

FINAL REPORT

Circular workwear in construction and industry

Environmental, economic, legal, and provider and customer perspectives

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Preface

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Contents

Preface.....	3
Contents.....	4
1. Sammanfattning	6
2. Summary.....	8
3. Background.....	10
3.1. Why do we focus on circular business models in the workwear industry?	10
3.2. A short introduction to the workwear industry	12
4. Research design.....	14
4.1. Overview of the research process.....	14
4.2. Design and business model interventions.....	14
4.3. Data analysis and data collection methods	16
4.3.1. Legal perspective.....	17
4.3.2. Provider perspective.....	18
4.3.3. Customer perspective.....	19
4.4. Life Cycle Assessment	20
4.5. Life Cycle Costing.....	24
5. Results	26
5.1. Environmental perspective	26
5.1.1. Life Cycle Assessment.....	26
5.1.2. Environmental impact – Scenario 1: Base – Linear.....	26
5.1.3. Environmental impact – Scenario 2: Repair.....	27
5.1.4. Environmental impact - Scenario 3: Washing Service	28
5.1.5. Environmental impact - Scenario 4: All-in-one.....	28
5.1.6. Interpretation	29
5.2. Economic perspective	30
5.3. Legal perspective	35
5.3.1. Product purchase vs. all-in-one solution from a legal perspective.....	35
5.3.2. A legal perspective on actors’ relationships in the workwear industry	37

5.4. Provider perspective	42
5.5. Customer perspective	44
5.5.1. Workers in SMEs.....	45
5.5.2. CIRK-L workwear users.....	48
5.5.3. Public procurers.....	51
6. Circular business models	54
6.1. Business models focusing on durability	54
6.1.1. Design for durability	54
6.2. Business models focusing on more efficient use	55
6.2.1. Design for more efficient use.....	56
6.2.2. Washing service	56
6.2.3. All-in-one solution	57
6.3. Business models focusing on repair.....	58
6.4. Business models focusing on reuse and repurposing.....	60
7. Conclusions, exploitation and next steps	62
8. Publication list.....	64
9. Project dissemination.....	65
10. References.....	67
11. Appendices	69
11.1. Suggested information to include in B2B contracts	69

1. Sammanfattning

Europeiska unionen (EU) har identifierat textilier som en av de sju nyckelproduktvärdekedjor som behöver ökad cirkularitet. Syftet med detta projekt har varit att ur ett miljömässigt, ekonomiskt, juridiskt och leverantörs- och kundperspektiv undersöka potentiella cirkulära affärsmodeller för arbetskläder, samt resulterande förändringar av deras design. Fokus har varit på arbetskläder för små och medelstora företag (SME) inom bygg- och anläggningsbranschen. Undersökningen inkluderar användbarheten av olika design- och affärsmodellförändringar som kan påverka resursförbrukningen och därmed bidra till en mer cirkulär ekonomi.

Ett nyckelresultat baserat på LCA är att alla undersökta förändringar, jämfört med en linjär modell, sannolikt kommer att leda till minskad miljöpåverkan för alla undersökta miljöeffektkategorier. Dessutom identifierades inga större juridiska hinder, även om vissa affärsmodeller kräver noggrann avtalsformulering. Flera förändringar leder dock inte till "bra affärer", antingen på grund av bristande acceptans hos användarna eller på grund av att de inte är ekonomiskt bärkraftiga.

Att designa och erbjuda arbetskläder med lång livslängd är en affärsmodell som många företag framgångsrikt implementerar. De flesta påstår att deras produkter är hållbara utan standardiserat sätt mäta.

En undersökt designförändring som vunnit accepts på marknaden och som erbjuds av projektpartnerföretaget CIRK-L är de avtagbara verktygsfickorna som möjliggör tätare och enklare tvätt och därmed längre livslängd för arbetskläder.

Tvättjänster och allt-i-ett-avtal som också möjliggör effektivare och frekventare tvätt accepteras dock inte i samma utsträckning. De visar sig vara logistiskt svåra att implementera, främst på grund av att arbetare frekvent byter arbetsplatser. De ansågs också vara för dyra för detta kundsegment, även om de framgångsrikt har tillämpats på andra segment inom industrin för arbetskläder. En anledning är att användaren för närvarande står för kostnaderna för transport och tvätt, medan dessa kontrakt skulle flytta denna kostnad till arbetsgivaren. Flera positiva värdeaspekter hittades med dessa undersökta affärsmodeller men inte tillräckligt för att uppväga kostnaderna och de praktiska utmaningarna.

Reparationstjänster baserade på reservdelar som kan bytas ut av användaren, såsom de av partnerföretaget CIRK-L erbjudna avtagbara underbenen på arbetsbyxor, förväntas vara ekonomiskt lönsamma. Då arbetskläder är relativt billiga är reparationer som involverar skraddare endast marginellt billigare än att köpa nytt då arbets- och fraktkostnader är dyra. Det innebär att kunden föredrar att köpa nytt. Flera åtgärder kan dock vidtas för att

förbättra situationen genom att adressera beteendeproblem kopplade till reparationer, vilket gör leveranskedjorna mer effektiva. Det finns även behov av att förbättra stödsystemen som möjliggör reparationer, t ex it- och distributionslösningar. Vissa initiala pilotprojekt och mindre satsningar som rör återanvändning eller användning för nya ändamål har identifierats men dessa kräver mer forskning.

Avslutningsvis, konsumtionsmönster för arbetskläder har också identifierats och det finns vissa tecken på överkonsumtion som bör studeras noggrannare.

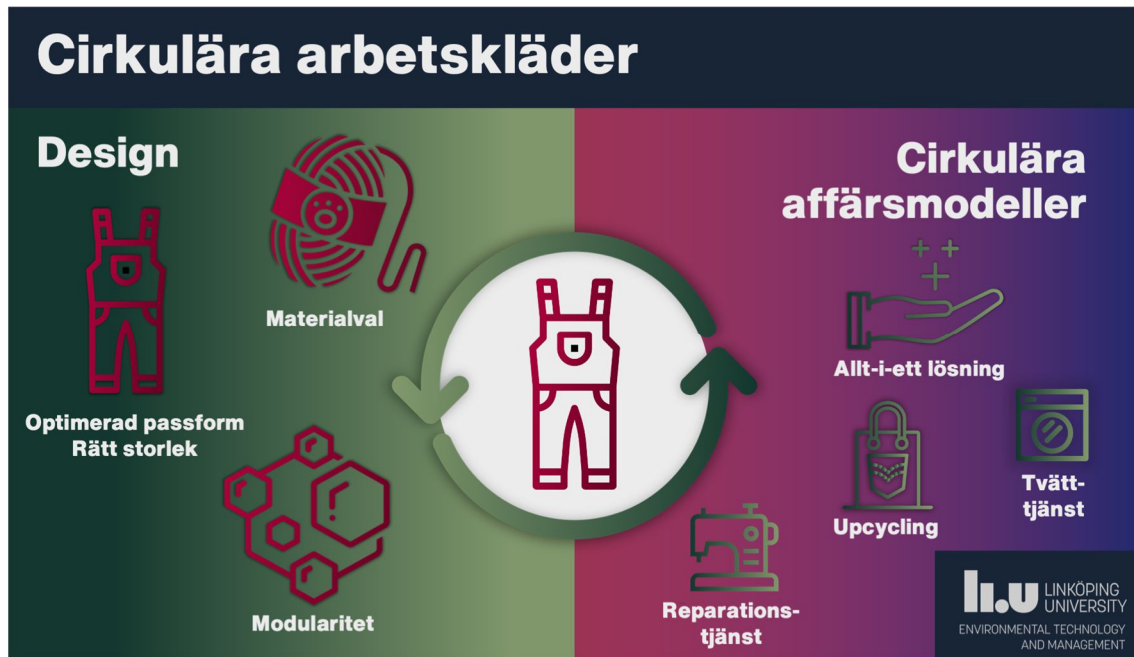


Figure 1 Graphical abstract

2. Summary

The European Union (EU) has identified textiles as one of the seven key product value chains that require increased circularity. This report aims to examine potential circular business models and changes to the design of products and services in the workwear industry from a holistic perspective, including environmental, economic, legal, and provider and customer perspectives. The focus has been on workwear for small and medium-sized enterprises (SMEs) in the construction and building sectors. In this study, the potential to implement various design and business model interventions, which could affect resource consumption and thus contribute to a more circular economy, were explored.

A key finding is that all the explored interventions, based on LCA findings, are likely to reduce environmental impacts in all examined impact categories compared to a linear model. Moreover, no significant legal barriers were identified, although some business models require careful contract drafting. However, several interventions do not lead to “good business” either due to a lack of acceptance by the users or because they are not economically viable.

Designing and offering workwear with a long lifespan is a business model that many companies are successfully implementing. Most claim that their products are long-lasting without a standardized way to measure.

One examined design change that has gained market acceptance and is offered by the project partner company CIRK-L is the detachable tool pockets, which allow for more frequent and straightforward washing and thus longer lifespan for workwear.

However, laundry services and all-in-one contracts that also enable more efficient and frequent washing, are not as well accepted. They prove to be logistically challenging to implement, mainly because workers frequently change workplaces. They were also considered too expensive for this customer segment, despite having been successfully applied to other segments within the workwear industry. One reason is that the user currently bears the costs of transport to the washing facility and washing, while these contracts would shift this cost to the employer. Several positive value aspects were found with these examined business models, but not enough to outweigh the costs and practical challenges.

Repair services based on spare parts that can be replaced by the user, such as the detachable lower legs on work trousers offered by the partner company CIRK-L, are expected to be economically viable. As workwear is relatively cheap, repairs involving tailors are only marginally more affordable than buying new because labour and shipping costs are relatively high. This means that the customer prefers to buy new. However, several

measures can be taken to improve the situation by addressing behavioural issues related to repairs, making the repair supply chains more efficient. There is also a need to improve support systems that enable repairs, e.g., IT and distribution solutions. Some initial pilot projects and small ventures related to upcycling or repurposing have also been identified, but these require further research.

Finally, consumption patterns for workwear have also been identified, and some signs of overconsumption should be studied more closely.

3. Background

3.1. Why do we focus on circular business models in the workwear industry?

Transitioning from a linear to a more circular economy is essential for developing a sustainable, resource-efficient and competitive economy (European Commission, 2020). The aim is to maintain the value of products, materials, and resources for as long as possible in the economy and minimize waste (ibid.). This is achieved by providing high-quality, long-lasting products designed for reuse, repair, and recycling (Tukker, 2015). Extending the lifespan of products is an effective strategy for reducing environmental impact since it can limit the need for producing new products, reduce transportation, and prevent waste (Kjaer et al., 2018).

Textiles are one of the seven identified key product value chains in the European Union (EU) where an increased circularity is needed (European Commission, 2020). The upstream pressure on this product's supply chain is the fifth-largest in regards to the use of primary raw materials and GHG emissions and has the fourth-highest impact on the environment and climate change, and the third-highest pressure on land use and water consumption in the EU (European Commission, 2022). Furthermore, it is estimated that the recycling rate worldwide of the material used to produce clothes into new clothing is less than 1% (Ellen MacArthur Foundation, 2017). According to the European Environment Agency (2019), about 60% of textile fibers are synthetic (mainly polyester), produced from carbon-intensive processes that require approximately 70 million barrels of oil annually. Additionally, the remaining fibers' primary origin is cotton, a major source of water and land use. Furthermore, large amounts of plastic microfibers are released into the oceans when washing clothes. Textile is also an important sector in the global economy and one that is rapidly growing, as do its negative environmental and social impacts (Ellen MacArthur Foundation, 2017). The need for addressing sustainability issues is therefore, pressing.

Although many actions can be taken to improve production (such as new technologies, shortened supply chains, and more benign chemicals), innovative solutions are needed to tackle overproduction and overconsumption. Extending the life of textiles – getting as much utility from them as possible and encouraging sufficiency – is crucial to reducing the total amount of textiles consumed. Essentially, textiles need to become part of a circular economy where products, materials and resources are kept in the economy for as long as possible, and waste is minimized (European Commission, 2022). Two perspectives have dominated the search for innovative solutions that foster the circularity of clothes: the first focuses on circular business models, and the second concentrates on private clothing. The premise of

this research is to maintain this focus on circular business models but apply it to workwear rather than fashion.

A business model describes how companies create, deliver, and capture value (Osterwalder and Pigneur, 2010). Circular business models describe ways that companies create, deliver, and capture value so that the value of resources is kept in the economy and resources are used more efficiently and effectively (Pieroni et al., 2019). Circular business models facilitate activities such as repair, maintenance, reuse, redistribution, refurbishment, remanufacturing, recycling, cascading, repurposing, and organic feedstock use (Lüdeke-Freund et al., 2019). They are particularly interesting since circular business models are considered a crucial prerequisite for establishing the business incentives needed to make a circular system that reduces adverse environmental and social impacts, economically viable (European Environment Agency, 2019). However, circular business models do not guarantee such reductions (Kjaer et al., 2019), and there is no certainty of environmental benefits through implementing circular business models in the textile industry (Ellen MacArthur Foundation, 2022). Therefore, circular business models need to be designed to deliver both economic and environmental benefits, and there need to be systems in place to ensure that these are distributed equitably (Kaddoura et al., 2019). To reap the benefits of circular business models, products and services must also be redesigned (Bocken et al., 2016).

In 2022, the EU adopted a strategy for sustainable and circular textiles (European Commission, 2022) that aims, among other things, to reverse overproduction and overconsumption, to discourage the destruction of unsold or returned textiles, to make textiles last longer, to facilitate their repair and recycle, to restrict the export of textile waste and to promote sustainable textiles globally. To achieve these aims, some key actions are: setting design requirements; creating a market for recycled textiles; introducing a Digital Product Passport; tackling greenwashing; introducing Extended Producer Responsibility rules; and incentivising “*circular business models, including reuse and repair sectors*”.

Although still quite a novel subject, most publications examining the cross-section of circular economy and clothing have focused on circular business models for the fashion and apparel industry and the individual consumer and have largely neglected clothes used for work (i.e., different types of uniforms and safety gear, etc.). These different types of clothing present different characteristics and thus need to be researched separately (Malinverno et al., 2023).

This report aims to discuss potential circular business models and changes to the design of products and services in the workwear industry from a holistic perspective including environmental, economic, legal, and provider and customer perspectives. Different methods are used to explore these various perspectives and provide insights on the environmental and economic benefits of various business models, the parameters affecting

them, and the potential to implement them from a legal, provider, and customer perspective.

These insights can primarily guide businesses in the workwear industry on what circular business models they can implement, how these can be expected to affect environmental impacts and economic performance, and the advantages and disadvantages of implementing them. Moreover, it can provide valuable input on designing the circular business model and the products and services to enhance the advantages and mitigate the disadvantages. Similarly, these insights can also guide policymakers on what is essential to address in policies to improve the advantages and reduce the disadvantages.

This report is structured as follows:

We outline the workwear industry before explaining the overall research design and methods. Then, we examine the following perspectives: environmental, economic, legal, and producer/consumer. Finally, we combine these insights to discuss four different types of business models:

- 1) business models focusing on durability,
- 2) business models focusing on more efficient use,
- 3) business models focusing on repair,
- 4) business models focusing on reuse and repurposing.

The research concludes with a summary and description of finalized communication activities and the next steps.

3.2. A short introduction to the workwear industry

Workwear can include all types of clothing and protective gear such as t-shirts, suits, overalls, jackets, trousers, skirts, gloves, and eye protection. Workwear can fulfill many functions, such as protecting the health and safety of the worker/wearer, enabling movement, and providing comfort. It can even be part of company branding by making employees easily identifiable. Certain types of workwear are regulated, for example, in the Swedish Work Environment Act (1977:1160, chapter 2:7). Moreover, in some countries, collective agreements require employers to provide workwear.

Workwear is a growing part of the clothing industry, valued at USD 16,773.3 million in 2021 and expected to grow annually at a rate of 5.6 % until 2030 (Grand View Research, 2022). According to marketing research, this growth is driven by a more professional approach to working conditions, branding, and a desire to decrease the number of workplace accidents

and fatalities globally (ibid.). Despite the size and expected growth of the workwear industry, the discussion of textile sustainability challenges has focused mainly on the fashion and apparel industry (Chen et al., 2021). Few research and government reports have started to investigate the workwear industry to identify overconsumption and fast disposal challenges and suggest circular solutions (Kumar et al., 2022; Malinverno et al., 2023). Early findings indicate that the structure of the workwear industry differs from the fashion industry, and thus, the potential of various circular business models differ; therefore, each should be researched in their own right. Firstly, there are large buyers and sellers in this market that have the power to orchestrate or resist change towards circular business models, such as large retailers and public procurers (Rainville, 2021; Huulgaard et al., 2022), whereas the fashion industry has more small-scale retailers and individual consumers. Moreover, economies of scale can be developed more easily around repair, recycling, and refurbishing because workwear is often made of uniform material, comes in large quantities, and is of high quality (Malinverno et al., 2023). Extant studies on workwear come mainly from the healthcare industry and not the construction and industry sectors.

4. Research design

4.1. Overview of the research process

This report aims to discuss potential circular business models and changes to the design of products and services in the workwear industry from a holistic perspective including environmental, economic, legal, and provider and customer perspectives. More specifically, focus is placed on a specific segment of the workwear industry: the building or construction industry, and even more specifically on small and medium-sized enterprises (SMEs).

Various design and business model interventions that could affect resource consumption and thus contribute to a more circular economy were examined to do this. This examination was comparative, i.e., the interventions were compared to the linear status quo. The status quo is considered a purchase or sale scenario with a product not optimised for long life. The comparison is made from the environmental, economic, legal, provider, and customer perspectives. The process for conducting this research was:

- 1) Identify the design and business model interventions to be examined.
- 2) Identify the tools or methods that could be used to examine each perspective.
- 3) Collect data to understand the status quo and the effect of the interventions from each perspective. This data had to be appropriate for the chosen methods.
- 4) Apply the methods and reach a conclusion for each intervention from each perspective.
- 5) Combine the different perspectives for each intervention to develop a holistic understanding and make recommendations regarding design and business models.

4.2. Design and business model interventions

This section describes the design and business model interventions to be examined and the process for identifying them.

Design interventions

A main project partner, CIRK-L, has designed modular workwear with two key features. The first is *detachable tool pockets*. These patented design features make it possible to detach the pockets from the work trousers quickly. This is hypothesized to enable easier washing as the workers in construction and industry do not have to empty their pockets from tools, nails, screws, gravel, etc. before washing their work trousers. This makes cleaning more

convenient and reduces the fear that the washing machine might get damaged from forgotten screws etc. It is expected that more washing will lead to a longer lifespan.

The second feature is *detachable lower legs*. This design feature makes it possible to unzip the lower legs from the knee down. This is hypothesized to enable repair of the knee section, which gets worn fast by offering spare parts that the workers themselves can replace. Moreover, it allows for using the work trousers all year round. It is expected that this will prolong the life span of the trousers. Exploring these hypotheses for these two design features was a primary motivation for starting the project.

Business models interventions

The business model innovation-related interventions are derived based on the circular strategies framework presented by Potting et al. (2017) that includes ten different strategies: Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover that can be applied to products. These are presented in more detail in Table 1.

Measures		Definitions
Smarter product consumption and production	Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
	Rethink	Make product use more intensive (e.g. through sharing products or by putting multifunctional products on the market)
	Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of products and its parts	Re-use	Reuse by another consumer of discarded product which is still in good condition and fulfils its original function
	Repair	Repair and maintenance of defective product so it can be used with its original function
	Refurbish	Restore an old product and bring it up to date
	Remanufacture	Use parts of discarded product in a new product with the same function
	Repurpose	Use discarded product or its parts in a new product with a different function
Extend lifespan of materials	Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality
	Recover	Incineration of materials with energy recovery

Table 1 Circular strategies from Potting et al. (2017)

Three of these strategies are not explored as part of this research. First, *Refuse* is not considered because the premise of this research is that workwear is necessary since people need to be clothed and workwear fulfils an important hygiene and safety function in many situations. Similarly, the two strategies that aim to expand the lifespan of materials, i.e., *Recycle* and *Recover*, are considered out of scope because they do not focus on prolonging the lifespan of a product.

The remaining strategies are the starting point for exploring the different scenarios or business model-related interventions to compare at the beginning of the research. Each perspective's analysis does not use the same scenarios, alternatives, or business model-related interventions. They are similar, but there are differences. The reason is that there are different important parameters to each perspective. For example, whether an all-in-one solution is provided by the producer or the wash service provider does not influence the environmental impacts significantly. However, it does affect the contracts and cost structure. Additionally, not all research was done simultaneously, so the latter parts became sharper due to input from the first findings.

One term central to understanding the exploration of business model-related interventions is “all-in-one solutions.” This is used broadly to refer to things described in the literature as “rental,” “functional sales,” “product-service systems,” and “products-as-a-service” (Tukker, 2015). These are integrated offerings of products and services that aim at jointly fulfilling customer utility and value (Boehm and Thomas, 2013). The provider of such a solution maintains ownership of the product and takes on responsibilities in the operational phase. Because the providing company retains ownership, is responsible for operating costs, and earns revenue from subscription fees, it is motivated to reduce resource use during the operational phase and prolong the lifespan. This means reducing resource use per unit of delivered function to the customer. Therefore, this type of business model is central to a circular economy. It should be noted that this reduction of resource use and associated environmental impacts is not always guaranteed (Kjaer et al., 2019).

Holistic perspective

Insights gained from comparing the environmental (WP1), economic (WP1), legal (WP2), customer (WP3), and provider (WP3) value perspectives of the design and business model-related interventions with the linear status quo are combined at the end to present business models from a holistic perspective. Although the circular strategies are the basis for these business models, the business model discussion explains how companies can create, deliver, and capture value and the expected environmental impacts.

4.3. Data analysis and data collection methods

In Table 2, the methods used for data analysis and data collection are presented.

Perspective	Methods	Data collection
environmental	Life cycle assessment (LCA)	- Quantitative data from project partners - Ecoinvent database - Interviews with builders in SMEs
economic	Life cycle costing (LCC)	- Interviews with project partners - Interviews with companies in the Swedish workwear industry
legal	Explorative study of legal frameworks	- Interviews with project partners - Review of relevant legal frameworks - Reviews of existing contract templates from project partners - Expert workshop with academics
provider	Descriptive study of circular business models on the Swedish workwear market	- Interviews with companies in the Swedish workwear industry including project partners
customer	Descriptive study of builders' workwear consumption patterns	- Interviews with builders in SMEs including project partners
	Explorative study of CIRK-L users' attitude to design interventions	- Trial of CIRK-L work trousers by project partners followed by focus group - Survey with product users
	Explorative study of municipal actors' attitudes to workwear	- Interviews with municipal procurement staff at project partner - Questionnaire with municipal workwear users at project partner
Holistic perspective	Combination of findings from individual perspectives and discussion	

Table 2: Overview of methods of data analysis and data collection

Specific methods, namely LCA and LCC, were used for the environmental and economic perspective. These are described in detail in a separate sub-section below. Descriptions of the approaches to other perspectives are given below.

4.3.1. Legal perspective

The essential question that had to be investigated from a legal perspective was whether a "functional sale" or "all-in-one" business model intervention could give rise to challenges on the legal level and whether agreements should be drawn up between the partners. Even the "repair" option added to a purchase is investigated. More specifically, the aim was to examine whether the current law would support or hinder the application of an all-in-one solution for workwear. The approach to investigating this question was to take each transaction from the case company CIRK-L, understand the legal frameworks that frame the context of the specific transaction, and explore if these would hinder or support each

proposed change. The data collection and analysis process included interviews and workshops with CIRK-L and Textilia to understand the current and possible future relationships. In parallel, legal documents, academic publications, and the companies' contract templates were reviewed to understand the legal frameworks that govern the relationships and the legal challenges. Based on the analysis of these data sources, a workshop with staff members from the Division of Commercial and Business Law at Linköping University was organized to obtain feedback on the identified legal challenges and solutions. After further analysis based on the workshop input, final interviews were conducted with Textilia and CIRK-L to collect additional data and refine the results.

4.3.2. Provider perspective

The structured approach to understanding the provider perspective included interviews with companies in the Swedish workwear industry described below. However, the project partners imparted substantial knowledge during several project meetings, data collection sessions for the LCA and LCC, discussions about how to set up a trial of the workwear, and informal discussions.

Interviews with companies in the Swedish workwear industry

Fourteen organisations representing different types of actors in the workwear industry in Sweden were interviewed. Two of these are project partners. Based on an internet search, key actors in the workwear industry were contacted for an interview. Then we asked a Swedish Science Park, which specialises in textile-related topics to suggest small companies and new ventures that could be interviewed to obtain a more holistic perspective on the market. We also asked interviewees if they could suggest other new ventures. During one informal discussion and an interview, the Science Park also provided input on the provider perspective.

All of the fourteen case organisations want to remain anonymous since they are active in the same market so we use a code instead of their names. The companies range from large, with several thousand employees, to medium, with fewer than a hundred and even small, with one to three employees. In three interviews more than one person participated, and three people were interviewed more than once. In total, 21 semi-structured interviews were conducted during 2022, and 20 people participated in them from fourteen companies and one science park. An interview guide was used, which covered: (i) the interviewee's role in the company and their knowledge on the circular economy, (ii) the status quo, i.e., the current business model or circular business model, (iii) the organisational and individual drivers and barriers concerning circular strategies, i.e. rental and repair etc. Despite having an interview guide, the format was semi-structured to be able to react to the information that the interviewee provided for the initial question (Kvale, 1983). All of the interviews were online and in Swedish. The software "Microsoft Teams" was used for conducting, recording and transcribing. The authors followed a traditional stepwise

approach to systematically analyse concepts and themes from the data (Miles and Huberman, 1994).

4.3.3. Customer perspective

The structured approach to understanding the customer perspective is described below. In addition, the project partners imparted substantial knowledge during the project meetings, the discussions about recruiting a company to set up a trial of the workwear and informal discussions. Moreover, during the interviews with companies in the Swedish workwear industry, described in the provider perspective several customer behaviours and needs were discussed because they are an organisational driver and barrier.

Interviews with builders in SMEs

During the autumn of 2022, 25 short interviews with builders or workwear buyers in randomly selected SMEs were conducted to reveal workwear consumption patterns. The interviewees work at different companies; 14 have fewer than 20 employees, and 11 have more than 20 employees. An overarching questionnaire was compiled. The questions focused on obtaining answers about how much workwear was consumed annually, the workers' clothing habits (such as washing frequency), and how the company managed the purchase of workwear. The questionnaire also included a section to evaluate the workers' attitudes toward and experiences with various circular strategies. The interviews were conducted over the phone, and notes were taken. The study's findings were compiled in an Excel spreadsheet. This was done to obtain a quantitative overview of some of the responses. For example, charts were created of workers' washing frequency and how often work trousers wore out. Based on this data, average values were obtained and later used in the LCA. The information from this set of interviews was used in the LCA and LCC to understand the business potential of specific business model interventions.

Trial of CIRK-L work trousers followed by focus group

A trial of workwear was set up with two of the partner companies, Obtech and JLbygg, to document the effect of the design features more closely. Obtech is an electrician firm specialising in installing smart home, heating, and home security systems. JLbygg is a small building company taking on a wide variety of projects, from kitchen renovation to building whole houses. The staff members at both companies trialled the CIRK-L work trousers for spans varying between several weeks to over one year. Of the five staff members at Obtech, those using the trousers the longest used exclusively CIRK-L trousers year-round.

A one-hour focus group was used to gather insight, feedback and reflections from Obtech. The focus group was structured according to the principles outlined by Patton (2002, p 385). Five participants were present locally, with a CIRK-L representative participating online in the focus group session through Microsoft Teams. A guide was used to structure the session, with a brief prompt given by the researcher based on prior interviews and the

questionnaire with municipal workwear users(described below). Moreover, several informal discussions between the project partners were also sources of feedback.

Survey with product users

Apart from the trials that aimed at collecting qualitative and contextual data from CIRK-L users, a survey was also sent out to all who had bought work trousers from CIRK-L and for whom contact information was available. The aim was to collect quantitative data and discover whether the design changes had influenced wash as hypothesized. CIRK-L and the research team developed the survey, which was sent out to 376 persons using the software Google forms, and 60 answered.

Interviews with municipal procurement staff

To understand the status quo, prior development, needs, and challenges in the context of the procurement of workwear in Swedish public organisations, interviews were held with staff at Lund municipality and its subsidiaries. These sessions were conducted as semi-structured interviews (Flick, 2018). Interview guides provided a starting point, but the data collected often exceeded the predetermined focus of the interview. All interviews were carried out and recorded online using Microsoft Teams.

Questionnaire with municipal workwear users

A questionnaire was used to gain broader insight into the perceptions of workers at Lund municipality and its subsidiaries on workwear and the potential of employing reuse, rethink, and recycling strategies. The link to the digital questionnaire was distributed to relevant staff by the interviewees. The questionnaires were conducted through Microsoft Forms, and the outcomes were exported as Microsoft Excel files and saved locally. The results delivered direct insights and served as input to further data-gathering efforts.

4.4. Life Cycle Assessment

The environmental assessment is performed for four alternative business models for work trousers. The assessment is based on a hypothetical model for a medium-sized builder firm that is transitioning to a more circular management of its workwear. The aim is to compare the environmental load of different business models. The purpose is to use the results to improve current handling of workwear from an environmental perspective.

The study uses Life Cycle Assessment (LCA) to estimate the environmental impact. LCA is a standardised and widely used method which entails a life cycle perspective and serves as a quantitative approach to evaluate a product's environmental load (ISO 2006a, ISO 2006b). The software SimaPro is used to model all the scenarios, where the database Ecoinvent is used for the life cycle inventory and the EPD(2018) is applied as the impact assessment method. The included impact categories are acidification (kg SO₂ eq), eutrophication (kg

PO₄³⁻ eq), global warming (kg CO₂ eq), photochemical oxidation (kg NMVOC), abiotic depletion – elements (kg Sb eq), abiotic depletion – fossil fuels (MJ), water scarcity (m³ eq) and ozone layer depletion (kg CFC-11 eq). An attributional, or accounting, approach is used, which includes all the resource flows of relevance for the assessment throughout the product's life cycle. A functional unit is defined to compare the environmental load of various scenarios. This is a reference to which the environmental impact is related to. In this study, the functional unit is “*One year of usage of work trousers for an average builder*”.

System boundaries

The system boundaries are cradle to grave, including the life cycle stages of extraction of materials, manufacturing of the workwear, shipping, use, and end of life. In this study, the focus is on evaluating the differences in the use phase of four scenarios of business models. A central step of the LCA-process has been researching the current user habits when managing workwear, which is used as a reference, and presented in this report. The system boundaries are drawn to only include the processes that will impact the assessment. For example, the transportation of the workers is assumed to be equivalent in all the scenarios and is therefore excluded from the assessment.

System modelling

The scope of the LCA is limited to assessing the environmental impacts associated with the CIRK-L work trousers. Information and specific data about the manufacturing phase are received from the CIRK-L, while data on the use phase and end of life is collected from interviews and literature. This foreground data comprises the material content of the trousers and geographical information about where the components are manufactured. The background data is the generic and average data defined in Ecoinvent. The material content of the studied working trousers is described in Table 3.

Material	Content [%]
Cordura ^a	58%
Polyester	23%
Gunmetal ^b	14%
Plastic	2%
Rubber	2%

^a Nylon and spandex

^b Brass

Table 3 Material content Cirk-L work trousers.

The CIRK-L trousers are made of Cordura, a synthetic fabric consisting of nylon and spandex. The fabric is produced in Taiwan, and the components, such as belt buckles, belt,

snap puller, etc. are manufactured in different countries, i.e., China, Thailand, Vietnam and Germany. The fabric and components are transported with container freight and trucks to Laos, where the trousers are manufactured and after that shipped to Sweden. The processes used to produce the fabric is based on Sandin et al. (2019).

Lifespan of work trousers

Based on our interview study, we found that, on average, builders use approximately 2.3 pairs of work trousers per year. We have incorporated this figure into our baseline scenario for modelling work trouser lifespan. During an interview with a company that has set up a repair option, it was suggested that implementing repairs and better maintenance for work trousers could extend their lifespan by around 100%. As a result, we assume that implementing a repair service, included in scenarios 2, 3, and 4, will lead to a 50% reduction in the number of trousers used per year, resulting in an estimated 1.2 pairs of trousers per year.

In the fourth scenario, we project that builders use 1.5 work trousers annually. This estimate accounts for the need to maintain an all-in-one business model, including an additional safety stock of approximately 20% for trousers.

Based on the responses from the interview study, it is assumed that the work trousers are incinerated after they have been used.

Washing

One of the main differences between the scenarios is that in two of them (1 and 2), it is assumed that the builders wash their trousers at home. The business model includes a washing service in the other two scenarios (3 and 4). This means that the differences in environmental impact of the two washing methods have been assessed.

Data for the energy and water consumption for home washing is described in Table 4. The data was collected from investigating the performance of the most frequently sold washing machines on the Swedish market (Elgiganten, 2023). Information about the performance of washing machines and transportation habits within the washing industry was collected in an interview with Textilia. To validate the data from the described methods, information from several sources with previous LCA studies in the textile industry was collected (Beemkumar and Mathews, 2015).

Regarding how much the washing machines are loaded, the industrial washing companies have, according to Textilia, a more optimised habit of loading the machines to their full capacity. The loading of the industrial machines is assumed to be 90% of the maximal load. In this study, the builders who wash their workwear at home are assumed to load their washing machines at 60% of their full capacity. This percentage corresponds with the average homeowner's washing habits in (Sandin et al., 2019).

	Industry (10 kg) Per cycle	Home (6 kg) Per cycle	Scenario 1&2 Per FU	Scenario 3&4 Per FU	
Energy	1,6	1,1	3,41	5,86	kWh
Water	60	40	128	213	l
Heat	2,01	2,01	8,1	11,6	kWh
Detergent	0,09	0,075	0,19	0,4	kg

Table 4 Data for washing at industry and at home with related reference flows

Scenarios

The four scenarios of business models assessed using LCA are described in Table 5, and they are defined according to information gained in the performed interviews and through literature. The first column (Linear-Base) describes the estimated current norms for using workwear in the building industry. The following three columns illustrate the main differences relative to the Linear – Base scenario when transitioning to a more circular business model.

	1.Linear-Base	2.Repair service	3.Washing service	4.All-in-one
No. trousers/yr	2,3	1,2	1,2	1,5
Washing	Home	Home	Industry	Industry
Load factor washing machine	60%	60%	90%	90%
Washing/yr	24	24	24	24
Repair no./trouser	-	1	1	1
Transport tkm/yr	-	0,096	0,768	0,768
Waste treatment, Incineration, kg/yr	1,84	0,96	0,96	1,2

Table 5 A description of the four scenarios.

In scenarios two and three, we explore business models where individual builders or firms retain ownership of their working gear, with the key distinction being that scenario three introduces a third party responsible for handling laundry services, this third party also performs repair. In contrast, in scenario 2 the builder washes the clothes himself but sends the work pants to a tailor or seamstress for repair. The fourth scenario represents a case where a third party rents, owns, and maintains the builder’s working gear.

4.5. Life Cycle Costing

An economic analysis entails the evaluation of costs and benefits. There are various types of analysis. This economic analysis is based on a lifecycle costing approach. Lifecycle costing aims at calculating the costs of products and services over their lifetime (Woodward, 1997). There isn't a common methodological framework for LCC. Many sector-specific methodologies and guidelines exist, such as the IEC 60300-3-3 (2017) for buildings (Gluch et al., 2018). There are many reasons why a company might use lifecycle costing. Sometimes, lifecycle costing is conducted in order to have a detailed and accurate account of costs associated with the lifecycle. Still, often the intended outcome is to facilitate a discussion or create a cost structure. LCC methods are tailored to fulfil this intended use (Gluch et al., 2018; Kambanou, 2021). In this research, we also tailor the LCC method to suit the aim of the study. The economic analysis is based on LCC, but costs are not presented; only change in costs in comparison to the base case 'direct sale producer to customer' is. The details of the economic analysis are shown in Table 6.

Method aspects	Method decisions
Objective	The objective is to understand the economic implications of implementing circular business models in the workwear industry (more specifically for the segment of builders, carpenters etc. working for SME building companies).
Functional unit	Same as LCA <i>One year of usage of work trousers for an average builder</i>
Alternatives	<ul style="list-style-type: none"> - Five alternatives: i) Direct sale producer to customer, ii) Sale through dealer, iii) Direct sale producer to customer, iv) all-in-one solution producer to customer, v) all-in-one solution washing service provider to customer - Alternatives are functionally equivalent, but are not of equal provider and customer value
Scope	<ul style="list-style-type: none"> - Application: SMEs in construction (e.g., electricians, artisans, builders) - Actors: producers, dealers, wash service providers, customers - Overheads are considered, but not indirect costs - Detailed understanding of production and other upstream costs are out of scope - End-of life costs (e.g., incineration costs are not considered)
Cost categories	<ul style="list-style-type: none"> - Overall cost categories adapted from (Kaddoura et al., 2019) - Cost elements developed in multidisciplinary team including practitioners and academics
Cost estimation	- Cost estimation is not performed; instead, change in relation to the base case (i.e. direct sale to customer is presented)
Uncertainty	- Uncertain reference flows (i.e., the amount of work trousers consumed in each of the alternative scenarios)
Interpretation and review	- The findings are interpreted both from the provider and customer perspective because the economic perspective changes for both.

Table 4 Details of economic analysis based on suggestions (Kambanou, 2021)

The process was to first formulate the alternative business models. Then an inventory of cost categories was created, followed by an exploration of how the costs change in the different scenarios/business models. The process was iterative and performed in collaboration with the two partners CIRK-L and Textilia, who provided most of the information and commented on its development. Moreover, some data was collected during the interviews with other companies in the workwear industry, directly with workers, and with the other project partners.

5. Results

5.1. Environmental perspective

In this section, the results of the LCA for the four scenarios, as described in section 4.4, are presented. The functional unit of the study is “one year of usage of work trousers for an average builder”.

5.1.1. Life Cycle Assessment

Figure 2 illustrates the differences in the environmental impact of the four scenarios: “Linear-Base”, “Repair”, “Washing Service”, and “All-in-one”. The graph shows that the base scenario has a greater environmental impact in all categories. The business model “Washing service” has in general the lowest environmental load in all four scenarios.

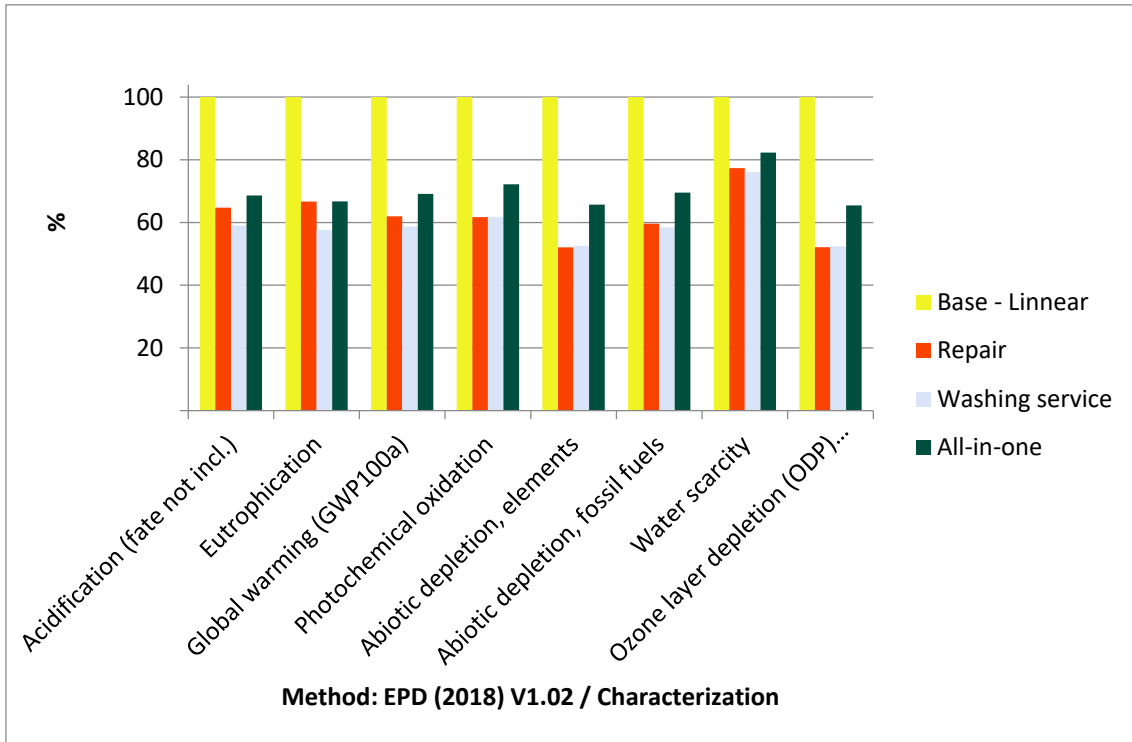


Figure 2: Graph illustrating the different environmental impacts of the four scenarios.

5.1.2. Environmental impact – Scenario 1: Base – Linear

Figure 3 shows the environmental impact of a linear business model for the investigated functional unit. The production phase of the trousers is responsible for most of the environmental load in all of the investigated environmental categories.

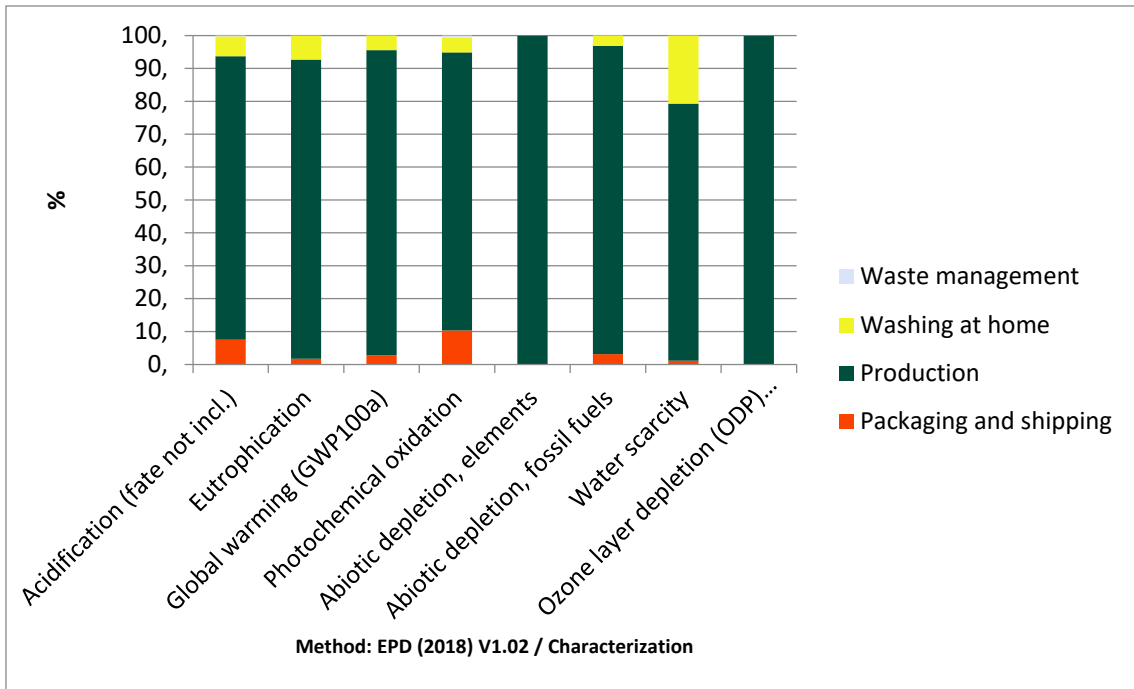


Figure 3: A graph which illustrates the environmental impact of one year of usage of trousers with the "Linear" scenario.

5.1.3. Environmental impact – Scenario 2: Repair

Figure 4 presents the environmental impact of the second scenario, labelled as "Repair."

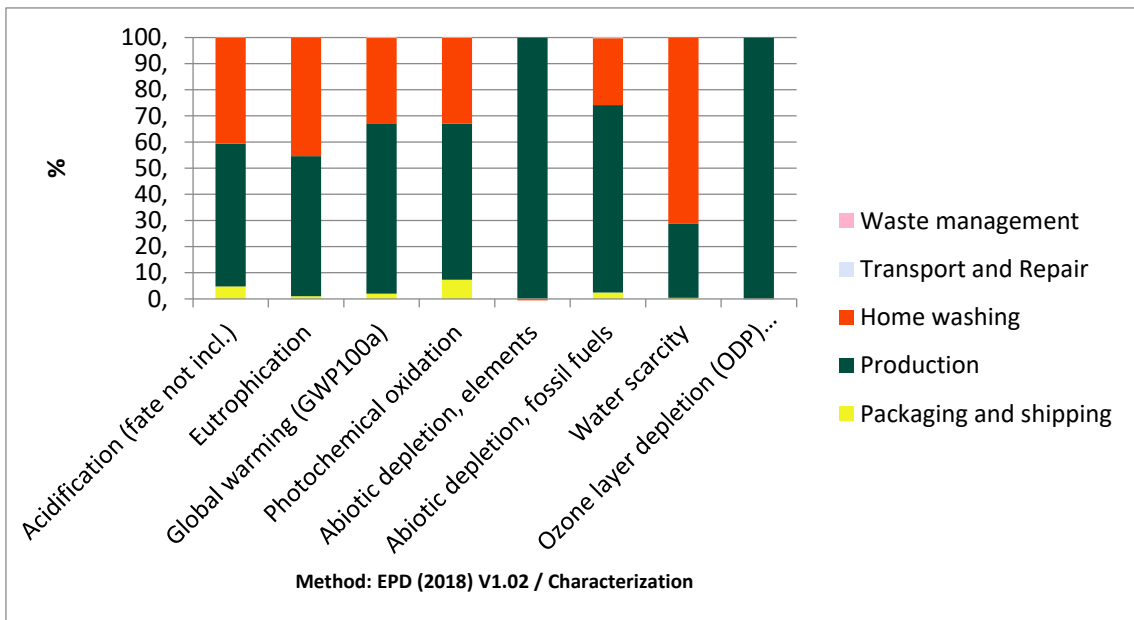


Figure 4: A graph which illustrates the environmental impact of one year of usage of trousers with the "Repair" scenario

Similarly to the previous scenario, the production phase is a major contributor to environmental impact. However, in this case the use phase will also be of importance, i.e., home washing. Especially when it comes to water use, where it consumes the most water of all phases.

5.1.4. Environmental impact – Scenario 3: Washing Service

Figure 5 presents the environmental impact of a business model which includes a washing service for one year of trousers usage for an average builder as well as repair. It is concluded that the production of the trousers is the phase that causes most of the impact on the environment. The consequences of the packaging and shipping and the transport of the trousers represent a minor part of the environmental burden. The production phase generates, on average, 70% of the products’ environmental footprint in each category on the condition that industrial washing is implemented. Washing is responsible for a majority on 67% of the products’ water use.

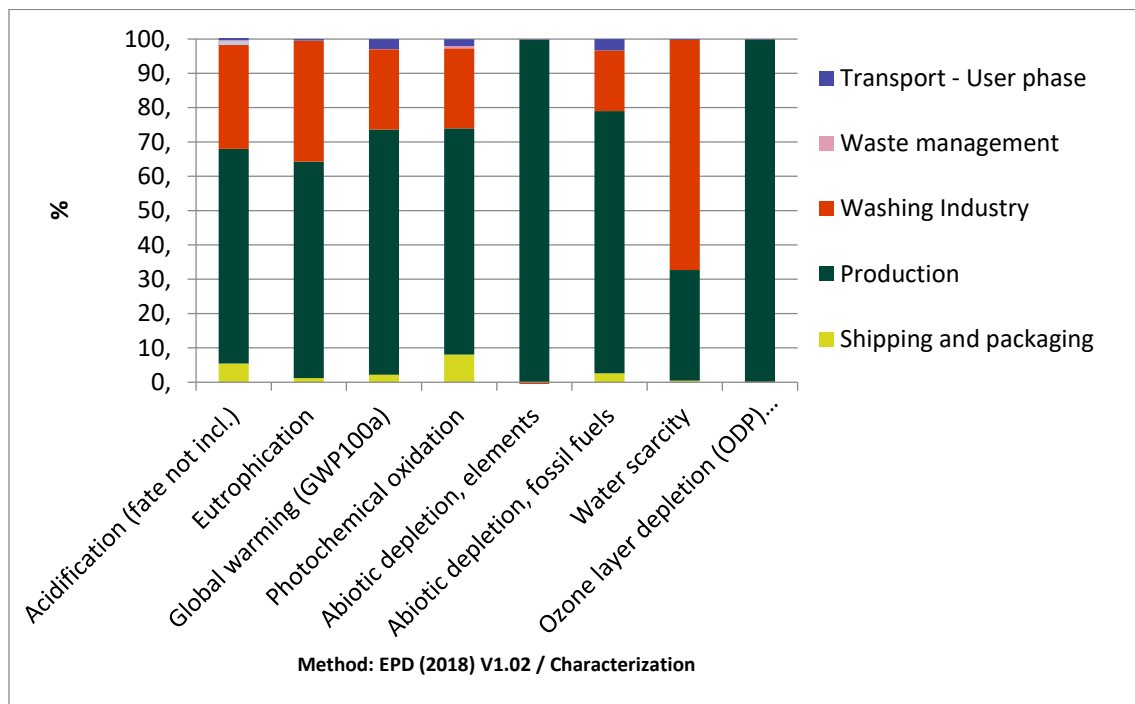


Figure 5: A graph which illustrates the environmental impact of one year of usage of trousers with the "Washing Service" scenario.

5.1.5. Environmental impact – Scenario 4: All-in-one

Figure 6 displays the results of the environmental impact of the fourth "all-in-one" scenario this includes both washing and repair. This graph is similar to Figure 5, but with a notable difference: it considers a higher production of trousers. As a result, the production phase has a more significant impact on the overall environmental footprint.

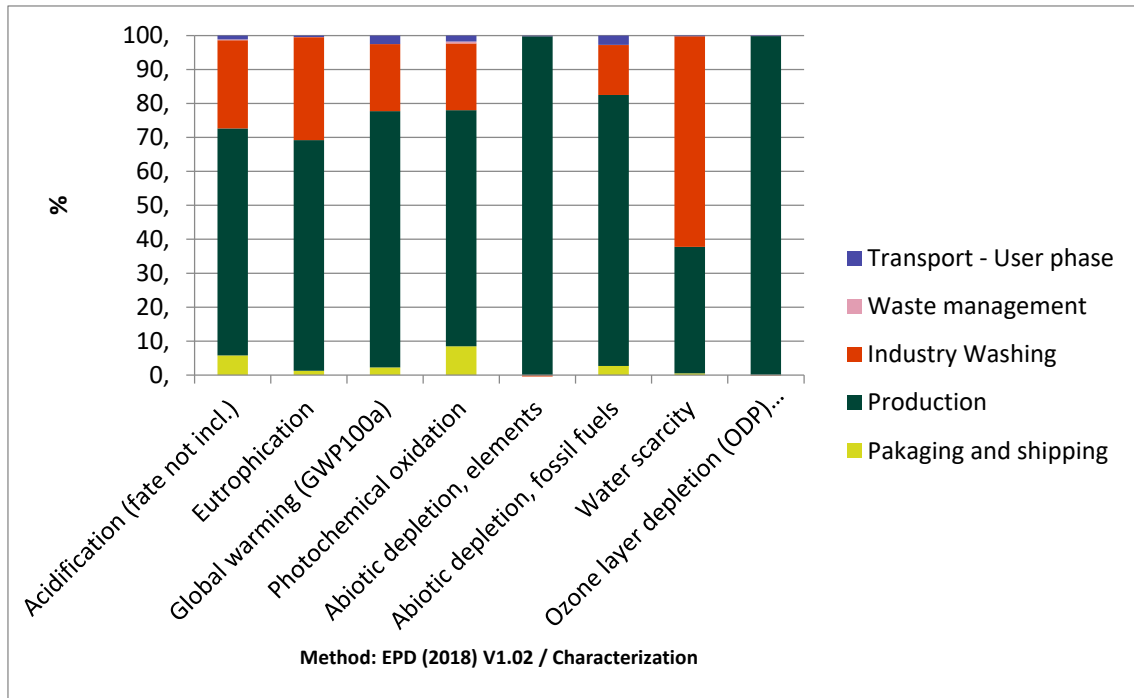


Figure 6: A graph which illustrates the environmental impact of one year of usage of trousers with the "All-in-one" scenario

5.1.6. Interpretation

When comparing the different scenarios using LCA, the Base-Linear scenario stands out with the highest environmental impact across all categories, where it is about 20 to 45 percentage points higher compared to the alternatives. This observation strongly suggests that adopting a more circular business model would be a more environmentally preferable choice. From Figure 2 it can be concluded that the all-in-one-scenario (4) has a higher impact than scenarios 2 and 3 in seven out of eight categories and is similar to scenario 2 in one category. Due to a lack of data and assumption-based modelling, the results are not entirely conclusive, though one can say that a business model including repair and industrial washing is more likely to perform better from an environmental perspective.

The reason Scenario 2 and 3 perform better in the assessment is likely because they are the scenarios with the assumed lowest amount of trousers used, this is mainly due to the repair which reduces the amount of trousers consumed by 50%. As illustrated in Figure 3 and Figure 4, production and extraction of materials represent a substantial part of the products' environmental impact. While efficiency in the use phase, including washing and transport, is important, the primary focus should be extending product lifespan and reducing the overall demand for materials when selecting a business model.

When investigating the all-in-one solution, which involves a complete product service system, it becomes evident that a well-developed logistics system and safety stock are required to operate such a business model. The safety stock is assumed to be 20%, but some interviewees have noted that companies that have incorporated an all-in-one solution for clothing overproduce or over procure substantially more than 20%. When up-scaling, the logistics chain needs digital solutions to manage the logistics chain efficiently. The characteristics of this digital solution can vary. Often some Radio Frequency Identification-based tags are used. Such technology is excluded from the assessment in this report. To further investigate the environmental impact when transitioning to an all-in-one solution, it would be relevant to evaluate the environmental consequences of digitalisation.

It is important to acknowledge that the outcomes of a life cycle assessment depend on the assumptions made, the allocation choices and system boundaries. Predicting the impact of implementing a particular business model on user habits is challenging. Nevertheless, this study concludes that a washing service is likely the most environmentally preferable business model among the four compared. However, it is essential to consider potential unintended consequences, such as whether introducing a washing service might encourage more frequent washing by users or if the assumption that systematic trouser repairs double their lifespan is overly optimistic. Further research is therefore needed to address these uncertainties.

5.2. Economic perspective

Five alternatives are compared to see how their economic performance relates to each other. The actors in these alternatives are: i) the producer that designs and has its brand (and may or may not manufacture the workwear), ii) the wash service provider that provides on-demand or by-subscription wash service, iii) the dealer or retailer that buys in bulk and sells to the customer, iv) the customer that is a building company responsible for buying the workwear for its workers, v) the user who works at the company. The alternatives are:

- i. **Direct sale producer to customer.** This is a classic sale scenario, and does not include a middleman i.e., retailer or dealer.
- ii. **Sale through dealer.** This is a classic sale scenario and includes middleman. Thereby the producer sells to a dealer, who then sells to the customer.
- iii. **Direct sale producer to customer and sale of spare parts or repair.** This is the same as (i) with the addition of offering spare parts or repair services.
- iv. **All-in-one solution producer to customer.** This business model also goes under the term product-service system, products-as-a-service or functional sales. For a fee, the customer gets a bundle of products and services, in this case, workwear,

washing and repair. A more detailed description can be found in 6.3.2. This is the scenario when it is the producer that provides it.

- v. **All-in-one solution washing service provider to customer.** The same as (v) but provided by the wash service provider.

The results of this comparison are presented in Table 7. In this table, we indicate who is responsible for a cost in each scenario and how it changes compared to the base scenario, i.e., increases or decreases. There is also a brief explanation of why the costs change how they do. The fact that costs do not just move between actors but also change in size is somewhat expected but also a finding. Some overarching and critical issues connected with each business model are discussed below.

The ‘Sale through dealer’ scenario just adds a middleman to the supply chain. There are cost savings in this business model due to economies of scale, especially in terms of marketing, storage and possibly even transport and sewing of customer logos onto the workwear. From the producer’s perspective, marketing, storage, and transport costs are lower, and only a basic order-handling application is needed, but the profit margins are also lower. Moreover, the flexibility to influence the client and promote the selling of modular workwear is also reduced. The addition of the dealer is also expected to increase the price for the customer. This scenario cannot be considered circular.

The scenario of ‘**Direct sale producer to customer and sale of spare parts or repair**’. Dealer and wash service providers are not part of this scenario. For this option, the costs are very similar to scenario (i) with some slight increase expected in marketing costs, i.e., IT system to handle repair requests, storage, new equipment, e.g. sewing machine, and some large changes expected to labour and transport costs. The interviews showed that customers expect repairing the work trousers to be cheaper than buying new ones. If only a spare part is sent out and the users can perform the repair themselves due to modular design, a lower price might be possible. Thus, it can potentially be economically viable. However, if sewing is needed and the trousers must be sent back and forth, the price is only marginally less than buying new. Therefore, the customer is expected to choose the option of buying new.

Economic analysis							
Cost items		Different scenarios					Explanations
Activity	Description	Sale	Sale through dealers	Sale and repair	All-in-one producer	All-in-one washing service provider	Comments
Marketing	Marketing	P	- D	+/- P	- P	- WS	All-in-one targets larger companies, so less advertising is needed and more sales can be achieved.
	Sales	P	+/- D	+/- P	++ P	++ WS	
	General overheads	p	+/- D	+ P	+ P	+ WS	All-in-one requires more time to write contracts. Repair also requires more time.
	IT system cost	P	+/- D	+ P	++ P	++ WS	Sale through dealers just requires a basic order handling system, whereas direct sale is more complex, repair is even more advanced, and all-in-one requires a whole new type of IT solution.
Procurement	Storage	P	- D	+/- P	+ P, +WS	+ P, +WS	Dealers have optimised storage. For all-in-one storage of spare parts and replacement workwear is required. Moreover, all-in-one also must store the workwear being washed.
	Buying the goods	P	+ D	- P	- P	-P	In the repair and all-in-one solution less workwear is need to be procured per person and per year.
	Logo placement	P	+/- D	+/- P	+/- P	+/- WS	The responsible for sewing the customer logo onto the workwear changes.
	Cost of capital	P	+/- D	- P	+ P	+ WS	In the all-in-one solution the cost of capital befalls the solution provider e.g., interest on loans & return on capital, who has it on the balance sheet for an extended period.
Distribution	Initial product transport to customer	P	- D	+/- P	+/- P	+/- WS	These transport costs are the same in all situations.
	Transport back and forth for washing and repair	0	0	+ P	+++ P	++ WS	Repair requires some additional transportation, whereas washing requires a lot. The washing service provider is better positioned to optimise these costs.
Opera	New equipment	0	0	+ P	+ WS	+ WS	Repair may require the provider to get sewing equipment, or some workwear may need special washing machines.

	Washing/drying /folding - energi, chemicals and labour	U	+/- U	+/- U	- P	- WS	Washing is done more efficiently by the wash service provider, but it is a user cost in the other scenarios.
	Administrative costs/overheads	0	0	0	+ P	+ WS	Slightly increase administration costs for the all-in-one solution for monitoring the relationship.
	Repair -sewing of torn workwear	0	0	+ P	+ P	+ WS	No repairs in direct sales but some repair costs in the other business models.
	Replacement of bottom half of leg or knee pad	0	0	+ P	+ P	+ WS	Modular design allows for spare parts exchange which is cheaper than repair and can be done by a user.
	Digital functionality in workwear and wardrobe, IT system	0	0	0	+ P, ++WS	+ P, ++WS	In the all-in-one solution there is need to increase digital functionality to monitor workwear and to reduce losses, these are a large cost driver.
Revenue	Purchase of worktrousers	C	+ C	-- C	-- C	-- C	Cost to buy workwear.
	Wash services cost	0	0	0	++ C	++ C	Monthly subscription cost.
	Repair cost	0	0	++ C	+ C	+ C	Cost of repair.
	Residual value	0	0	0	0	0	e.g. second hand market. Currently this is 0 but in the future, there could be a residual value and the all-in-one solution is best positioned to take advantage of it.

Table 5 Results of economic analysis.

P	Producer
D	Dealer
WS	Wash Service provider
C	Customer
U	User

++	Much more than base case
++	More than base case
+/-	Approximately same as base case
-	Less than base case
--	Much less than base case

The **'all-in-one scenario'** for this customer segment was found to not be an economically viable option because of large increases in certain costs. First, this scenario shifts the costs from the user to the customer, i.e., from the employee to the employer. Many collective agreements state that it is the employer's responsibility to ensure workers have workwear. However, they do not give them responsibility for the washing and repair. Thus, the most common scenario is that the user washes the workwear at home or when they come to the main office. Additionally, repair does not take place. Further information on these issues can be found in Section 5.5, where the customer perspective is presented. The all-in-one solution where the customer, i.e., the employer, pays for washing means that the employer is essentially taking responsibility for a user's cost and thus lacks the motivation to do it.

Furthermore, transport costs for collecting used workwear and delivering clean are an extra cost that does not occur in the sales because users wear the workwear when they go home. Additionally, because construction workers move between different building sites and the market segment is small companies, economies of scale are less likely to be achieved for transportation and substantial administration is required.

To be able to successfully wash the workwear and return it to the right worker as well as to account for lost workwear and monitor the garments to bill the customer etc., there is a need for adding digital functionality both to the workwear, e.g., chips and to the infrastructure, e.g., smart hangers, smart wardrobes, handheld sensors etc. This incurs substantial costs. Here, we also see a difference where the wash service provider can achieve economies of scale across its operations and do data management in-house. If the producer provides the all-in-one solution, the data systems must be developed and synced with the wash service provider.

Finally, changes also occur to marketing costs because all-in-one requires more sales, i.e., labour time and less advertisement. More administration is also required to write a contract and develop and maintain a customer interface.

This cost increase could be offset by the longer lifespan of the workwear, i.e., the provider reduces costs by buying less new workwear. This is an assumption presented in Table 4. However, there is high uncertainty about whether an all-in-one solution would significantly reduce the amount of new workwear. In conclusion, the all-in-one solution was not found to be economically viable for SMEs in construction under the current circumstances.

Apart from the costs, there are other economic consequences. Firstly, a small producer like the project partner CIRK-L might have more difficulty accessing capital to invest in workwear to provide the all-in-one solution. Moreover, the ownership of the stock of clothing would be recorded in CIRK-L's balance sheet as an asset, which means that the company's total asset value increases. A small provider might not be able to balance this asset increase, whereas a large service provider is better positioned to absorb this increase.

5.3. Legal perspective

The aim was to investigate whether the current law would support or hinder the application of an “all-in-one” business model and “repair services” for workwear. The legal investigation started with interviews of the main actors in this field, trying to identify the legal issues. Subsequently, colleagues at the Department of Commercial and Business Law were invited to a seminar where the identified legal issues were presented. Then they discussed whether there were problems that the principal researcher had not seen. Thereupon, a series of interviews followed in order to substantiate the findings already achieved.

When reading the sections relating to the legal perspective, it is important to distinguish between the law as it is today and a possible future law. It is impossible to make legal assessments according to a law that does not exist, which means that the assessments made in the following are made regarding the current law.

5.3.1. Product purchase vs. all-in-one solution from a legal perspective

Today's distribution of goods and services is based legally on a principal level, and with a certain simplification on the "purchase" contract type. This type of agreement is based on the idea that one person, the seller, hands over ownership and possession of an object to another person, the buyer, in exchange for handing over money or the equivalent to the counterparty. This type of agreement can be varied so that "buyer" instead of ownership, receives a right of use, e.g., in the case of leasing agreements. Even pure service contracts are based on this fundamental principle, e.g., the work or assignment agreement. In these cases, the "object" that is bought is often not a thing or access to a thing. Still, the object of the agreement is a more intangible asset, e.g., the employee's or the contractor's skill or competence in something essential for the employer or the contractor. If we stick to the most common type of agreement, i.e., "purchase" of tangible goods, such an agreement has consequences for the buyer. The buyer becomes the owner and must pay for the operation of the object, maintain it, and possibly replace it with another and new one when the object has served its purpose and can no longer fulfil the function it originally was intended to have.

All-in-one solutions are based on a different logic, which briefly means the following. A buyer who "functionally buys" something does not buy a product but a function. For example, a buyer purchasing light as a function does not buy the fixture and light source, but purchases the function of illumination. The agreement between the buyer and the seller does not specify that a particular fixture is handed over with a light source. Still, the agreement specifies, for instance, that in the living room, there should be light of a certain quality, with a certain brightness, placed in certain places. The most important consequence in legal terms is that ownership remains with, in the first place, the provider of the all-in-

one solution. (In this respect, this type of contract is similar to the leasing contract, especially operational leasing). The relationship, in turn, has consequences in that the costs of operation and maintenance remain with the object's owner, giving rise to the function.

In contrast, the function buyer only pays a fee at fixed intervals to access the function. However the contract type differs further from the usual purchase in that the function seller has the right to replace the object that gives rise to the function with another object that gives rise to the same function. A given condition is that the replacement product provides a function with the specifications agreed between the function seller and the function buyer. (In this respect, the function purchase differs from operational leasing; in the latter case, the right of use is tied to a specific object specified in the agreement.)

The legal challenges associated with the all-in-one business model may look different, depending on the circumstances of the individual case. Four distinct categories of challenges were identified.

- A. If the object that will give rise to the function consists of different parts and different owners individually own these parts, then the question is raised as to who the owner of the whole is. This cannot be answered with certainty according to current regulations. On the one hand, there is the possibility, based on the legal case NJA 1960 p. 9, to interpret the legal situation so that a separate right of ownership, when different owners own a single object, cannot be considered to exist "[...] to an object that was an accessory to a main object and which was joined to the main object, even if it is straightforward and without special costs to remove the accessory again." On the other hand, the Swedish Supreme Court (which decided in the case mentioned above) found in a later court case (NJA 2008 p 282) "[...] a rule that would entail the right to 'separate accessories where it can be done without substantial damage' to the main thing." – This problem is unlikely to arise when it comes to the objects, which are the focus of this study, namely workwear.
- B. Companies that own different parts of a product and co-deliver the function can be considered to be cooperating in some way. Classifying this collaboration has challenges; in some cases, it may conflict with competition protection rules. More specifically, there are today several different associations to choose from. The actors can form a trading company, limited liability company or possibly an economic association for the purpose. If an association specifically intended for the purpose is not chosen, there is a risk that a court will find that an unincorporated partnership (UP) has been formed, which, depending on the circumstances, means that the parties will be subject to a set of regulations they did not intend to be used for cooperation.
- C. There is also the challenge of formulating contracts for an all-in-one solution so that the rights and obligations of both the function buyer and the function seller are clear

and respected. The current situation is that writing a function sales agreement is possible. The challenge is that legislation that would need to be applied in the event of a dispute between the parties is not designed with the feature sales agreement in mind. Today's purchase and consumer purchase laws are designed with the "classic" purchase agreement in mind. The rules on the right to use movable property are based only on case law and give scarce information when applied to functional selling contracts.

- D. Concerning public procurement specifically, there is the challenge of whether the current regulatory framework allows a function to be procured publicly and how this can be organised. However, in most cases, the problem is not that the procurement rules put obstacles in the way. Instead, it is the habit of the public procurers thinking in other categories than the usual purchase, which places obstacles in the way of procuring a function instead of objects. This is further researched in the interviews with the partner Lund municipality.

An attempt to describe how these problems may be assessed according to the present legal order is made in the following.

5.3.2. A legal perspective on actors' relationships in the workwear industry

a) The relationship between CIRK-L AB and the manufacturer

The company CIRK-L and the manufacturer in Vietnam communicate using e-mail, which is also used to place orders. No written agreements are drawn up, but communication and agreements take place informally, using email to negotiate and come to an agreement. Should any severe disagreements occur, e.g., in the form of a dispute between the parties, these can be resolved, as both Sweden and the country of operation for the manufacturer have ratified "The Convention of International Sales of Goods" (CISG). There is, thus, a supporting regulatory framework to fall back on should a dispute arise between the parties. Should another manufacturer be chosen, CIRK-L should ensure that the same or similar legal framework is in place. This transaction is not affected by a change in the business model.

b) The relationship between CIRK-L and their customers when providing repair

This is a variant of the current business model where CIRK-L owns the products purchased from the manufacturer. These are then sold to companies or consumers. The purchase agreement between CIRK-L and the customers is short, and contains clauses on price, delivery time, order confirmation, payment options (Klarna), shipping, transport damage and right of withdrawal. It is supplemented by the rules in the Purchase Act, which apply subsidiarily. In the repair variant, CIRK-L also provides repair services. This means the customer retains ownership of the workwear while CIRK-L takes the necessary

improvement measures. Several clauses can be added to the contract to regulate the terms of repair. Suggestions of information to include in the purchase and repair agreements are presented in Appendices A1 and A2 in Section 11.1.

c) The relationship between CIRK-L and their customers when CIRK-L provides an all-in-one solution

Here, CIRK-L retains ownership of the workwear, while Textilia washes, repairs minor damage, and replaces the components that need to be replaced. This means that CIRK-L takes care of the stock, while Textilia has spare parts with them. If CIRK-L sells workwear as a function, the customer and CIRK-L will sign a right-to-use contract. The contract between the function seller and the buyer should be referred to as a "service" agreement, described in 6.3.2. Suggestions of what to include in such an agreement are presented in Appendix A3 in Section 12.1.

A service contract, an agreement with another person for work performance, can be referred to as a service agreement or assignment agreement. The term service agreement refers to an employment relationship. To determine whether the agreement is to be understood as an employment agreement or an assignment agreement, the question becomes what relationship the parties of the agreement have with each other. If the person who performs the work is independent in relation to the client (independent contractor), the agreement is to be understood as an assignment agreement; If the person performing the work is dependent on the client (employee or dependent contractor), the agreement is to be understood as an employment or service agreement.

The assignment agreement can be divided into agreements for tangible and intangible services. Material services refer to work on property, which is work that does not necessarily presuppose that a certain result is achieved. Intangible services are tasks not linked to a specific property, for example, tasks given to a lawyer, accountant, real estate or insurance broker or fund commissioner. (The services rendered by CIRK-L in an all-in-one solution contract would probably be regarded as tangible services since the work to be done concerns clothing.) Some intangible services, such as insurance or real estate agents, are subject to special legislation. – Some agreements combine the two tasks and contain parts that can be described on the one hand as tangible service and as intangible service on the other hand, so the question arises as to how such an agreement should be classified. Crucial is which form of service is dominant. If the element of material service is dominant, should the agreement be perceived as an agreement for tangible services even if there are elements of intangible service and vice versa.

According to the Consumer Services Act (1985:716) Section 1, the law is applicable to work on both real and movable property. (The law is considered applicable by analogy even

outside its immediate area scope of application; see below¹). But according to the same law, storage or deposit is also counted as services to which the law is applicable. Deposit or safekeeping refers to an agreement which means that an object, deposit, is left in the custody of one person, the depositor, with another, the depository. The regulation can be assumed also to have a terminological effect; safekeeping is not a service that involves someone working with a thing but only entails a duty of care for the person who has the thing for safekeeping.

To the extent that the Consumer Services Act does not provide guidance, regardless of whether it can be applied directly or by analogy, there is little help to be had from the legislation. The right to use a loose thing is not regulated by law, apart from a few provisions in ch. 13. The Commercial Code, which today has no meaning. However, the rule in section 2 of the chapter still applies. (It concerns the case where one person, the lessor, rents out the same thing to two tenants.) Otherwise, there is essentially no case law, nor is the literature in the area particularly extensive. In such cases, support for rulings is obtained by "referring to analogies from other legislation", primarily the Purchase Act and the Consumer Purchase Act.

d) The relationship between CIRK-L and their customers when Textilia provides an all-in-one solution

CIRK-L sells the products to Textilia, which owns the product and then sells its functionality, fixes the products and replaces the parts that need to be replaced. In cases where a customer does not want to buy CIRK-L's products as a function, the company must have its own stock of products to sell to these customers in the usual way. Concerning the agreement, the same applies between Textilia and the customer as described under point c.

e) The relationship between CIRK-L and Textilia when CIRK-L provides all-in-one

Since CIRK-L is the one who supplies the workwear, they need to purchase the laundry services provided by Textilia. The result of the assessment of whether a UP (unincorporated partnership, see 5.3.1) exists should depend on who carries out the repairs: If it is Textilia that does these, the assessment should be that a UP has arisen. If CIRK-L performs the repairs, the assessment becomes more questionable. Since the rules in ch. 4 in the law (1989:1102) on trading companies and unincorporated partnerships (UP) are dispositive, i.e., possible to be disregarded by agreement, the parties can design their relationships as

¹ A legal regulation has, according to Swedish legal practice, only effect if the situation under scrutiny, is covered by the wording of the statute. In certain, few, cases the Supreme Court allows the application of the principle behind the regulation to be applied in a situation which is not covered by the wording of the statute. When this happens, Swedish lawyers talk about applying the regulation by "analogy".

they wish. In any case, a UP lacks legal power to act as a separate legal entity. This fact entails that each partner of the UP only acts on their own behalf and not on behalf of the “company” unless a power of attorney is deemed to exist.

However, the following is currently to be noted in terms of accounting and tax law. "Fundamentally, the UP is a contractual solution, and each partner is taxed for his share of the income and expenses that result from this agreement." But there are two circumstances to take into consideration: Firstly, the rules state that profits and losses of the UP are distributed equally between the partners unless they have agreed on a different distribution (chapter 4 §§ 1-2 and 2 ch. 8 BL)" [...] "Secondly, the law regulating the partnership is dispositive with respect to the internal relationship of the partners, but not with regard to the company's relationship with third parties. UP's are dissolved through liquidation. It is a rule of importance concerning third parties and is thus not dispositive. During the liquidation, the partnership's property must be converted into money to the extent necessary for all debts (with a relevant connection to the UP) to be paid and for the company to be dissolved expediently. Unless otherwise agreed between the partners, the assets may not be transferred until all known debts have been paid or the necessary funds have been set aside for such payment. In the event of a shortfall in connection with liquidation, the partners must contribute funds, as UP's cannot go into bankruptcy. The liquidation rules appear (but the regulation is far from clear) to give members of UP's a kind of debt coverage responsibility, with their company-related assets (or shares in assets), for other members' company-related debts. This rule, and in general collaborations regarding business activities within the framework of simple companies, can give rise to tax difficulties.

The design of the agreement between Textilia and CIRK-L naturally depends on the nature of the collaboration: It can be based purely on a contractual basis, considered a UP, or the collaboration can be designed as a commission relationship. However, if the parties choose the first-mentioned option, there is a risk that the collaboration will be perceived as a UP. It does not have to have started as such, but as the collaboration develops, it may become so close that a court would consider that a UP has been formed. I will, therefore concentrate on the two latter options.

Such an agreement should contain, among other things, rules on responsibility for transport costs, marketing costs, capital costs, and overhead costs. The responsibility for damages, the responsibility for shortages or delays in deliveries should be regulated, and the responsibility for debts when the UP is liquidated. Suppose the parties wish to deviate from the principle in the Companies Act that the profit in simple companies must be distributed according to the main figure with 50% to each party. In that case, this must also be regulated in the agreement.

The issue of ownership should also be regulated in the agreement. Regarding the location of ownership, the agreement does not matter because the question of who owns it is decided

on grounds reserved to the court. That is, the court that determines who owns which property based on the so-called right of rem. However, such a clause gives a court guidance on how the parties thought when they entered the collaboration.

Should the parties design the agreement as a commission agreement, there is a ready-made set of regulations in the form of the Commission Act (2009:865) and agreement templates that can be used as a basis for negotiations between the parties. Since commission is an accepted contract form, tax and accounting laws should also regulate how assets, liabilities, income, expenses, etc., should be treated.

f. The relationship between CIRK-L and Textilia when Textilia provides an all-in-one solution

CIRK-L sells the products to Textilia, which owns the product and then sells its function, fixes the products and replaces the parts that need to be replaced. In this case, CIRK-L will sell the products to Textilia based on the Sales Act. Also, in this case, the collaboration may, depending on the circumstances, be considered so close that a corporate relationship arises. (On the consequences of this, see The relationship between CIRK-L and Textilia when CIRK-L provides all-in-one).

Regardless of whether CIRK-L or Textilia provide the all-in-one, the assessment depends greatly on how the collaboration will take shape. The storage costs will probably fall on both companies, but how will marketing, capital, and overhead costs be distributed? Before an agreement exists, this is difficult to assess.

g) The relationship between CIRK-L and Textilia when they are part of a commissioned relationship

A third variant is that CIRK-L and Textilia are part of a commission relationship, where CIRK-L is the principal, and Textilia is the commissioner. The agreement means that CIRK-L retains ownership of the workwear, while Textilia is the party that, on CIRK-L's behalf, has contact with the customers and sells their functionality.

The relationship may have accounting law and tax law effects. According to accounting law, in such a case, CIRK-L, the owner of the workwear would have to report them as an asset on its balance sheet and, consequently, also write them off. Regarding tax law, the relationship should be classified as follows: "If the intermediary instead agrees to his own name, there is a special rule in ch. 6. § 7 law on value added tax. He is then considered to have sold the service himself. The service will be regarded as provided first from the principal to the intermediary and then from the intermediary to the function buyer.

To conclude this part of the investigation, the problems concerning the all-in-one solution for workwear are not so much related to writing a contract or legal ownership. The issues are concerned with more general legal regulations relating to tax, accounting and reporting,

and how cooperation between different companies involved in the business model will be assessed.

5.4. Provider perspective

To get a broader understanding of what circular business models are successfully applied in the workwear industry and what drives or hinders companies from implementing them, a set of 20 interviews with 14 different companies, 2 of which are partners, was carried out. Companies C8-C14 are new ventures and thus small.

The interviews aimed at understanding what kind of circular initiatives are undertaken and pursued. All the companies stated that they try to reduce environmental impacts connected to their products and services. This includes more efficient use of resources. In Table 8, the various companies are presented.

Code	Description	Circular aspects of their business model
C1	Provider of all-in-one and washing services	Offer all-in-one as main business offering and have pilot projects.
C2	Provider of all-in-one and washing services	Offer all-in-one as main business offering and have pilot projects.
C3	Own brand and retailer	Prolong the lifespan through material choice and design.
C4	Own brand and retailer	Prolong the lifespan through material choice and design. Also offer some small-scale all-in-one.
C5	Own brand and retailer	Prolong the lifespan through material choice and design.
C6	Own brand and retailer	Prolong the lifespan through material choice and design. Also initiating textile recycling.
C7	Buyer consultant	Encourage sufficiency by advising on materials and other procurement choices.
C8	Retailer	Encourage sufficiency by advising on correct clothing size. Currently setting up a repair process. Also offer some small-scale all-in-one.
C9	Retailer	Provide small scale washing services and encourage sufficiency.
C10	Repairer	Take used workwear and repair them for a fee.
C11	Material Consultant	Offer consultancy but the main vision is to commercialise a technology for separating textile fibre.
C12	Repurposing	Create new workwear from textile waste e.g., towels.
C13	Own brand and retailer	Modular design of workwear to enable washing. Prolong the lifespan through material choice and design. Setting up all-in-one solution.

Table 6 Circular initiatives of companies operating in the Swedish workwear industry

For the companies operating upstream that have their own brands, a key common goal is to prolong the life of the workwear and contribute to a circular economy by making appropriate material choices and or design choices so that the workwear lasts longer. However, durability is not currently measured and thus is subjective. Durability also does not necessarily affect the consumption behaviour of the users. Although it is a simple form of a circular business model, it is expected to have some positive impacts. For example, Company 8 says that they help customers choose the correct size of clothing because the wrong size increases wear and thus reduces the lifespan of workwear. They showed the researchers data to back up this claim. However, there is a lack of published data to add nuance to this claim. Two companies, an SME and a new venture, even work as consultancies to try to help buyers and public procurers make appropriate choices. Therefore, this is a successful business proposition. Companies that have their own brands also work with their upstream suppliers, when possible, to improve efficiency and waste of all types of materials in production processes.

Companies 1 and 2 are large firms and offer all-in-one solutions that include rental, repair and washing services or washing and repair services for hotels, restaurants, healthcare providers, industries etc. According to the interviewees, this business model is profitable in some customer segments of the workwear industry, e.g., hospitals or hotels because i) there they can achieve economies of scale due to large volumes, ii) workers do not need their “own” workwear and thus items are shared between workers, and iii) that the delivery and pick up spot does not change. Additionally, they informed us that they have performed environmental assessments of some customer segments that demonstrate that this business model leads to environmental impact reductions compared to sales. However, there is a lack of published research to add nuance to this claim. Companies 3 and 5 also mentioned that they support the all-in-one solutions provided by companies like Companies 1 and 2. They say that they participate indirectly in a circular business model, i.e., they provide durable clothing that withstands many washes. This type of supporting role is not often discussed in circular business model literature. However, the importance of business ecosystems for achieving circularity has recently been highlighted (Kanda et al., 2021). In Table 8, one can observe that several companies diversify their business model by offering small-scale all-in-one solutions but do not intend to transform their business model.

Concerning repair, it is almost always included as part of a washing service or all-in-one contract and in this form, it is economically viable. However, Company 10, which offers this as their primary business and Companies C8 and C13, which have tried to set up repair services, report that it is hard to make it economically viable. They have mentioned a lack

of demand because workers are not in the habit of repairing their workwear and prefer to have new, especially since the cost of buying new burdens their employer. Company 8 mentioned that transport costs are high and that the postal services are organised around a company initiating a transaction and the customer returning it, not the other way round, which happens in a repair scenario. Moreover, labour costs for repair are high, and skilled workers are lacking. The cost of work trousers is small compared to labour and transport costs for repair, and thus is not attractive to the customer. Modular workwear that allows for sending spare parts that the user replaces could be a type of economically viable repair, but it is limited to specific parts of the workwear.

Most of the larger companies have initiated several successful pilot projects on repurposing and material recycling, but these have not led to permanent business model changes in this direction. As we understand from the interviews, the financial incentive is not large enough for them to initiate it permanently, and extended producer responsibility is not yet a requirement. There are also other barriers, such as a lack of recycling technology and skills and even difficulties with recycling some materials. Many companies are looking into repurposing and recycling more intently, such as Company 6, since the new EU Strategy for sustainable and circular textiles has been introduced (European Commission, 2022), that will place new requirements on them. Many of these pilot projects are done in collaboration with new ventures; for example, Company 6 is redesigning a chef's jacket to become a skirt.

What can be observed is that large retailers and their own-brand manufacturers implement pilot projects and small-scale diversification of their existing business model. These companies have their existing partnerships, expertise, logistics or digital systems, etc., which are obstacles to implementing more extensive changes to their business model. Another issue is that the profit margins in the industry are relatively small because many large customers have considerable purchasing power and push prices down. Price has also been a critical focus for the public procurers that form a large part of the market. Therefore, there isn't much room to experiment.

On the other hand, new ventures have a blank canvas, and can implement more ambitious initiatives, but they all struggle with their profitability.

5.5. Customer perspective

To understand the customer perspective, several different approaches were taken. Three key approaches are:

- A set of 25 interviews with workers or workwear buyers in randomly selected construction companies to reveal workwear consumption patterns.

- An in-depth workshop with five technicians at the electricians' company Obtech in Linköping. The extent of the usage of the work trousers spanned from several weeks to over one year.
- 60 customers of CIRK-L workwear answered a digital survey.

5.5.1. Workers in SMEs

This section presents the results from the first set of interviews with the construction companies. The interviewees provided various reasons for discarding workwear and explained their attitude towards circular strategies that can prolong workwear's lifetime.

Workwear management

In Sweden in several work environments either the state or collective agreements assign employers the responsibility of providing workers with their workwear. The building and construction industry is such work environmental. Workwear in Sweden can be tax deductible for the employer. To be eligible it has to bear the employer's name or logo, so it noticeably differs from everyday clothes and is only used when working. The management of workwear varies from one company to another. Some companies offer their employees unlimited access to new clothing, while others have a per employee or overall budget that limits purchases. According to most interviewees, their employers consider the cost of providing workwear low. On average, the interviewed workers have 2-3 pairs of work trousers available at any time.

Discarding workwear

The number of discarded work trousers per year can be seen in Figure 5. There are two main reasons that work trousers are thrown away. The first is due to wear and tear and other forms of damage. The most common types of damage are abrasions in the crotch or holes in the knees, but tears can also come from loose screws and other sharp objects, seams can come apart and zippers break. The second is the loss of aesthetic value and comfort due to staining, misshaping or fraying and even changes in the wearers' style preferences.

The frequency of discarding clothes in the workwear industry has been influenced by two conflicting factors in recent years. On one hand, the design of clothing over the past 15 years has contributed to extending its lifespan. This includes the incorporation of stretch fabrics, improved fitting, the addition of crotch gussets (diamond-shaped fabric pieces sewn into the crotch area), enhanced knee reinforcement, and the use of easier-to-maintain materials, all contributing to increasing the durability and comfort of workwear.

On the other hand, there is a growing emphasis on appearance, driven by both construction companies and individuals. Appearance plays a vital role in a company's branding and has become a matter of personal image at the individual level. Consequently, the demand for new and fresh-looking garments has risen. This increased emphasis on appearance has also

led people to dispose of their clothing more readily over minor issues like stains. However, this mindset isn't universal, as several interviewees noted that workwear is utilized until it is completely worn out. And increased focus on appearance somewhat balanced by people becoming more attentive to taking care of their clothing. The decision to discard clothes is left to the individuals, who determine whether to sort them into textile recycling bins or dispose of them as household waste.



Figure 7: Number of discarded work trousers per year

Washing workwear

Out of the 24 interviewees who provided data on their washing habits interviewees, 17 and 4 report washing their workwear at home or on the company's premises respectively. 3 claimed that they never or very rarely wash their work workwear although they are supposed to do it at home. Expenses for washing of clothes are generally paid by the worker. Although in some few instances the company may give the employee a small compensation.

Washing at home is not generally seen as a problem. Although some interviewees said that it is not easy to remove some stains and two interviewees reported damaging their washing machines due to nails or screws in the pockets of their work clothes. The transitioning to more modern garments in workwear has made it easier and more efficient to wash workwear.

The frequency of washing clothes differs both between types of clothing and between users. T-shirts are mostly washed after every use. However, as seen In Figure 8, among the surveyed participants, 20% of workers wash their trousers once a week, 20% every other week, 20% once a month or longer, 12% somewhat unexpectedly never wash their trousers, and 28% are unsure how often they do.

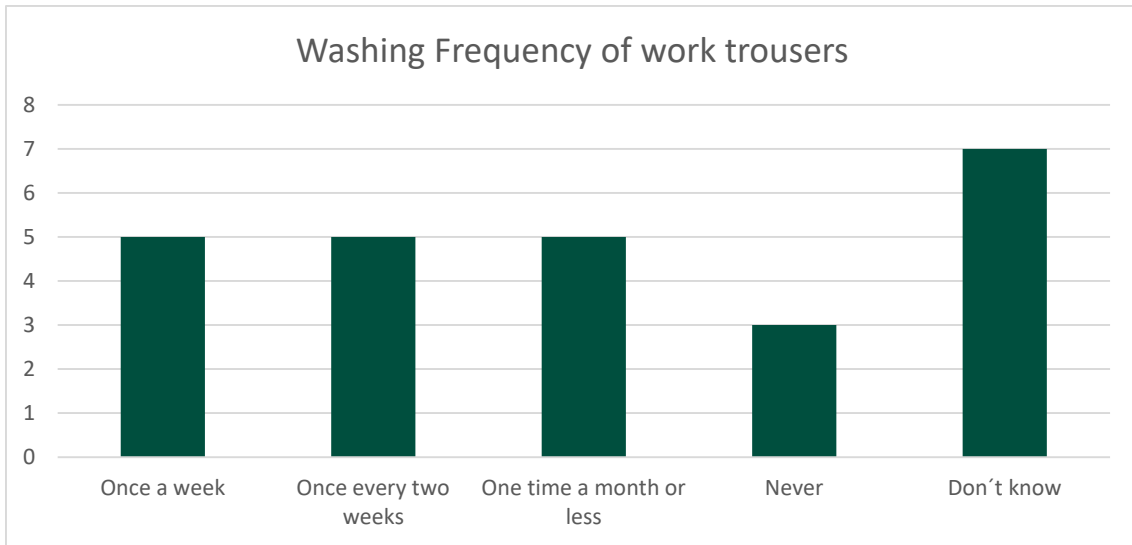


Figure 8: Graph of how often the builders wash their work trousers.

Concerning adopting washing services or alternative business models, most interviewees were from small to medium-sized construction companies and often changed construction sites and moved between different projects. According to them, implementing a washing solution would be logistically complex. Additionally, many said that they were not willing to share clothing because construction workers typically require workwear tailored to their specific measurements in length, width, and job-specific needs. Therefore, the concept of a shared workwear solution similar to the ones implemented in hospitals is generally not considered applicable.

Repair and other circular strategies

None of the interviewees repair their workwear. Many of them state that repairing their clothing is not a worthwhile use of their time or effort. Both mending clothes themselves and utilizing repair services, such as tailor or a seamstress, are perceived as time-consuming tasks. This is because they need to find an appropriate person, drive there to leave the garment, drive there to pick the garment up again, pay for the repair and reclaim the money from the employer. They report that there is a lack of well-defined and user-friendly procedures for utilizing repair services. Instead, they opt to discard their workwear when it becomes damaged. Furthermore, there is a dearth of incentives, as it is the company's responsibility to provide new workwear, and individuals gain no personal benefit from repairing their garments.

Since company logos are present on the clothing, workwear cannot be repurposed by others. However, there is potential for the same clothing to be reused within the company, particularly for seasonal staff, provided that they are the correct size, suitable for the intended purpose, and in sufficiently good condition.

5.5.2. CIRK-L workwear users

This section focuses on the unique features offered in the CIRK-L Workwear concept and how these features have affected the behaviours of the construction workers who have used them.

The project design was based on several hypotheses concerning how CIRK-L's unique features would enable more efficient use of resources and create new possibilities for circular models within workwear. To test these hypotheses, user tests according to work package three were done with two companies during the project. To collect input from the trials, a workshop was facilitated with Obtech, and an in-depth interview is planned with JL Bygg. Furthermore, to get more quantitative data, a survey among CIRK-L's existing customers was conducted with 60 respondents.

Hypothesis 1: Detachable tool pockets enable easier washing, reduce damage and increase flexibility and longevity

With CIRK-L's work trousers, it is possible to detach the tool pockets from the trousers quickly. Our first hypothesis was that this feature should enable easier washing as the workers wouldn't have to empty all the pockets from tools, nails, screws, gravel, and so on before washing their trousers. They just detach the tool pockets before washing and then attach again after washing. Consequently, it was also anticipated that this would result in the trousers being washed more frequently.

Based on the results from the survey, we have generated substantial evidence in support of this hypothesis.

1. 90% consider it easier to wash their work trousers with detachable pockets
2. 61% wash their work trousers more often

This is a very positive finding as according to the same survey, the most common reason for discarding a pair of work trousers is that they have become stained and dirty. Furthermore, contamination of the textile fibres will decrease their lifespan and work trousers that are washed more often will likely also last longer.

Additionally, technicians at Obtech using the CIRK-L reiterate the benefits indicated in the survey and go even further. Critical design benefits pointed out were:

Tools-caused damage and flexibility

- The technicians reported less damage to vehicle seats and hand brakes were incurred because the detachable pockets were removed when entering the vehicle.

- When not needed, the respondents reported leaving the detachable pockets in the car, ensuring a professional look when discussing with potential customers.
- Furthermore, the respondents mentioned having several pockets for their most frequent tasks, so instead of exchanging individual tools, they switch out the entire pocket and ensure they have everything they need for a given task.

Washing and longevity

- None of the respondents forgot to take off the pockets before washing.
- Respondents mentioned washing more frequently than regular work trousers and explicitly pointed out increased longevity: “I think I washed much more frequently. When they get dirty, you just throw them into the washing machine. So you treat them more like regular trousers. With other work trousers, some people wear them until they can stand by themselves and then toss them out.” Service Technician
- The detachable pockets on the trousers led to much less sawdust, drilling dust, and dirt making their way into the trousers and, thus, the washer. According to one technician, this led to less dirt in the washer and dryer, resulting in less maintenance and wear on these machines.

Additionally, the practitioners identified potential opportunities for design improvements:

- The technicians would have appreciated a more robust locking mechanism on the pockets because if heavily loaded, they do not stay in place but move around the hip. This did not affect longevity.

Hypothesis 2: Detachable lower legs make it possible to replace worn-out sections with spare parts

With CIRK-L’s work trousers, it is possible to unzip the lower legs of the trousers. The lower leg part consists of the knee section and the calf section. The second hypothesis was that detachable lower legs would enable offering spare parts only to replace the lower legs (e.g. for when the knee panel was worn out), which is the second most common reason for discarding a pair of work trousers according to this survey.

Based on the results from the survey, we have generated substantial evidence in support of this hypothesis:

- 90% would buy new lower legs if the knee panel was worn out or got broken.
- 10% answered that the complete trousers would probably need replacing when the knee panels have been worn out. However, with our concept, we anticipate this wouldn’t be the case. Our trousers are easier to look after and launder (due to the detachable pockets), so we expect them to outlast the detachable lower legs.

This sentiment was shared by the technicians at Obtech, who trialled the trousers for an extended period. Although none of the trousers in the trial had developed any failures, users appreciated the possibility of exchanging the parts with the most wear and tear, particularly the knee area. Only replacing the lower legs will save resources as the lower legs contain less material and require less labour compared to the trousers' upper section. The exchange of only the lower legs will most likely lower the environmental impact and come at a lower cost for the user because as seen in the LCA, production is the main cause of environmental impacts across all scenarios. Another benefit of the detachable lower legs is that when the shorts are worn out or broken, the lower legs can be reused on a new pair of shorts or as spare parts if the user decides to buy new trousers.

In addition to praise for the performance of the trousers, the practitioners at Obtech weighed in with additional opportunities for design improvements:

- An improvement opportunity all workshop participants supported was having the knee area as a separate, leading to a two-section zip-off. The benefits expected by the users were two. Additional reduction of material used over the life of the trousers, as the part with the most wear can be exchanged separately. Extra comfort through the ability to zip off just the lower part, leading to 7/8 trouser legs.
- Two of the respondents also mentioned that they would need short-sized trousers. According to them, this could be solved by offering different lengths for the zip-off trousers without needing differently sized trousers.
- Currently, the zippers used in CIRK-L trousers are of insufficient quality and can potentially negatively affect the life length of the trousers.

Hypothesis 3: Detachable lower legs enable dual-purpose wear

The possibility to unzip the lower legs in CIRK-L's modular trousers also enables the user to use the trousers as shorts, meaning the product has a dual purpose. Therefore, the user doesn't have to buy a pair of shorts and can quickly change from trousers to shorts if the temperature increases. The third hypothesis was that the dual functionality would remove the need to buy separate shorts.

Based on the results from the survey, we have generated solid evidence in support of this hypothesis:

- 95% of users would use our modular trousers as shorts instead of separate shorts.

The 5% who wouldn't use the dual functionality confirmed they do not wear shorts at work. Hence, 100% of the users that use shorts answered that they will use our modular trousers also as shorts, and there is no longer a need to buy shorts separately.

This four-season capability was utilised by all Obtech staff who were part of the extended trial. The practitioners said that the zip-off legs made the purchase and ownership of additional shorts obsolete – a sentiment shared by all staff members present.

The wear and tear of the shorts would increase if they were to be used as trousers and shorts. However, considering that the shorts are part of a modular system where both pockets and lower legs are exchangeable, it will be a more efficient use of resources especially if the dual function of the trousers would be compared with a regular pair of workwear shorts where the pockets are permanently attached to the shorts.

Summary of the results from CIRK-L users

The results from the survey strongly support the hypotheses the project was based on. The results were also further confirmed during the workshop with Obtech. Based on the findings, a modular product concept maximises each component's total lifetime and improves the possibilities for creating circular business models. Finally, there is also an indirect benefit of CIRK-L's modular product concept that was not explicitly investigated in the survey. The fact that modular trousers are built up by separate components makes it possible to separate the lifetime of one component from another, thereby making it possible to optimise the quality of each part individually. In traditional workwear, it is the weakest point determining the life of all components because the whole garment is usually discarded when one component breaks. The result is a short garment lifespan, which in turn means that investing in more advanced features or high-quality materials is not economically viable. The modular concept, therefore, allows CIRK-L (and the tradespeople) to invest in the highest quality to optimise and maximise the lifetime of each component.

5.5.3. Public procurers

In interviews and an in-depth questionnaire carried out at Lund municipality, insight was gathered into the needs, expectations, and opportunities of public entities procuring and using workwear. The respondents work for Lund municipality directly or its subsidiaries.

The respondents in the interviews and questionnaire reported a diverse picture of how workwear is currently used and handled at Lund municipality and the associated procurement challenges. Below, key findings are pointed out.

Procurement

Workwear plays a central role for organisations and the individuals wearing them. As a result, procurement processes are centrally focused on these aspects, according to a service administration manager.

All respondents point out that having new workwear is expected and required by the wearers, in contrast to a focus on workwear that “just works”. This is what the current procurement contracts are focused on, and as a result, repair services are not currently

considered in the procurement phase. There are instances of repairs being performed, as reported by the service administration manager. However, these are rare, and turnover times are very long.

Previous efforts to make workwear procurement and provision more efficient have led to substantial cost savings. The unit manager of mobility service reports that more restrictive policies to receive a new set of workwear have led to an up to 40% reduction in the volume of workwear provided over five years. According to the same respondent, however, this avenue has been exhausted, and further restrictions may lead to marginal benefits and could alienate workers. However, the prior changes mentioned are reported to have been well-received, as employees are aware of a need for increased efficiency in connection to both a sustainability focus and cost-cutting efforts.

Innovations regarding the clothes and their handling appear less well-received in the context of the investigated organisation. Users are keen on consistency in both the quality and handling of their workwear, which has led to challenges in the past, according to the service administration manager. As a result, approaches that included sharing workwear between individuals have not been explored in the context of the procurement process. However, the unit manager mobility service assumed a much higher degree of adaptability for their staff, saying: “Humans are quite adaptable, and we get used to most changes quickly if we dare to try. I guess the fear of trying, not the change itself, is holding us back.”

The recent focus on cost-cutting in the context of workwear has led to challenges: As a contract was established with a workwear supplier for the entire range of workwear needed (including jackets, trousers, shoes, shell jackets, shell trousers, T-Shirts, etc.), some items turned out to be of inferior quality. The use rate of some outerwear (trousers, jackets, and shoes) skyrocketed to three times the usual rate at the start of a new contract period, meaning that these items only lasted one-third as long as those supplied during the previous contract duration. As the procurers pay for every item, in contrast to, e.g., paying per user and year, this has led to massive cost increases despite the lower price of the individual garments, according to the unit manager mobility service.

Design and use phase

According to all respondents, safety is the primary factor determining the use phase of workwear where outerwear is concerned. This materialises, e.g., in the need to maintain clean and visible reflective patches. Even with outerwear in otherwise perfect condition, according to the unit manager of mobility service, defects or permanent blemishes on these patches will lead to immediate decommissioning.

All respondents remarked an aversion to modular workwear. The unit manager mobility services points out that, save for defects on safety-critical parts, garments are worn until they are spent in their entirety, which the respondent considers an argument against

modular clothing. Fit is also a critical issue, as workers with different builds have highly varying needs for clothing, which currently available products cannot always meet.

Currently, most staff wash their workwear at home. Individuals working at Lunds municipality sewage service are an exception, as their outerwear must be centrally and professionally cleaned, as the buyer municipal infrastructure company pointed out. In the questionnaire, nearly all respondents made clear not to be open to sharing workwear, one going as far as stating: “Because it’s [expletive] disgusting!” as the reason.

Circular opportunities

Several issues concerning both the workwear themselves, as well as their handling and use throughout the lifecycle, were pointed out or reflected upon by respondents.

- Digital try-on and fit testing beforehand can ensure a smooth workwear pickup process at the beginning of an employment.
- Central washing may increase legitimacy for a more integrated approach to providing and handling workwear.
- For more integrated approaches, including washing, repairs, and exchanges, respondents mentioned scale and central pickup and delivery to be critical.
- Repair was seen as a further possible steppingstone towards a more integrated approach to handling workwear. Similarly, user convenience was pointed out as the decisive factor in ensuring its adoption.

6. Circular business models

Following Potting et al.'s (2017) strategies, the preferable approach would be to *refuse* the production and purchase of workwear. This is not an option as workwear provides several critical functions. The vital aspects mentioned by respondents in interviews, workshops and questionnaires in this project are safety, protection, company identification and representation, comfort, freedom of movement, isolation, and ventilation. Thus, instead of focusing on eliminating workwear, the focus lies on identifying approaches towards fulfilling the functions of workwear in a way that leads to reduced resource consumption. In this section, we provide an overview of possible business models for workwear that can achieve that, based on combining the results from all the perspectives: environmental, economic, legal, provider and customer. The business models are grouped into four overarching categories:

1. business models focusing on durability,
2. business models focusing on more efficient use,
3. business models focusing on repair,
4. business models focusing on reuse and repurposing.

6.1. Business models focusing on durability

6.1.1. Design for durability

Bocken et al. (2016) refer to the business models described here as classic long life. It is a variant of the linear business model or the base case. The customer takes over the ownership of the product, but the product is designed to be durable. According to the interviews with the builders, damage is the primary reason for replacing work trousers. They also mentioned that design for durability, e.g., stretch fabrics, and crotch gussets, has improved the longevity of clothes over the last 15 years and they appreciate these changes. From a provider perspective, all retailers said that they design for durability in terms of material choices and design features of the clothes. This does lead to additional costs, which are reflected in the price of the garments. We can, therefore, conclude that it is a viable business model economically. Two companies mentioned that there was room for further improvements. This business model doesn't differ from the base case from a legal perspective. From an environmental perspective, the results show that reducing the number of work trousers per functional unit is key to reducing environmental impacts.

There are some considerations regarding durability. The first is that safety is paramount, and durability should not compromise safety and protection. Also, it should ideally not come

at a cost to company identification, representation, comfort, freedom of movement, isolation, and ventilation.

The second is that there are limits to durability. At some point in time, workwear will be damaged or worn out. Therefore, this business model should be combined with other business models to move to a truly circular economy. This is exemplified by the fact that although “business models focusing on durability” are commonplace in the Swedish workwear industry, the workwear industry is still unsustainable and not circular. Another reason for this is linked to the third consideration, which is the behaviour of the users, i.e., workwear may be discarded for reasons other than they have lost their functional properties as emphasized in the survey. For example, the service administration manager at Lund municipality mentioned that it was a challenge to identify the *right* time to discard workwear. Too early changes would be wasteful, while late changes could inhibit workplace safety and a representative staff look.

Additionally, the service administration manager said that workers expect to be supplied with new workwear at a certain rate. This was also reflected in the interviews with the builders in SMEs, who noted that some individuals are concerned about their appearance and thus expect a certain rate of change, with one interviewee saying: “*Some people change clothes just because they are done with a construction project*”. However, this attitude did not reflect the majority of workers or the experience of a unit manager mobility service at Lunds municipality. We conclude that design for durability should also be linked to efforts to change behaviour. Moreover, if these are early signs of fast fashion tendencies, policymakers should try to nip them in the bud by formulating strategies to address them.

The conclusion is that this business model can be and is successfully brought to the market, but some considerations should be taken into account.

6.2. Business models focusing on more efficient use

Efficiency in use measures cover what Potting et al. (2017) refer to as *rethink* and *reduce*. *Rethink* means using workwear more intensively, e.g., through sharing. *Reduce* is about increasing efficiency during the manufacturing and use phases. Many companies reported implementing *reduce* measures. For example, the own brand companies and wash services companies stated clearly that they implement ambitious efficiency measures in clothes production, transport, washing, etc. In Lund municipality, more restrictive policies on workwear distribution have led to reductions in per-person expenditure of up to 40% over five years. These measures, however, do not constitute a business model. They are internal efficiency measures and thus are not further discussed here. Sharing between workers from different companies is also impossible because workwear bears the company logo and therefore, it is not further discussed here. The company logo has to be sewn on due to

company branding and tax regulations, i.e., for workwear to be tax deductible, it must be distinguishable from private clothing.

Three business models focusing on more efficient use were identified. Two are all slight variants of the linear business model, where the customer takes over the ownership of the product. Still, in one case, the product is designed for more efficient use; in the second, another company offers after-sales washing and repair services. The third is similar to send but the company offering after-sales washing and repair services also rents out the clothes.

6.2.1. Design for more efficient use

Design for more efficient use is the current offering by CIRK-L. According to the survey, detachable tool pockets, a key feature, enable more straightforward and frequent washing. Some interviewees added that more frequent washing increased the lifespan of their work trousers. In the interviews with workers in SMEs, 12% reported never washing their clothes. Although, this business model was not explicitly explored from an environmental perspective, production is found to have a much higher impact compared to washing and thus any effort to prolong the lifespan is almost definitely going to improve environmental performance. From a legal perspective, it doesn't differ from the base case. From an economic perspective, the only difference is that the detachable tool pockets are slightly more expensive than normal ones. Still, there is a willingness to pay for this feature since it delivers several types of customer value, as described in Section 5.5.2. Therefore, there is a market for this business model.

6.2.2. Washing service

The second business model, which can facilitate more efficient use, is washing services. After buying the workwear, the customer procures a wash service contract, leading to more resource-efficient and frequent washing and, thus, longevity. This type of service is a precondition for sharing workwear within a company. This service includes collecting dirty clothes from a pickup spot at predetermined intervals while dropping off clean ones. These are then taken to the central facility to be washed. Simple repairs are often included in such contracts. This business model was considered to have the best environmental performance out of the four compared scenarios, i.e., "linear", "repair", "washing services", and "all-in-one". From a legal perspective, contracts must be carefully formulated, but nothing prohibitive to this business model was identified.

This business model, together with "all-in-one," is successfully brought to the market in several workwear market segments. It is the primary business model for one of the project partners. However, based on the economic analysis, it is not found to be an economically viable option for small to medium-sized building or construction companies. There are four main reasons for this. Firstly, economies of scale cannot be achieved with small companies. Secondly, logistics costs increase because employees change building sites frequently.

Thirdly, washing services often go hand in hand with intercompany sharing of clothing, i.e., a worker gets a clean t-shirt to wear that is not their personal t-shirt. Most employees in building companies said they need to get their own clothes back. Having “personal” clothes in such a system requires adding digital functionality to the clothes and having more spares, which drives up the cost. Lastly and most importantly, it is an expensive solution for the customer. 68% of the interviewees currently wash their clothes at home, thus, bearing the costs of washing and transporting the clothes. Washing services would essentially transfer a cost from a user or employee to the employer, which the employer has little incentive to do. Therefore, this is not a viable business model for this customer segment. At the start of the project, a washing services or all-in-one solution trial had been planned, but this was abandoned after prolonged efforts to set it up because it didn’t make financial or even practical sense to the customers. Instead, a trial of the work trousers was carried out to understand the effect of the design features.

A solution to these challenges is to try to reduce the costs and identify the value opportunities. Several have been identified in the previous sections. For example, interviewees argued that they need to have their “own” clothes returned to them because they are specific to their type of work and need to be the right size for safety and comfort reasons. In contrast, others opposed the idea: *“Disgusting to exchange bodily fluids. Even if it is washed.”*. However, other responses to the question of sharing workwear were also elicited. One person suggested that people are adaptable and have gotten used to prior workwear changes quickly, so the same may be true here, and another said, *“If it’s good enough for people working in hospitals, why not for us?”*. Also, an interviewee mentioned that public procurement is becoming more and more open to subscription-based services. Value can also be derived from a professional look. Individuals use garments with different intensities and varying points of wear. Sharing may serve to spread out this wear, in turn, help the workwear last longer. Another solution is changes to regulations or to collective agreements, if this becomes the employers’ responsibility then the economic incentives are less important.

6.2.3. All-in-one solution

All-in-one solutions integrate the rental of workwear, washing, and repair. The company offering this solution can be either the producer or the company providing washing services. In principle, there are two all-in-one business models. The customer is charged for the rental and pays a sum for the washing, and the rental is integrated into the washing cost.

Many of the “washing services” findings described in 6.2.2 apply to the “all-in-one” business model. However, there are differences. Firstly, there are fewer environmental benefits, mainly due to the system’s need for backup clothes. From a legal perspective, it is more complicated to organise the relationships, and there are more possibilities for conflict to arise and a need for the involvement of lawyers. Many provisions are needed in the contracts. For example, the number of employees at the customer may change over time. If

the business model assumes that the washing should bring the profit, the agreement should contain a rule that says that the clothes that are stocked and not washed are also charged in some way or that washing frequency should not fall below a certain level. There should also be provisions for an increase in employment. Suggestions of what to include in the contracts can be found in the appendix 11.1. From an economic perspective, this is business model is also not economically viable for the reasons described in 6.2.2. However, the economic outlook is not identical because there are possibilities for the wash service providers or producers to benefit from economies of scale and extra information. However, because providers of all-in-one solutions “buy” a lot of risk, the cost can be expected to be higher. Moreover, customers may become more careless with the clothes, leading to extra costs.

The overarching finding is that this business model is not an interesting business proposal under the current circumstances for SMEs in construction, even though it can potentially deliver environmental benefits. It is, however, interesting in other workwear industry segments.

6.3. Business models focusing on repair

According to Potting et al’s (2017) strategies, three strategies are somewhat similar: repair, refurbish and remanufacture. *Repair* means using workwear with its original function by the same or another construction worker after its repair. *Refurbish* and *Remanufacture* mean restoring workwear to its original function by making large interventions or only using parts of it. Neither of these later two strategies were mentioned by any interviewee, probably because the properties of workwear do not allow for larger interventions beyond repair. This study examined two similar business models that focus on providing repair services. The first is sending out spare parts that the user can replace. This is enabled by CIRK-L’s design feature of the detachable knee pads. For simplicity, we call this “user repair” in this section. The second is that the user sends their work trousers to a repair shop that repairs them and then sends them back. For simplicity, we call this “tailor repair” in this section. For both repair business models, the ownership of the product is taken over by the customer, and repair is an after-sales purchasable service. Repairs are also part of the all-in-one solution, dealt with under a separate section.

The “tailor repair” was modelled in the LCA, and it performed better in all impact categories compared to the base case. This option is expected to be the more impactful of the two options, i.e., because transport is doubled. Therefore, we can say that “tailor repair” reduces environmental impacts compared to the status quo and “user repair” most likely does. Legal frameworks do not hinder either solution, although contracts will have to be amended. Suggestions of what to include in contracts can be found in the appendix. There is a potential for high demand for repair because, according to construction companies, physical defects to the product are the most common reason for discarding workwear. However, this

demand is almost non-existent. According to the interviewees at the building companies and the municipality, repair to workwear never happens. Some key reasons that are identified are presented below.

First, in all sets of interviews, interviewees said that they are not in the habit of repairing workwear and rarely do. Only some internal staff employed at Lund municipality repair workwear on a case-by-case basis, although this does not apply to outerwear. In a similar line, respondents postulate that workwear is only discarded once worn out, so they do not “see the need”. However, as stated by one interviewee, it is a matter of perception of what is entirely worn out and what constitutes a minor defect. This person went on to say that workwear is being discarded with minor defects, such as holes created by nails, which could be fixed. Therefore, user behaviour and habits are a key reason.

Second, many said that repairing their garments is not worth their time or effort due to opportunity costs. One electrician said that finding a tailor, packing and sending the goods or dropping them off and picking them up afterwards required about one hour of his time, which he equated to about SEK 1,500 - SEK 2,000 in lost revenue. It would be cheaper to buy new, he concluded. Here, we see a difference between the options “tailor repair” and “user repair”. The survey indicated that “user repair” seemed more feasible as long as formal and easy-to-use processes are set up. Similar findings came from people working at the municipality and construction companies. Some, however, such as the unit manager mobility service, were sceptical towards modular clothing that makes worn-out parts replaceable because they may have low acceptance for fear of failure.

Third, there is a lack of incentives as it is the employers’ job to provide new workwear, and users personally gain nothing by repairing it.

Fourth is the challenge of downtime in the case of “tailor repair”. For the time of the repair, workers need alternative clothing to wear. If there are insufficient backups, this might lead to an increase in items in rotation.

Fifth, the existing structures, such as postal services and billing apps, are organised around a company initiating a transaction and the customer returning it, not the other way round, which happens in a repair scenario. This is a significant barrier for companies wanting to provide “tailor repair”.

Sixth, derives from the economic analysis, namely that the cost of work trousers is small compared to labour and transport costs for repair. Therefore, “tailor repair” is not attractive to the customer. It is only marginally cheaper, so the customer decides to buy new. The provider also has meagre profit margins. Moreover, there is even a lack of skilled workers. These costs could be lowered by sending workwear in bulk for repair.

Providing incentives to employees to repair more was seen as key solution to increasing repair. Ideas provided by interviewees were (i) the employer leading by example, (ii) sewing on a *patch of honour* to your work trousers to show that you had had them repaired, (iii) lowering workers' buying allowance for new workwear (iv) having a well-organised and straightforward process for sending and receiving garments to be repaired and paying to make the repair more convenient. Companies in the workwear ecosystem, e.g., providing postal services and making apps, can also play a significant role in making this business model attractive. There is also the possibility for cost savings in the repair business model, which only comes with expertise. One company currently setting up such a system for workwear said that in the beginning: *"You learn and don't earn"*. Policy interventions could also level the playing field, e.g., incineration fees.

In conclusion, both "user repair" and "tailor repair" will reduce environmental impacts across most categories; however, many barriers to their implementation need to be addressed. The "user repair" seems the most promising, and similar design initiatives should be expanded. However, it is limited what types of damage "user repair" can solve. It is also essential to bear in mind that repair must not compromise workwear safety.

6.4. Business models focusing on reuse and repurposing

According to Potting et al. (2017), *reuse* means using discarded workwear by another worker without intervention to the clothes. Several companies offering reuse have popped up in the fashion industry. However, no such business opportunity was identified in the sectors of the workwear industry that were within the scope of this research. First, the consumption patterns show that most workwear is discarded when damaged; thus, reuse, as defined here, is impossible. Additionally, the Swedish tax agency states that for work wear to be tax deductible, it must bear the employer's name or logo so that it noticeably differs from private clothing. To make clothes usable by people outside the company, they should be re-designed so that the logo is removable, e.g., stitched on. Apart from these very practical barriers, an interviewee also presented a psychological reason by saying that *"...in healthcare and social care there are rarely good working hours and good pay, so if they were to get what we call clothes that have been given a second life, it's a bit like first you have to work hard and long, and then you don't even get new clothes."* This thinking also affects other business models presented here and has been touched upon in other sections. None of the fourteen companies in the Swedish workwear industry that were interviewed have implemented reuse business models or even pilot projects. This is not currently considered an implementable intervention.

According to Potting et al. (2017), *repurpose* means using discarded workwear or parts of discarded workwear in a new product with a new function. Another name for this which

was used by interviewees is upcycling. Of the fourteen companies in the Swedish workwear industry, two new ventures build their business model around upcycling, and three larger companies have initiated pilot projects around repurposing. This type of business model was not explored in detail because the project focuses on prolonging the workwear for its original purpose. Thus, repurposing is on the borderline of the project's scope. Regardless, some initial findings can be reported. The first is that both the new ventures struggle to make this business model economically viable. The companies implementing the pilot projects report similar challenges and thus have not moved from pilot to standard offering. One company said that if they get back enough workwear of the same type, it might be profitable because they can build economies of scale around it, making repurposing more lucrative in the workwear industry than in the fashion industry. The environmental and legal perspectives did not touch on this issue at all. Repurposing is at an early stage in the workwear industry, and support is needed to develop this solution's potential.

7. Conclusions, exploitation and next steps

Several design and business model interventions which could affect resource consumption connected to workwear in the construction industry and thus contribute to a more circular economy were explored. A key finding is that all the explored interventions, based on LCA findings, are likely to reduce environmental impacts in across all explored impact categories compared to a linear model. Moreover, no major legal barriers were identified, although some business models require careful contract formulation. The design interventions which enable a longer lifespan were all marketable since they are basically improved versions of the linear model. However, the interventions connected to washing and repair services were not “good business” either due to a lack of acceptance by the users or because they were not economically viable. There is potential to motivate some users and take actions to reduce costs, which might change these findings in the future.

Based on these outcomes, CIRK-L and the other project partners will continue to develop their products, services and business models. Project results have been disseminated in several forums, including 21 oral presentations. The project has also been added to IVA's annual 100 List, highlighting current research with the potential to create value through commercialisation, business and method development, or societal impact. Moreover, based on these findings, a new venture, Qfix, a digital platform that facilitates local repair of returned or faulty products, has been initiated, as has a follow-up project based on this company. This project includes Linköping University and several other new project partners and is described below.



Figure 9 Badge for making it on the IVA 100 list 2023

Next step - A digital service connecting local tailors to increase the number of repairs

During the initial interviews, it became clear that a potential repair service needs to be much more user-friendly and cost-efficient than what is currently offered. An idea developed during the project to create a platform that connects local tailors and seamstresses into one

user-friendly digital service, aiming to make repair services easier to find, transparent to purchase and more cost-efficient for a company to use. To evaluate the workers' attitudes toward today's repair services and potential future solution some questions were added to the survey sent to CIRK-L's existing customers. The survey confirmed the findings from several interviews. For example, only 50% would consider using a repair service today. However, 63% would be prepared to use a repair service if it was digitalised and more cost-efficient. The results seem promising and have been confirmed with users within other textile segments, such as fashion, outdoor and sports. Consequently, a new company has been founded to develop the service. This service could also be used to repair product claims within the warranty period locally.

8. Publication list

Academic publications

Kambanou, M.L., Gagnerud, K., Lindahl, M. (2023). Consumption patterns of construction workwear and circular strategies to prolong its lifetime. *Proceedings of 5th Product Lifetimes And The Environment (PLATE) Conference*. p 474-479

Engzell, J., Kambanou, M.L. (2023) Incumbents vs circular start-ups in the workwear industry: organisational and individual drivers and barriers to a circular economy, *International Small Business Journal* (in print)

Academic articles in preparation

Kambanou, M.L., Matschewsky, J., Carlsson, A., Lindahl, M. (2022). Five business models for the workwear industry (in preparation)

9. Project dissemination

The primary goal of the project dissemination strategy is to build awareness for actors within the workwear industry and promote interventions towards a circular economy. The primary recipients of the results are industry stakeholders, academics and the general public. The project team disseminated results and will continue to do so through the following channels:

Government agency presentations

19th April 2023, *Transport som möjliggörare för cirkulära affärsmodeller*, Trafikverket, Marianna Lena Kambanou

Industry presentations

4th October 2023, *Cirkulära arbetskläder inom bygg och industri*, Research2Business Summit, Kungl. Ingenjörsvetenskapsakademien (IVA), Marianna Lena Kambanou (*planned*)

1st June 2023, *Cirkulära affärsmodeller*, Tillsammans – VD Strategigrupp för hållbart företagande, ALMI Östergötland, Johannes Matschewsky

26th May 2023, *Presentation of Qfix – local repair of product claims*, Aster (Alliance for sustainable e-commerce), Christian Ahl

12th April 2023, *Presentation of Qfix – local repair of product claims*, Almi Skåne, Christian Ahl

17th November 2022, *Cirkulära arbetskläder inom bygg och industri*, Digital cirkulär mässa arbetskläder, Science park Borås, Marianna Lena Kambanou and Christian Ahl.

5th October 2022, CIRK-L Workwear presented at SKANSKA's "Green Week" in Malmö, Christian Ahl

30th May to 3rd July 2022, CIRK-L Workwear exhibited at H22 at Helsingborg in the GreenTech house, Christian Ahl

12th May 2022, *Cirkulära arbetskläder inom bygg och industri*, Re:Source Dagen 2022, Johannes Matschewsky

28th February 2022, CIRK-L Workwear presented at the webinar Klimatlöfte 9. Cirkulära arbetskläder at Västra Götalandsregionen

30th November 2021, *Draknästet cirkulära arbetskläder*, VD grupp Kunskapsbron, Almi Östergötland, Christian Ahl, Johannes Matschewsky and Marianna Kambanou

Academic conferences

30th May 2023, *Circular business models*, 19th Student Conference Management Science and Technology, Athens, Greece, Marianna Lena Kambanou

31st May 2023, *Consumption patterns of construction workwear and circular strategies to prolong its lifetime*, 5th Product Lifetimes And The Environment (PLATE) Conference, Helsinki, Finland, Marianna Lena Kambanou

Educational programmes

TKMJ53, Perspectives on energy and environmental systems, HT 2022 and HT2023, Marianna Lena Kambanou

TKMJ32, Integrated Product Service Engineering, HT2022 and HT 2023, Johannes Matschewsky

TKMJ46, Advanced Ecodesign, HT2022 and HT2023, Johannes Matschewsky

Guest lecture, Presentation of CIRK-L Workwear and Circular business models at IHM Business School, Christian Ahl

Guest lecture, Presentation of CIRK-L Workwear and Circular business models at EC Utbildning., Christian Ahl

Project websites

<https://liu.se/forskning/cirkulara-arbetsklader> This is hosted by Linköping University and provides key information about the project.

<https://www.iva.se/en/what-iva-does/awards/ivas-100-lista-eng/circular-workwear-in-construction-and-industry/> This is hosted by the Kungl. Ingenjörsvetenskapsakademien (IVA) in recognition of the project making into on to IVA's 100 List: current research with potential to create value.

LinkedIn

The project members have used their private LinkedIn accounts for dissemination of short easily digestible information and of the articles, webinar and conferences.

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11. Appendices

11.1. Suggested information to include in B2B contracts

In this section suggestions of what should be regulated in a B2B contracts for various types of business agreements are presented. The starting point is that the parties conclude the agreement in Sweden, have places of business in Sweden (see Act 1987:822 on international purchases) and that Swedish law applies to the agreement. Thus, the Swedish Sales Act is the applicable legal text.

A1. Purchase agreements

1. Parties
2. Objects - logos (removable or fixed)
3. Services linked to the agreement e.g. repair, washing (see A2 and A3).
4. Delivery
5. Delay
6. Fault in the product
7. Complaints and time limits for complaints
8. Cost for return
9. Warranties – area of use of the garment, period of the warranty
10. Price
11. Time for the conclusion of the agreement

A2. Purchase agreements plus repair

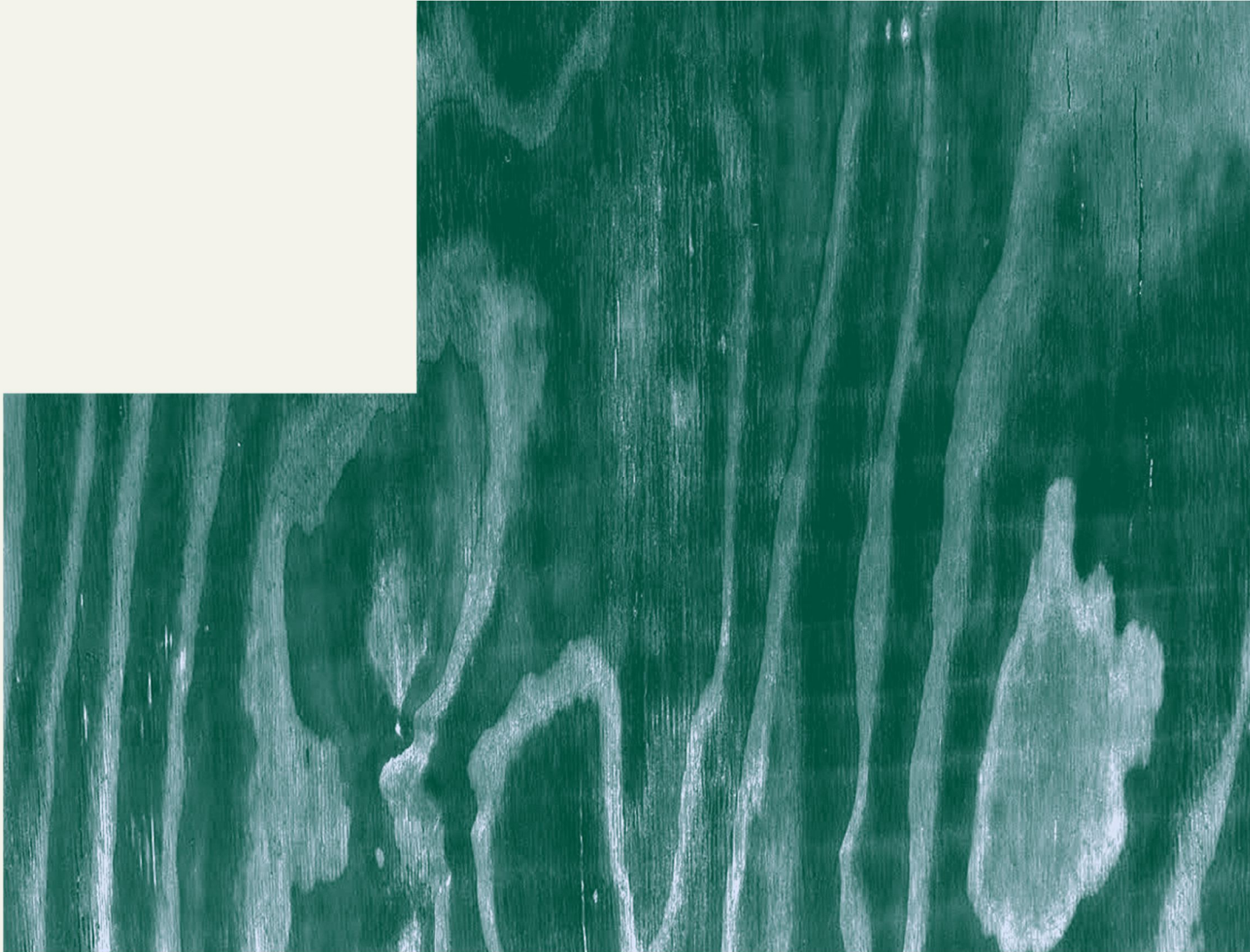
1. Parties - subcontractors.
2. Contract period.
3. Object repair of workwear. Since there may be different forms of repair services e.g. changing sleeves or legs based on modular design or "sewing repairs" for damage to parts that cannot be replaced as easily, these should be detailed.
4. Quality of repair. After repair, the garment must be usable in the same way as if it had been new, given that the wear and tear the garment has been subjected to is taken into account.

5. Contact between the parties and effect of missed contact. This concerns cost of repair not in relation to the cost of a new garment.
6. Cost of transport
7. Error in service
8. Time for repair. This point should be determined together with ordering the repair in the individual case.
9. Delay in service
10. Complaints and complaint period
11. Additional services along with purchase and repair for example
12. Early termination.
13. Right for the client to extend the agreement a certain amount of time.

A3. Right of use agreement

1. Parties. If subcontractors are allowed, this should be stated and they should be identified.
2. Brief background.
3. Contract period. It would preferably be 4 – 5 years, as the clothes are depreciated during that time.
4. Object – field of use
5. Condition of the item upon delivery
6. Ownership issues
7. Fault in the product
8. Time of delivery
9. Returns – cost for returns
10. Delay
11. Complaints and time limits for complaints
12. "Normal wear and tear" and subsequent action. The determination of what is normal and abnormal wear in the following point may have to be determined together with the customer. On the one hand, the customer wants to have an influence on how the agreement is designed, and on the other hand, the customer probably knows best the wear and tear his or her employees expose the clothes to.
13. "Abnormal wear and tear"

14. Damage or loss of items. The issue of wastage can be checked, for example, using a chip that is read in connection with washing. If a garment is not registered for 90 days, it is considered lost and the cost of the garment will be charged. If it is subsequently registered again, the customer is credited with the same amount.
15. Notification obligation between the parties in the event of events important to the agreement
16. Additional services, e.g. wash or repair (see A2 as well).
17. Early termination. Here the effects are primarily for the lessor.
18. Return and condition of goods at the end of the contract. This includes defining who must return and who bears the cost of the return and the expected residual value of the returned garments.
19. Amendment/addition to the agreement or possibilities to change the agreement. During such a long contract period, the number of employees may increase or decrease.
20. Right for the client to extend the agreement a certain amount of time.
21. Applicability of Swedish law



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