchange per 3 months and that the user exchanges one hoodie for one hoodie. Then the hoodie is transported to professional laundry service at a distance assumed to be 10km away. So in total 10years*4months*10km*2times. The transport occurs by full van.

Washing at professional laundry service

Only for System 3: Every time the hoodie is returned (once per 3 months), it is washed at a professional service. So in the 10 years the hoodie is washed $10\text{years} \times 4\text{months} = 40$ times. Washing service is assumed to use 0.03 kWh electricity and 0.83 kWh natural gas per kg clothes (data from expert judgment). Detergent is assumed to be the same as for home-wash.

End of Life

Regarding Behaviour

System 1: 75% incineration, 25% reuse

In total $25\% \times 7$ hoodies go to reuse

and $75\% \times 7$ hoodies go to incineration

Avoided production due to reuse: The max technical life time of the average hoodie is 300 days. The user discards it after 171 days. So it can be 'devaluated' by $171/300 = 57\%$. So for 1 item taken for reuse, there is an offset of $1 - 0.57 = 0.43$ items.

System 2: 75% incineration, 25% reuse

Avoided production due to reuse: The max technical life time of the average hoodie is 3000 days. For the first 2 hoodies: The user discards it after 486 days. So it can be 'devaluated' by $486/3000 = 16.2\%$. So for 1 item taken for reuse, there is an offset of $1 - 0.162 = 0.84$ items

The 3rd hoodie has been used almost half of the expected time. This means that the last hoodie has only been used for 243 days so $243/3000 = 8\%$ of its lifetime (this is the 'devaluation'). So for 1 item taken for reuse, there is an offset of $1 - 0.08 = 0.92$ items

System 3:

In 10 calendar years the hoodie has been devaluated by 40% So for 1 item taken for reuse, there is an offset of $1 - 0.4 = 0.6$ items

Regarding Technologies

a) For incineration: Ecoinvent process used: Waste textile, soiled {RoW} | treatment of, municipal incineration | Alloc Def, U

-For avoided production from incineration:

2.5 MJ/kg: Electricity mix, AC, consumption mix, at consumer, < 1kV SE S

8.2 MJ/kg: Heat, district or industrial, natural gas {Europe without Switzerland} | heat production, natural gas, at industrial furnace low-NOx >100kW | Alloc Def, U

b) Reuse: avoided production of an average hoodie

Sensitivity analysis

All systems are tested *ceteris paribus* except for the last one in the table bellow

Sensitivity	System checked	Life cycle stage	Difference to reference system
Sens1_Sc3_tr_a	System 3	Transport to consumer	all transport occurs by car (but we keep the assumption that it is only 25% of the customers that they do the travel solely for this purpose)
Sens2_Sc3_tr_b	System 3	Transport to consumer	all transport occurs by bike
Sens3_Sc3_tr_c	System 3	Transport to consumer	12 km instead of 5
Sens4_Sc3_wash	System 3	Washing at home	no need for electricity related to tumble drying
Sens5_Sc3_lifetime600	System 3	Technical life time	600 days (double the average) instead of 3000. So the user discards 1 hoodie after $600/10=60$ months, so after 5 calendar years. In 10 calendar years the user has used 2 hoodies. There is no more lifetime in these therefore they are sent for incineration
Sens6_Sc2_lifetime600	System 2	Technical life time	600 days. (double the average) instead of 3000. in 10 years the user has used 2.47 hoodies. At the EoL the substitution rate changes a) for the first 2 hoodies it changes from 0.84 items to 0.19 items ($=1-486/600$). And for the last hoodie it changes from 0.92 to 0.6 items ($=1-243/600$)

Sens7_Sc3_proflaundry	System 3	Professional laundry	Laundry is in the same location as the exchange shop (the transport to laundry is removed)
Sens8_Sc1_eol	System 1	EoL	85% reuse /15% incineration
Sens9_Sc2_eol	System 2	EoL	85% reuse /15% incineration
Sens10_Sc3_washing	System 3	washing	The user is washing it before giving it back to Houdini
Sens11_Sc3_combined_worst	System 3	Transport to consumer/ Washing at laundry/ transport to professional laundry	1 exchange per 1.5 months (so double the transport to consumer, double the transport need to the laundry place, and double the professional washing), all exchanges by car (but we keep the assumption that only 25% of this transport is attributed to the product), washing before return with tumbledrying
Sens12_Sc3_combined_best	System 3	Transport to consumer/ Washing at laundry/ transport to professional laundry	all delivery by bike 2) no laundry travel 3) no tumble drying

Appendix E: Beta version digital platform



Start / Subscription / Essentials Wardrobe

Essentials Wardrobe

Do more with less. The essentials wardrobe includes clothes we love to wear every day-at work, on our bike commutes to and from work as well as for our active everyday life, no matter the weather.



Find the right garments based on your activity



Let us help you put together the right package for your next adventure

Gender ▾ Category ▾ Color ▾ Size ▾ Activity ▾ Function ▾ Sustainability ▾ 16 products

Gender: Women × Size: M × Size: L ×



Start / Subscription / Curated Packages

What activities do you need gear for?

Please choose the activities which you need gear for.

<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Skiing	Running	Everyday wear	Ice skating	Cycling
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Climbing	Yoga	Indoor training		

Back

Next

Do you have any color preferences?

Please choose which colors you prefer.
We'll try to match these according to availability.

✓ Black	White	✓ Greys	Beiges	✓ Blues
Greens	Reds			

Curated Packages

Let us help you put together a curated package for your next adventure.

	Send me a curated package based on my activities	>
	Send me a curated package, but I would like to choose type of garments	>

< Continue shopping

HOUDINI

Checkout

Choose 2 garments to return

Your subscription allows you to have 4 garments on rotation.

☒ W's Wisp Jacket
Storm Green, Size M

☒ W's Power Houdi
Powderday White, Size M

☐ W's Route Shirt Dress
True Black, Size M

☐ W's Activist Tee
In The Mood, Size M

Do you have a campaign code?

+

Delivery Method

Your bag

Houdini Subscription - The Essentials Wardrobe

 W's Power Houdi
Lust Round Red, Size M

 W's Wooler Houdi
Wheat White, Size M

Shipping 125 SEK

Total 125 SEK