Analysis and optimization of secondhand flows

Final report 241008

CIRCULARHUB
twin transition

Co-funded by
the European Union

In collaboration with

VIRTUAL
manufacturing.

LINDEX

Summary

The work reported in this report has been carried out on behalf of the Circular Hub Twin Transition, which is funded by the European Regional Development Fund via the Swedish Agency for Economic and Regional Growth, VGR, the Borås region/Sjuhäradsförbundet, Region Halland and the Swedish Textile Research Foundation.

The assignment, which was carried out by Virtual Manufacturing AB, was to analyze and document a typical flow for second-hand sales of clothes and to identify and fix bottlenecks in this flow. In addition to describing the process for process development, the assignment included presenting proposals for efficient flows and capacity calculations as well as creating guiding principles and good examples for how companies can scale up the volumes of secondhand garments. The assignment was carried out with Lindex AB as a case study. Since 2020, Lindex has explored secondhand as a circular business model.

The purpose of the assignment and the report is to support companies in optimizing the handling of secondhand garments.

The report highlights four guiding principles for getting started with secondhand handling

- **A physically scalable solution** – In order to be able to adapt production to different volumes, the solution needs to be scalable without requiring a large investment.
- **Start with a low initial investment - Basically all companies can get started with second-hand** management of their sold clothes with only a low initial investment
- **Minimize handling –** Handling is what creates the highest costs – by minimizing handling, the costs of the products will be lower.
- **One-piece flow in as much of the process as possible -** Requires less floor space, reduces handling time, improves quality

The report describes the general process and the case study in 3 different steps:

- Documentation and analysis of the current situation
- Development of future scenarios
- Choice of future scenario

Disclaimer:
This report has been translated from Swedish. Some sections may contain text in Swedish or use Swedish notations.

Content

1. Introduction

1.1 Background

CircularHub Twin Transition
CircularHub is a regional platform with the aim of leading the transition to a circular economy. The new one, CircularHub Twin Transition, now also contributes to circular transition through Twin Transition, i.e. digital technology is used to support the green transition.

With the main focus on the textile and fashion industry, the platform supports companies, especially SMEs, in the transition through digital technology in circular processes. The expected result is new business models, increased use of digital technology in green processes and a strengthened second-hand industry.

Areas for exploration and support

- Expand understanding of how digital technologies can play a central role in the collection and analysis of data and how to create new business models through this.
- Provide support for achieving a more automated secondhand industry.
- Support companies in understanding bottlenecks in local production and second-hand and create automated processes for this with the goal of extending the life of products on a larger scale.
- Networking and collaboration with industry players and other innovation environments for new innovations in processes, production and product.

Our goal is to be an impact factor and actively support and drive the transition to a circular economy. We are primarily targeting small and medium-sized companies in western Sweden, but we also collaborate with large companies, municipalities, politicians and companies in other industries and regions. This is because the circular transition is a system shift that requires several actors to collaborate. West Sweden is already a leader when it comes to innovative, sustainable and circular projects and processes in textiles, fashion, interior design and furniture. Through our platform, we want to highlight projects and research environments that work with circular business models and increase knowledge about circular economy.

Our vision is to position West Sweden as a global partner and role model in circular economy for textiles, fashion, interior design and furniture, with a particular focus on small and medium-sized companies. In western Sweden, there is a large concentration of companies in textiles, fashion, interior design and furniture, as well as strong expertise in academia, institutes and business. This gives us the best possible conditions for promoting and supporting circular business models in textiles, fashion and furniture.

CircularHub is run by Science Park Borås and is funded by, among others, the European Regional Development Fund and Region Västra Götaland, but also the Borås Region/Sjuhäradsförbanet, Region Halland and the Swedish Textile Research Foundation. Our main focus is on working within the Västra Götaland region and in collaboration with Region Halland.

Virtual Manufacturing AB
Virtual Manufacturing is a Swedish company that specializes in modern production development, with a focus on helping companies achieve operational excellence. They offer a wide range of services, from industrial project management to automation, lean manufacturing, and digital solutions. By combining traditional production methods with state-of-the-art technology, they help companies streamline processes, improve productivity, and reduce costs.

The company's expertise spans multiple industries, including automotive, aerospace and defense, food, and energy, making them a versatile partner for many manufacturers. They emphasize innovation, customer satisfaction, and sustainable, long-term improvements in production environments. Virtual Manufacturing excels at offering both physical and virtual production development services, enabling customers to test and optimize processes before production starts

If you're looking for ways to improve production flows, reduce costs, and implement advanced automation or lean processes, Virtual Manufacturing may be the right partner for you. Their experience in various industries and their commitment to the customer's success make them a valuable partner.

Lindex AB
Lindex is an international fashion company with approximately 440 stores in 18 markets, as well as a strong online presence through both its own e-commerce and third-party partners. Lindex offers concepts in women's clothing, children's clothing, underwear and cosmetics. In 2020, Lindex started exploring secondhand as a circular business model and has since developed the collection and sale of secondhand children's clothing. Lindex was considered to be in a perfect phase to constitute a case study in the project.

1.2. Purpose

The assignment was to analyze and document a typical flow for second-hand sales of clothes and to identify and fix bottlenecks in this flow. This is to be able to support companies in optimizing the handling of secondhand garments. The assignment included presenting proposals for efficient flows and capacity calculations as well as creating guiding principles and good examples for how companies can scale up the volumes of secondhand garments.

2. Guiding principles

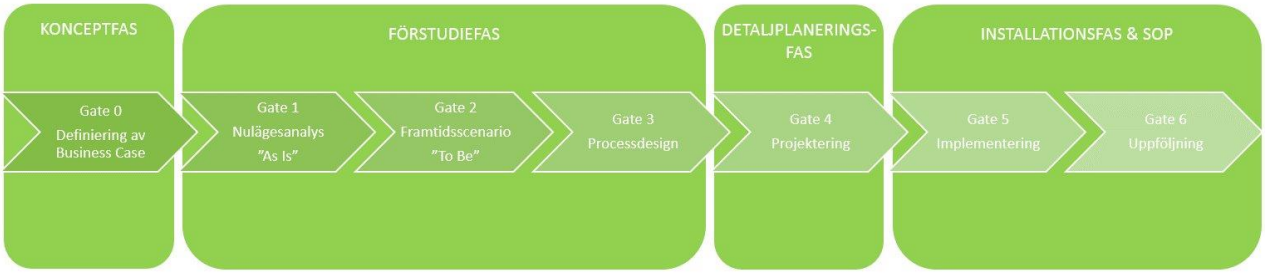
During this project, we have discussed what you as a company should consider when making decisions about your secondhand flow. It can be helpful to have a number of guiding principles. Below we present those that we consider to be most important.

- **A physically scalable solution** – In order to be able to adapt production to different volumes, the solution needs to be scalable without requiring a large investment. (https://www.business.com/articles/the-importance-of-scalable-business-models/)
- **Start with a low initial investment-** Basically all companies can get started with second-hand management of their sold clothes with only a low initial investment (https://fastercapital.com/topics/low-startup-costs.html#:~:text=lower%20initial%20investment%3A%20One%20of,equipment%2C%20inventory%2C%20and%20marketing.)
- **Minimize handling –** Handling is what creates the highest costs – by minimizing handling, the costs of the products will be lower. (https://blog.unex.com/how-to-reduce-work-in-progress-wip-manufacturing#:~:text=Reducing%20WIP%20is%20one%20of,performance%20of%20a%20team's%20production)
- **One-piece flow in as much of the process as possible** - Requires less floor space, reduces handling time, improves quality (https://blog.gembaacademy.com/2008/03/27/10-benefits-of-one-piece-flow/https://blog.gembaacademy.com/2008/03/27/10-benefits-of-one-piece-flow/)

3. General process

3.1 Documentation and analysis of the current situation

Generic process for developing production/management



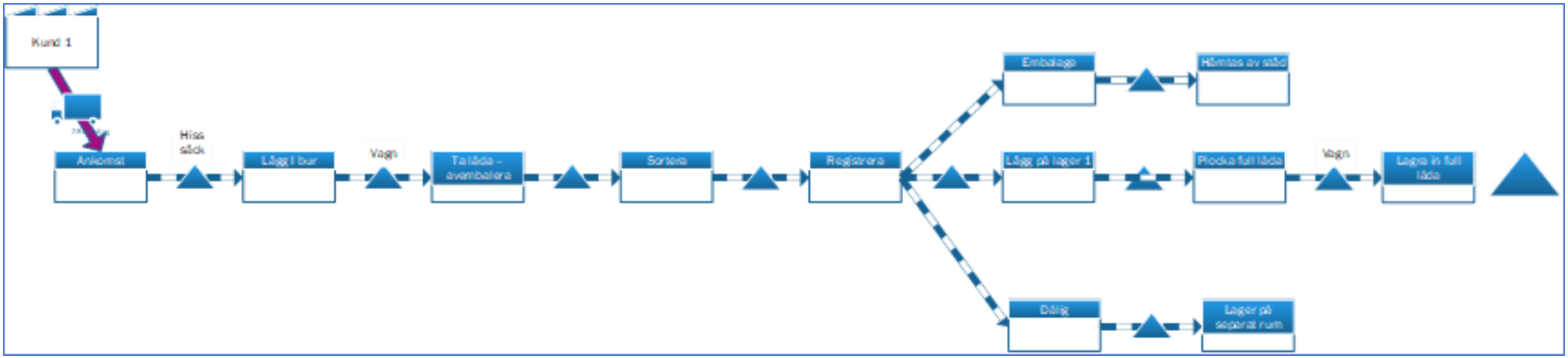
Boundaries

In this project, we have worked in the feasibility study phase for Gate 1 Current Situation Analysis and for Gate 2 Future Scenario, therefore only these parts of the process are described.

Current situation analysis

- Document the process today
- Perform value stream mapping (VSM https://www.lean.org/store/workbooks/creating-continuous-flow/)
- Video the process from start to finish
- Document what the premises look like – preferably by making a layout – the fastest way is to 3D scan (https://virtual.se/businessarea-pages/3d-scanning/)
- Review videos for what creates value in the process and what doesn't create value
- Compile how much time value is created per garment, how much time of handling is without value and how much time the garments wait in the process (read more about value creation)
- Show and go through the videos and your reflections on the process – this creates a good understanding broadly about what does not create value.

Description of a flow- The rectangles contain a process that is carried out, the triangles represent some form of storage.



2.2 Development of future scenarios

- Based on the current situation analysis
- Brainstorm and document ideas on how:
- Non-value-adding time can be removed
- The amount of products in work can be minimized
- How scaling can happen without a large initial investment
- What does the benchmark say, has anyone else created a similar process
- In the same product area?
- In any other product area?
- Create a way to visualize the new ideas
- 3D modeling – the entire surface/flow and 3D sketches of new equipment/station layout
- Videos on benchmark
- Cut your own films into one-piece management
- What will be new times? Lead times? Cutting times?
- Future Potential Capabilities

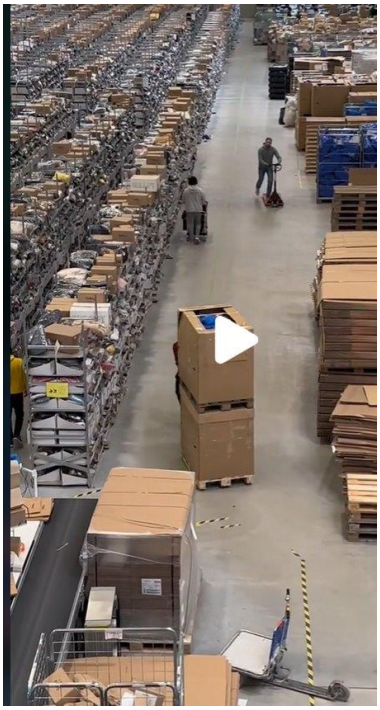
Future scenario idea bank
Create an idea bank for different solutions. See examples below;

- https://inimini.se/ https://inimini.se/
- https://acgpulse.com/business-areas/garment-handling-solutions-healthcare/ https://acgpulse.com//
- https://www.youtube.comsorting with RFID clothing (RFID)
- https://www.jensen-group.com/.html

Pictures above show solutions to store without folding.

Amazon https://www.youtube.com/watch?v=NZTVgExZqoI

Sellpy https://www.tiktok.com/@wearesellpy/
https://www.tiktok.com/@wearesellpy/video/7285790659745746208video/7285790659745746208



2.3 Choice of future scenario

- Based on brainstormed ideas
- Scale down to a maximum of 3 suggestions that feel reasonable

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- Present and discuss the different future scenarios and decide on a reasonable path

3. Case study Lindex

Delimitations
Lindex, clothes are sorted into what can be sold directly and what needs further processes before they can be reused or recycled. In this project, we have handled the sorting of all garments but not the handling of those that need extra processes. However, we can apply the same principles if this is to be developed, for example a fragrant process could be built up according to the same principles or a process where you repair clothes is also possible to create according to the same principles.

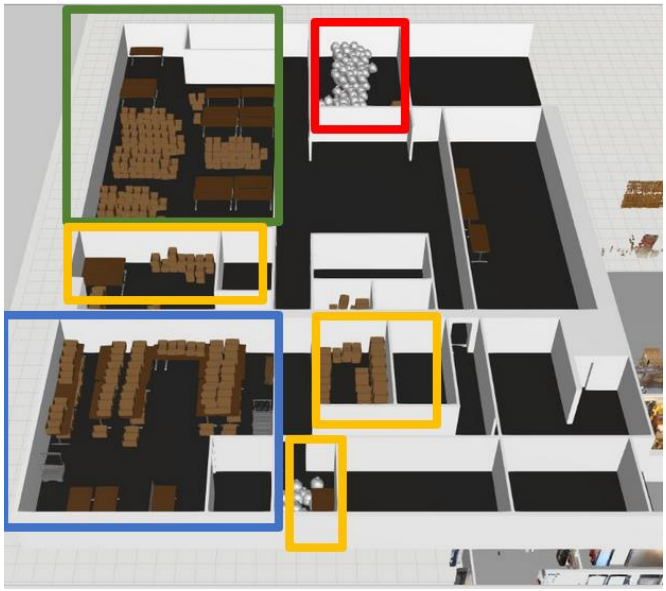
For upscaling and e-commerce, an IT platform is needed – this has been excluded from this project. When handling smaller volumes with in-store sales, it is possible without an IT platform.

3.1 Documentation and analysis of the current situation

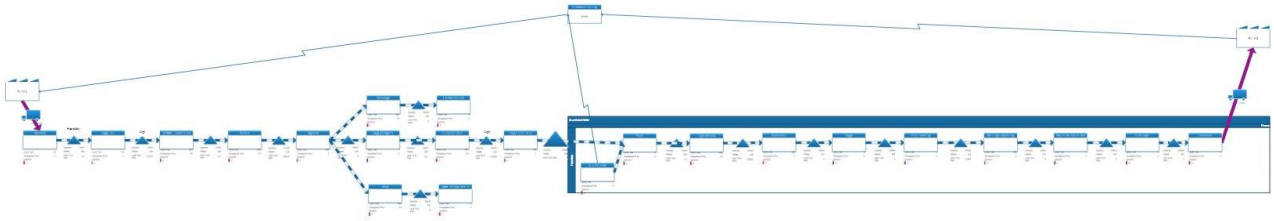
The current situation analysis has been done according to the method described in the generic way of developing a process earlier in this document.

Documentation of current process

- The process starts in blue area. This is where unpacking, inspection, sorting, registration, categorization, size/type sorting is done.
- In the green area, warehousing, pick-up of order and marking for stores take place
- In yellow areas, storing of garments that can be sold directly in stores without extra measures.
- In red area, what needs further research is stored on how it can best be part of a circular flow without having to recycle energy.

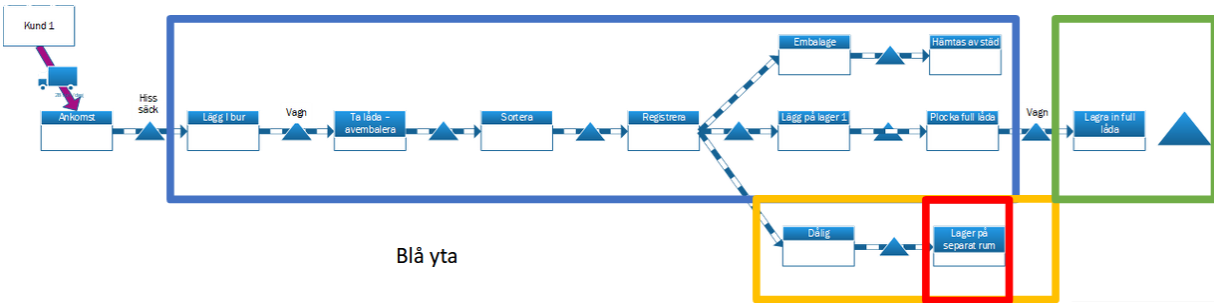


Picture of the current situation



Description of the process as a flow - the rectangles contain a process that performs while the triangles are some form of storage.

Step 1- How is the incoming material handled?



- Pick up the parcel
- Open parcel
- Put parcel packaging on the other side of the table

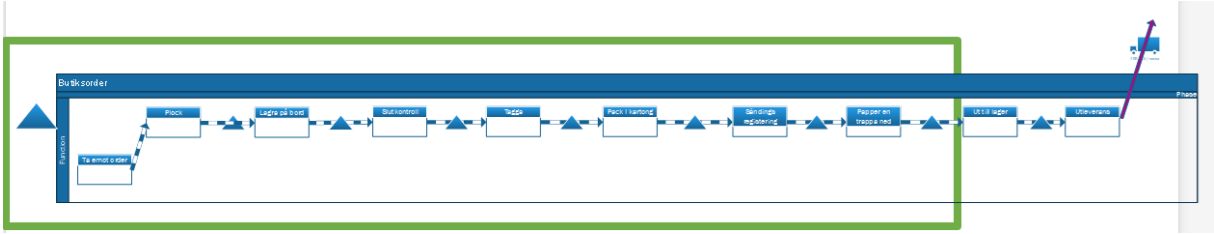
- Pick up garment
- Inspect garment
- Fold garment
- Put down garment
  Repeat 4-7

- Go to other side of table
- Pick up parcel packaging
- Read parcel packaging
- Register customer
- Throw parcel packaging

- Pick up garment
- Read size
- Register size and type
- Fold garment
- Put down garment
  Repeat 13-17

- Pick up garments
- Go to storage area
- Put the garments in the right boxes

Step 2. What is the process for outgoing material?



- Read pick-up list

- Go to box with the type of product
- Find the right garment in the box
- Restack boxes if garment from the bottom is to be delivered
- Go back to the table with garment
- Lay down garment on table
  Repeat 2-6

- Pick up the garment

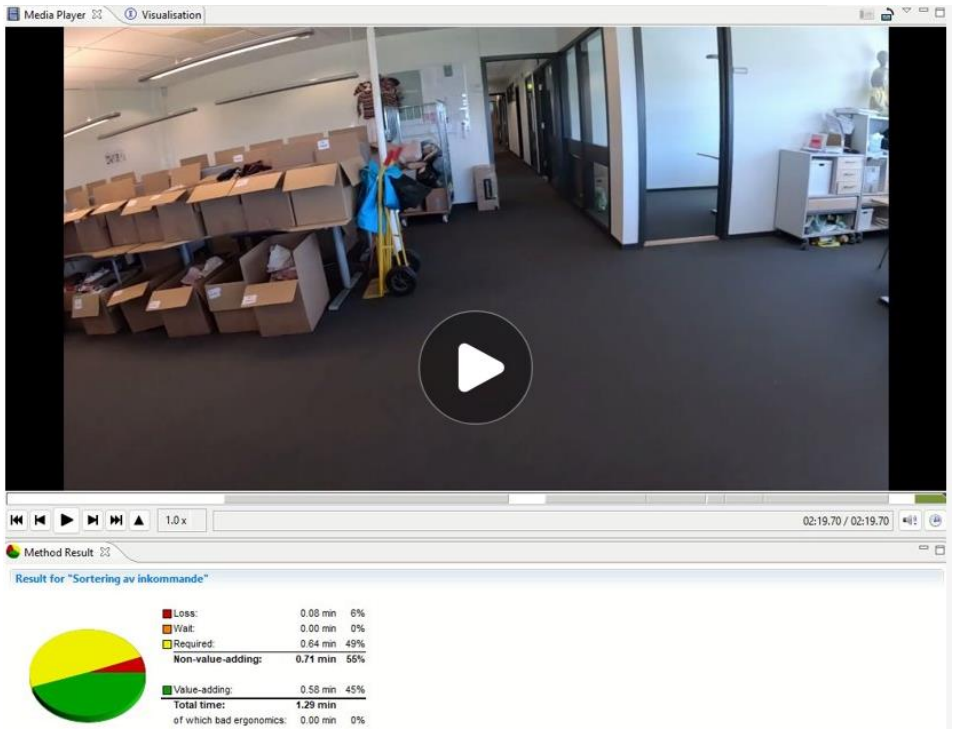
- Label garment
- Lay down garment
  Repeat 7-9

- Pick up garment
- Register the garment
- Fold garment
- Pack garment in box
  Repeat 10-13

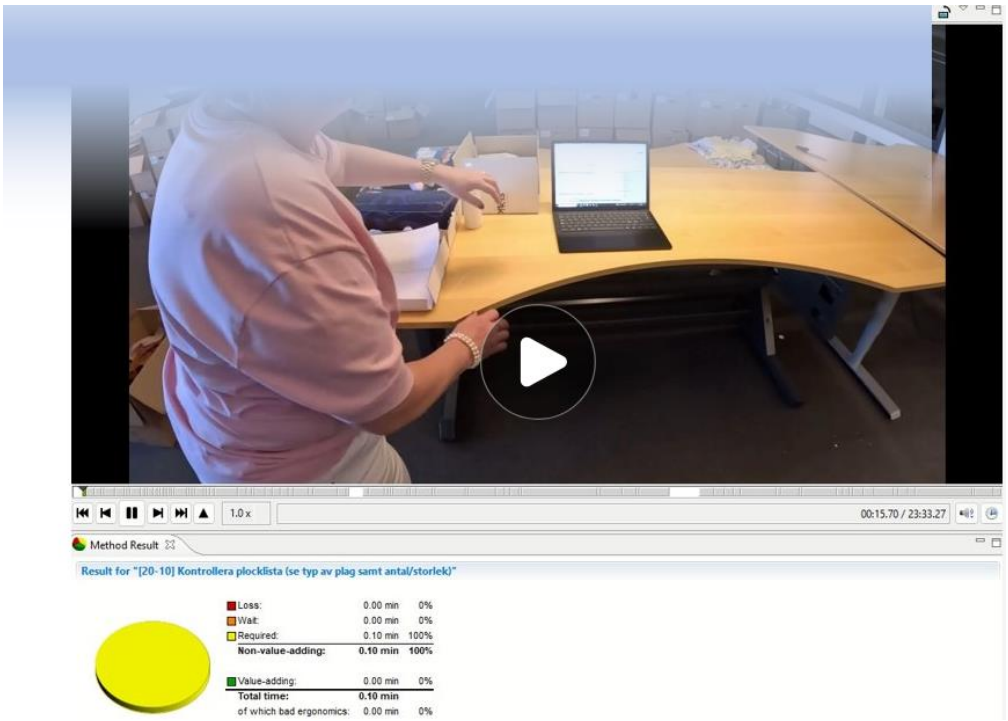
Current situation analysis - Analysis of Total time and Value added time

Once the process flow had been documented, the videos were analyzed based on what creates value and what does not create value.

Video for incoming material



Video for outgoing material

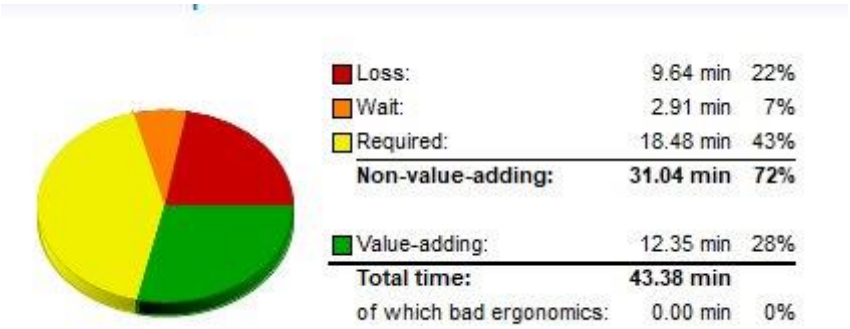


The pie chart below shows summed times divided by the number of garments handled.

Conditions:

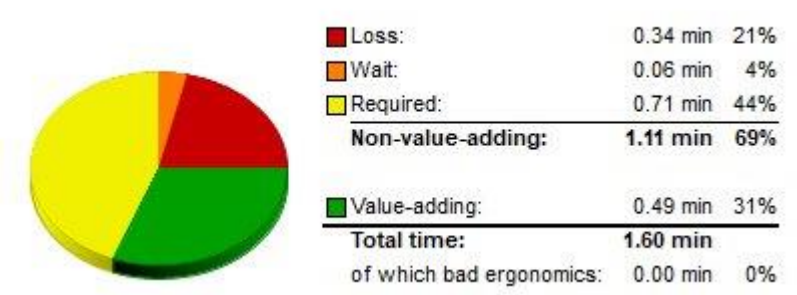
- Total hourly cost is SEK 14 per garment with the current setup
- The incoming process takes place every day because the submitted customer wants to know if the garments were ok
- Deliveries and order picking take place every two weeks

From arrival to warehousing



Loss:	9.64 min	22%
Wait:	2.91 min	7%
Required:	18.48 min	43%
Non-value-adding:	**31.04 min**	**72%**
Value-adding:	12.35 min	28%
Total time:	**43.38 min**	
of which bad ergonomics:	0.00 min	0%

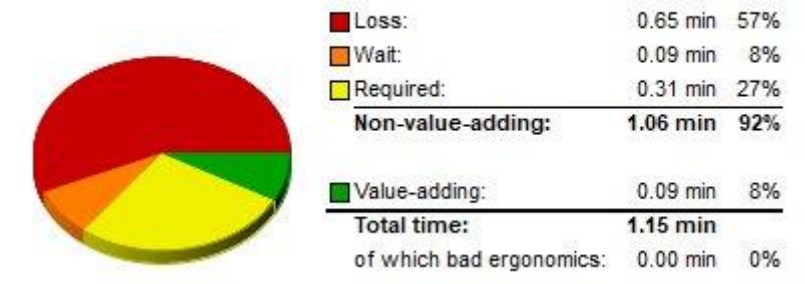
Per garment 1.6 min approx. 8 SEK (300 SEK/h)



Loss:	0.34 min	21%
Wait:	0.06 min	4%
Required:	0.71 min	44%
Non-value-adding:	**1.11 min**	**69%**
Value-adding:	0.49 min	31%
Total time:	**1.60 min**	
of which bad ergonomics:	0.00 min	0%

From warehousing to dispatch

Per Garment 1.15 min approx. 6 SEK (300 SEK/h)



Loss:	0.65 min	57%
Wait:	0.09 min	8%
Required:	0.31 min	27%
Non-value-adding:	**1.06 min**	**92%**
Value-adding:	0.09 min	8%
Total time:	**1.15 min**	
of which bad ergonomics:	0.00 min	0%

In the blue part of the process, we found that the garments were handled several times. A lot of focus for the future has therefore been to create an understanding of how we can reduce the number of times you handle the garment.

3.2 Development of future scenarios

Brainstorming was carried out according to the described process and with the help of the idea bank described in chapter 2.2.

Based on the analysis of **value-added** and **non-value-added** time, below is a description of what we have focused on removing in the handling of the garments.

Incoming material

- Pick up the parcel
- Open parcel
- ~~**Put parcel packaging on the other side of the table**~~

- Pick up garment
- Inspect garment
- ~~**Fold garment**~~
- ~~**Put down garment**~~
  Repeat 4-7

- ~~**Go to other side of table**~~
- ~~**Pick up parcel packaging**~~
- Read parcel packaging
- Register customer
- Throw parcel packaging

- ~~**Pick up garment**~~
- Read size
- Register size and type
- ~~**Fold garment**~~
- Put down garment
  Repeat 13-17

- ~~**Pick up garment**~~
- Go to storage area
- ~~**Put the garment in the right box**~~

Outgoing material

- Read pick-up list

- Go to box with the type of product
- ~~**Find the right garment in the box**~~
- ~~**Restack boxes if garment from the bottom is to be delivered**~~
- Go back to the table with garment

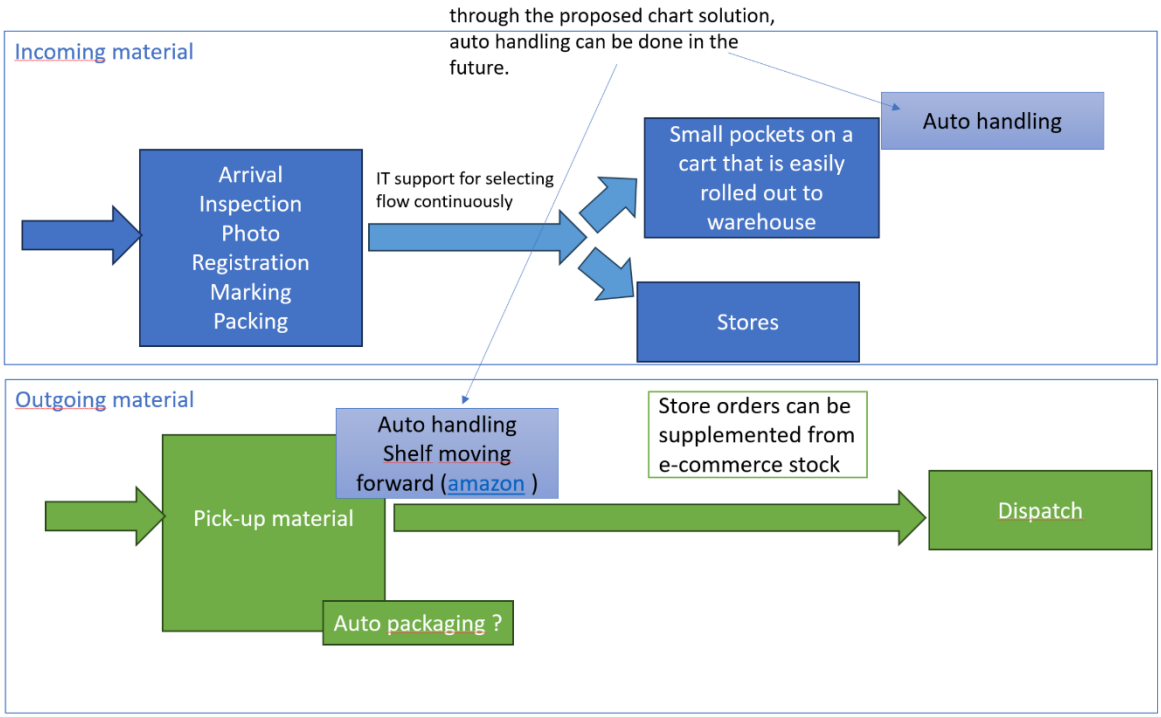
- Lay down garment on table
  Repeat 2-6

- Pick up the garment
- ~~**Label garment**~~
- ~~**Lay down garment**~~
  Repeat 7-9

- ~~**Pick up garment**~~
- Register the garment
- Fold garment
- Pack garment in box
  Repeat 10-13

By focusing on one garment at a time, we can minimize the number of times the garment is handled in the process – this means that we process each garment faster

Upcoming overall process



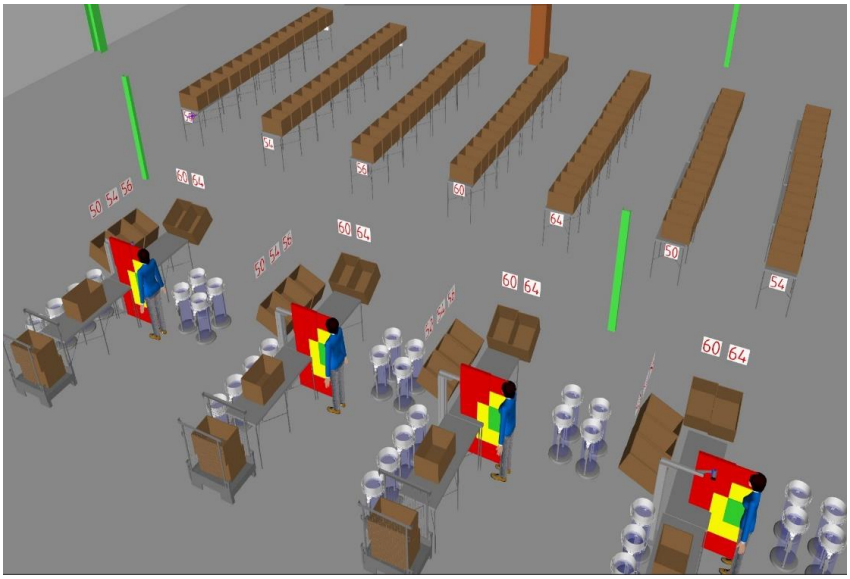
Depending on which of the different future scenarios 1-3 (described below) is chosen, automatic handling can be chosen/ or not.

Below are 3 different proposals on a new process, all based on the overall process.

Future scenario 1

- Like today but scaled up
  - A simple solution that doesn't require much development of the workplace
  - Searching in boxes for the right garment will be required in e-commerce

    - In order not to have too poor ergonomics, only one layer of drawers on tables can be handled – this means that fewer garments can be handled
- Size sorting in station
    - Will reduce how much you have to move to put the garments in boxes
- Look in each box when picking for unique garments
- 1400 boxes of 50 garments = 70,000 garments



Overall picture of future scenario 1

Picture future scenario 1, Sort

- The in-station consists of a simple table where parcels are placed. Inspection and AI recognition of the garment can take place on the table.

- Sorting can be done directly to store locations, to warehouses or to sorting B or C, which need additional processes before they can be sold to customers

Picture future scenario 1, Pick and find

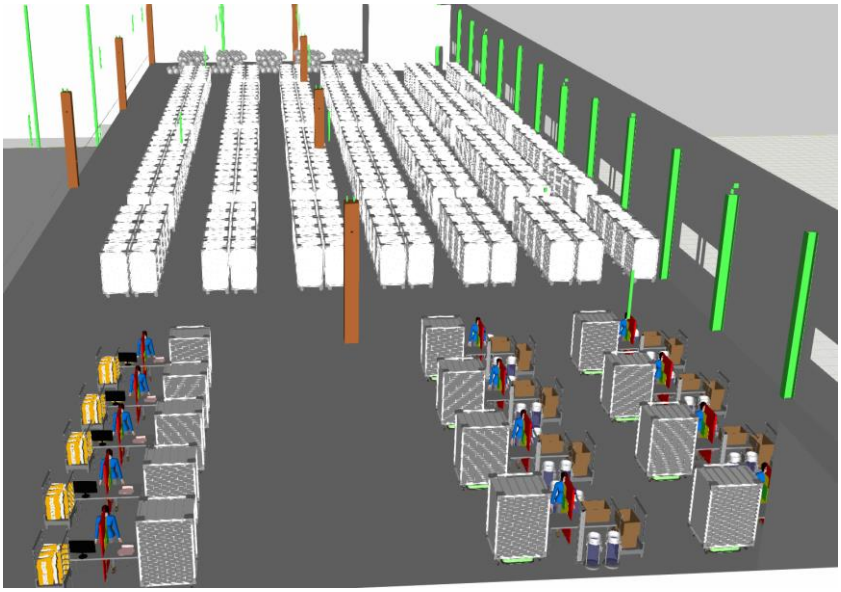
- The pick- up is done by picking up garments from the box containing the garment type. To find a specific garment, you need to search in the box.

Picture Future Scenario 1, Pack

- The packing process is a simple process. The selected garments are placed in packaging and sent to the customer.

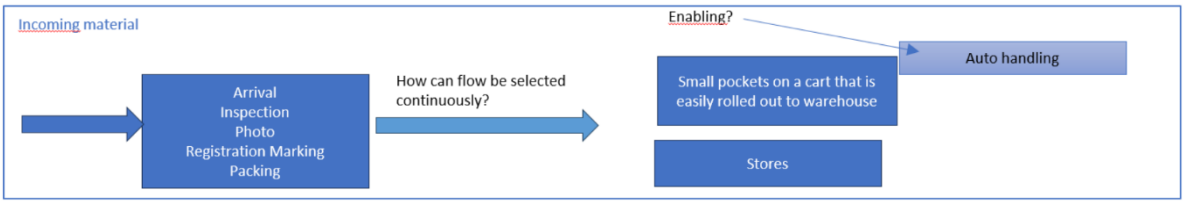
Future scenario 2

- 149,000 unique warehouse locations
- 10 in-stations
    - 1 min per garment in gives about 120 k x 10 = 1200,000 garments in (including out to the store)
- 5 out stations
    - 1 min per garment out gives about 600,000 garments out to e-commerce
    - 15 people + leaders = SEK 7.5 million
- Investment Equipment
    - Shelf trolleys 15 thousand pcs * X
    - Workstation 30 thousand SEK per station
    - Approx. 6,000,000 in total at full volume



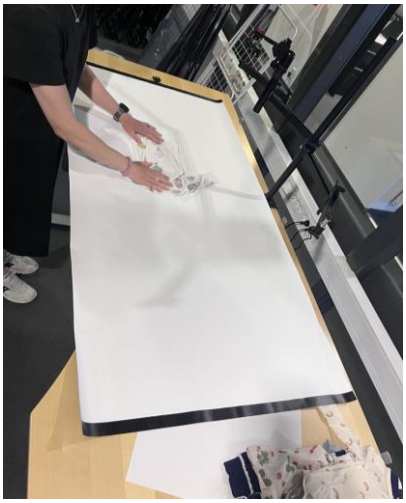
Overall picture of future scenario 2

Picture future scenario 2, In-station



Picture future scenario 2, Arrival – inspection – registration – photo – marking

- Register customer (if new package)
- Open package (if new package)
- Inspect a garment – Sort out the garment that is not approved and start over
- Take a photo of a garment (see next page)
- Register a garment
- Label a garment
- Sort to e-warehouse or to store (– HOW to select or see possible store orders?)
    - Orders to Store locations in “store box”
    - E-commerce in "cart"
- Drive carriage to storage area when full

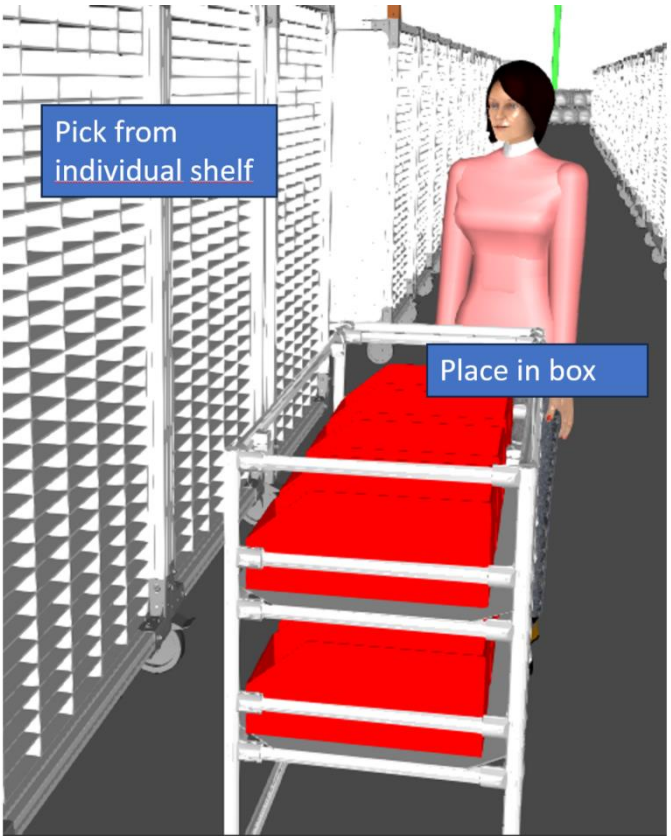


Picture future scenario 2. Photo with the help of AI
(the development of this has been a separate project at Lindex)

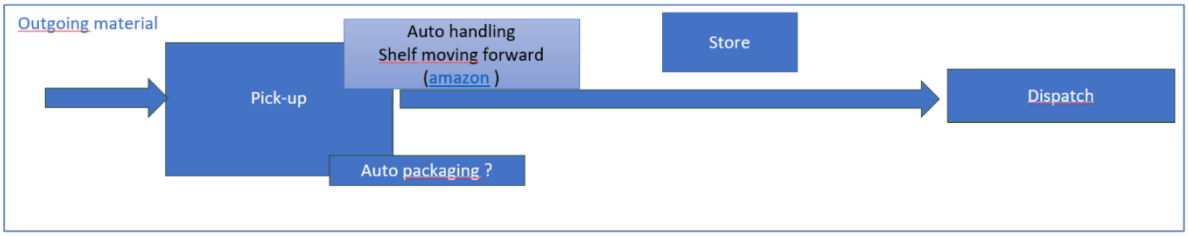
- Person- Take picture

- AI- Link image to sold garment – looking in Lindex's database
- Person- Register what type of product it is to the database
- AI- develops Ean Kod
- Person– Scans
- AI– Creates label with RFID tag
- Person- Putt label on garment

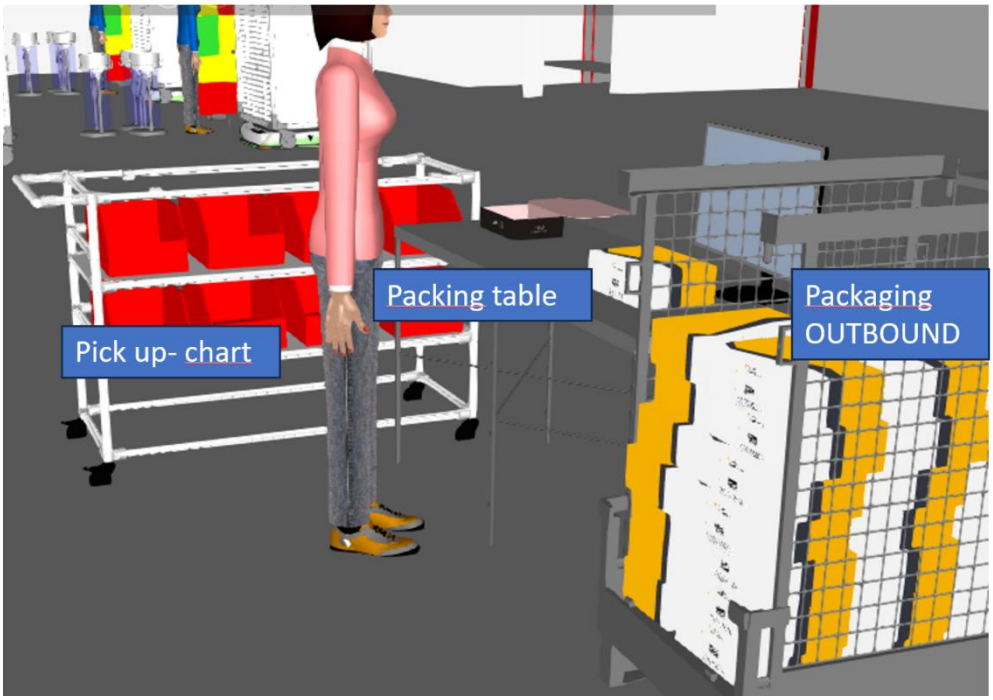
Future scenario 3 (E-commerce)



Picture future scenario 3, pick E-commerce



- Go to location according to the pick-up list
- Pick – check if it is the right garment with RFID reader
- Fold garment
- Pack in “outbound box”
- If possibly co-pack with others
- Most likely, on the same round, you can pick more than 10 one-piece trade orders



Picture future scenario 3, Utstation

- Pack garments in packaging with delivery note
- Mark box with delivery address
- Put box in the outbound chart

3.3 Choice of future scenario

The next step for Lindex is to decide which of the three proposed future scenarios to proceed with.

4. Reflections

4.1 Overall reflection

The fashion industry is facing a major transformation driven by both increased consumer demands for sustainable solutions and stricter legislation from the EU. One of the most significant changes is the development towards a circular economy, where reuse and second-hand flows are becoming increasingly important. The requirement to effectively manage these flows becomes particularly critical in light of upcoming EU legislation and producer responsibility, which is expected to increase the costs of new production if companies fail to adapt to circular business models.

Traditionally, the fashion industry has relied heavily on cheap production in countries with low labor costs and outsourced manufacturing processes, but this is changing. To manage second-hand flows as a form of "local production", the industry must now develop systems that enable efficient collection, sorting, processing and resale of used clothes. This requires a radical restructuring of logistics, where products are received and processed close to the consumer, instead of relying on global supply chains.

This change means that fashion companies need to scale up their capacity to manage used garments efficiently, from sorting to repair, repackaging and distribution. Efficiency will be crucial, both to reduce the costs of these processes and to stay competitive in a market where new EU regulations can mean higher costs for companies that continue to put new products on the market without taking responsibility for their entire life cycle.

Producer responsibility is likely to mean that companies have to pay for the recycling or disposal of the clothes they put on the market, creating incentives to design products that are more sustainable, easier to reuse and recycle. It also requires companies to invest in technical solutions and platforms that can enable traceability and better management of second-hand flows. To survive in a circular economy, companies need to develop systems that are scalable and can grow in line with market needs, while maintaining low operating costs. This requires innovation in both business models and technologies.

It is therefore crucial for the fashion industry to adapt to these new conditions in some form and develop effective circular systems. Otherwise, there is a risk that the costs of new production will increase sharply and companies will lose ground to those players who manage to adapt to the circular economy. Scalable second-hand flows, which function as a local form of production, will not only help reduce the fashion industry's climate impact, but also create new business opportunities at a time when sustainability and responsibility are becoming increasingly important.

4.2 Reflection from a process perspective

The handling of second-hand clothing can follow the same principles that is applied in all manufacturing of products.

The difficult step, which is unique to the product secondhand clothes, is the inspection of the garments after arrival. Here you need knowledge about the function of the garments and what a complete and clean garment is. The variation in the incoming garments means that it is the part of the process that takes the longest to learn.

An additional element that differs from clothing sales of new garments is that in e-commerce for second-hand, the customer will want the specific garment presented on a sales portal. This means that in the process, you must have a way to be able to find and ship that particular garment.

From a process perspective, efficiency, flow and resource optimization are crucial when fashion companies are scaling up their second-hand management. A key goal in this context is to minimize the handling of the garments, regardless of whether this is done by human handling or automated handling. Every time a garment is handled, for example for inspection, sorting or resale, both costs and consumption of time increase. Therefore, it is important to design processes that limit these steps, which can also reduce the risk of errors and inefficiencies.

To ensure that garments are not handled multiple times for the same purpose, a carefully structured process is required. This can mean that garments are identified, registered and categorised digitally from the first handling, minimising the need for additional manual control further down the chain. By integrating technical solutions such as RFID technology, AI-based quality control systems, or automated warehouse management systems, the process can be optimized to ensure that garments move smoothly through the supply chain without unnecessary stops.

However, which solution is most suitable depends largely on the volumes to be handled. For smaller volumes, more manual handling can still be cost-effective and fast enough, while larger volumes require more sophisticated and scalable solutions. Here, investments in technical solutions become necessary to handle increased flows without skyrocketing the costs of warehousing, handling and distribution.

Another important consideration is the extent to which the company is willing to implement technical solutions and automation. High-tech solutions require larger initial investments, but in the long run can provide significant cost savings and create a scalable process that can handle large quantities of garments with minimal human intervention. However, companies that choose to implement such solutions must balance these investments against their business model and the long-term strategy of the second-hand business.

As a guide, we see in this case study that picking garments from warehouse to customer takes about 40 seconds per garment with a fully manual solution and only 5 seconds with an automated solution. Per garment, this will be about SEK 5 – with a possible volume of 100,000 garments, there will be a cost of SEK 500,000, but for a million garments it will be SEK 5 million, which would quickly provide a paid off automation.

In summary, an efficient process flow in secondhand handling requires early identification and implementation of solutions that minimize unnecessary handling, avoid duplication of work and are adapted to the volumes you plan to handle. The larger the volumes, the more automation and technical integration becomes necessary to create a sustainable and competitive business.

4.3 Key Factors for Automation of the Secondhand Industry

When automating second-hand flows, there are a few key factors to consider:

1. **Volumes and scalability**: Automation solutions should be adapted to the volumes that the company handles. Small volumes can be handled with simpler systems, while larger volumes require more complex and scalable technology.

2. **Technical infrastructure**: Investing in RFID, AI-based quality control, and automated inventory and sorting systems can reduce manual handling and increase efficiency.

3. **Process integration**: Automation solutions need to be integrated into existing business systems to enable smooth flows without interruption or duplication of effort.

4. **Cost-effectiveness**: Initial investments in technology should be balanced against the long-term savings and increased profitability that automation brings.

5. **Flexibility and customization**: Systems should be able to handle variations in quality and type of garments, while also being flexible enough to adapt to changes in the market or business needs. Adapting to many different garments in one inspection is probably initially very difficult and will require advanced AI and automation. The focus should be on automating the processes that make it easier to use proven automation and digital solutions.

Contact

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