



# Lindström Talo Circular Economy Pilot Project

Helsinki

# Table of contents

Foreword	2
1. Introduction	3
2. Project Overview	4
2.1 Project scope - Implementing a circular economy and resource efficiency approach for the Lindström Talo Renovation Project.	4
2.2 Project objectives	6
3. Project implementation and execution	7
3.1 Implementation timeline	7
3.2 Circular pilot project design philosophy	9
3.3 Deliverables / work-packages	10
3.4 Challenges	27
4. References	29
Appendix	30

# Foreword

This Circular Economy Innovation Challenge Project at the historical Lindström Talomarks a milestone in promoting circular economy practices within the real estate and construction industry. This project provided a unique opportunity to implement circular strategies, resource mapping, and material innovations in a real-world renovation setting. Through the close collaboration of key stakeholders, including Castellum Oy, the City of Helsinki, Spolia Design, and zupply, we were able to explore sustainable solutions that not only minimized waste but also offered valuable insights for future projects within the built environment. This pilot has successfully demonstrated the potential to reduce CO2 emissions and resource consumption, laying the groundwork for scalable circular practices in construction and renovation projects.

The lessons gained from this initiative have been transformative. By leveraging zupply's digital platform and tapping into the expertise of Spolia Design, key partners and other stakeholders like the interior architecture agency, Mint&More, we developed practical methods for reusing materials, designed circular innovations, and documented best practices that can be transferred to future endeavors. This report outlines the project's successes, challenges, and overall outcomes, showcasing our ongoing commitment to sustainable and resource-efficient building practices. We hope this project will inspire future circular economy efforts both in Helsinki and globally, contributing to the transition toward a more sustainable construction industry.

# 1. Introduction

The Lindström Talo Renovation Circular Economy pilot project was designed as part of the broader Circular Economy Innovation Challenge, aimed at integrating and testing circular economy principles in real-world construction and renovation projects. This pilot project was provided by Castellum and the City of Helsinki and conducted at Castellum's property, Lindström Talo's first floor, located at Lautatarhankatu 6, Helsinki. The project was executed through the collaboration of zupply, and Spolia Design. The overarching goal was to explore and implement innovative strategies to maximize resource reuse, refurbish existing materials, and reduce waste streams during the renovation process. By leveraging zupply's digital platform and Spolia Design's expertise, the project sought to advance circular economy management in the building and construction industry, offering a replicable framework for future projects.

The scope of work for the project covered various key aspects essential for achieving circularity. The project area included the entire first floor of Lindström Talo, excluding kitchen, service toilets, staircase access, and storage areas. The project began with the creation of a digital twin of the pre-renovation condition, followed by a comprehensive resource mapping exercise. Selected resources were analyzed, and circular innovations were developed through a process that involved testing, prototyping, and budgeting. The aim was to identify 5-8 circular innovations that could be integrated into the renovation project, including reuse strategies for materials like lighting, ceiling panels, and furniture. A digital twin was also created post-renovation to document the transformed space, aiding future facility management and enabling circularity in ongoing operations.

A key element of the project was the on-site supervision provided by Spolia Design. Spolia Design's involvement included supervising the dismantling, refurbishment, and reinstallation of selected materials, providing guidance on resource mapping and overseeing the implementation of circular strategies on-site. This supervision helped maintain quality control, minimized material wastage, and ensured that circular practices were applied effectively during the renovation, reinforcing the project's commitment to sustainable and efficient outcomes.

Throughout the project, emphasis was placed on transparency and knowledge sharing. zupply's platform facilitated real-time data sharing, allowing stakeholders to track the progress of circular strategies and resource management. Moreover, extensive documentation, including dismantling instructions and recommendations for circular strategies, was prepared to ensure that the lessons learned could benefit the industry at large. In addition, a series of sessions and reports were planned to disseminate the project's findings, including a best practices manual that could be adopted by future projects looking to implement similar circular economy principles.



# 2. Project Overview

## 2.1 Project scope - Implementing a circular economy and resource efficiency approach for the Lindström Talo Renovation Project.

The project scope of work main objective was to implement a circular economy and resource efficiency approach during the renovation of LINDSTRÖM TALO first floor area with an address of Lindström Talo, Lautatarhankatu 6, 00580 Helsinki.

The circular economy and resource efficiency approach implementation was to be managed utilizing supply's digital platform and with and execution of circular design innovations and site activities by Spolia Design Oy.

This circular economy pilot project was to be managed and executed as a separate project from the general renovation project, and the scope of work described in this report was considered as an additional scope that ran in parallel with the renovation project.

**Work packages:** The scope of work major work packages are listed below:

- a. Resource mapping and establishment of a resource strategy based on circular economy principles.
- b. Design circular innovations
- c. Site monitoring
- d. Post renovation project documentation and circular recommendations.
- e. Lessons learned, sharing knowledge and handover.

Major work packages are described in detail in next sections. *Project implementation and execution* in this report.

**Stakeholders:** The stakeholders involved in this project are:

*Customers / End-users:*

- Castellum Oy - Real Estate Developer and property owner of the building LINDSTRÖM TALO.

Focal points: Annmari Kallioinen (Annmari.Kallioinen@castellum.fi) / (Commercial matters) and Elmeri Kauko (elmeri.kauko@castellum.fi) / (Operational matters).

- City of Helsinki - Cluster programme for Circular Economy and sponsors of the innovation challenge with interest of testing new approaches towards circular construction practices and utilizing the lessons learned and knowledge developed into scaling them into a wider application within the City of Helsinki.

Focal points: Mira Jarkko - Project Manager (mira.jarkko@hel.fi) and Ronny Rantamaki - Senior Advisor (ronny.rantamaki@hel.fi).

*External stakeholders involved in the renovation project:*

- Project Management: Antti Taivalkangas - project manager appointed by Castellum to be responsible for managing the renovation project.

- Interior Design: Mint & More Creative Agency - appointed by Castellum to undertake the interior design works for the renovation project. Focal points: Kristian Linnoinen, Roosa Riski and Bea Sävikari.

During the course of the renovation project other stakeholders were involved including the general contractor and technical advisors. They did not have direct works with the circular economy pilot project described in this report; these included: Mekol-Rakennus Oy. Äyräväinen Oy and Removeo Oy.

*Project execution team for the circular economy pilot project:*

The circular economy pilot project was managed and executed by two companies with the following description:

ZupplySite ApS (hereafter referred as zupply)

Zupply is a company providing software and services related to establish, implement and scale circular economy and resource efficiency practices within the built environment. It is headquartered in Denmark with business operations within Europe and North America.

Spolia Design Oy (hereafter referred as Spolia Design) is a company providing consultancy services on the reuse of construction components, site supervision and re-sale of the actual reusable construction components. Their main services include consulting customers on the reusability of construction components, designing operating models for reuse as well as site supervision among others. Spolia Design Oy is based in Finland.

**Project area details:** The renovation project area was limited to the 1st floor. The area under the scope of work of the project is from reception door to the back-entrance door in the first floor excluding kitchen area, service toilets, staircase access area and storage room in the back side.

Refer below floor plan for further understanding.

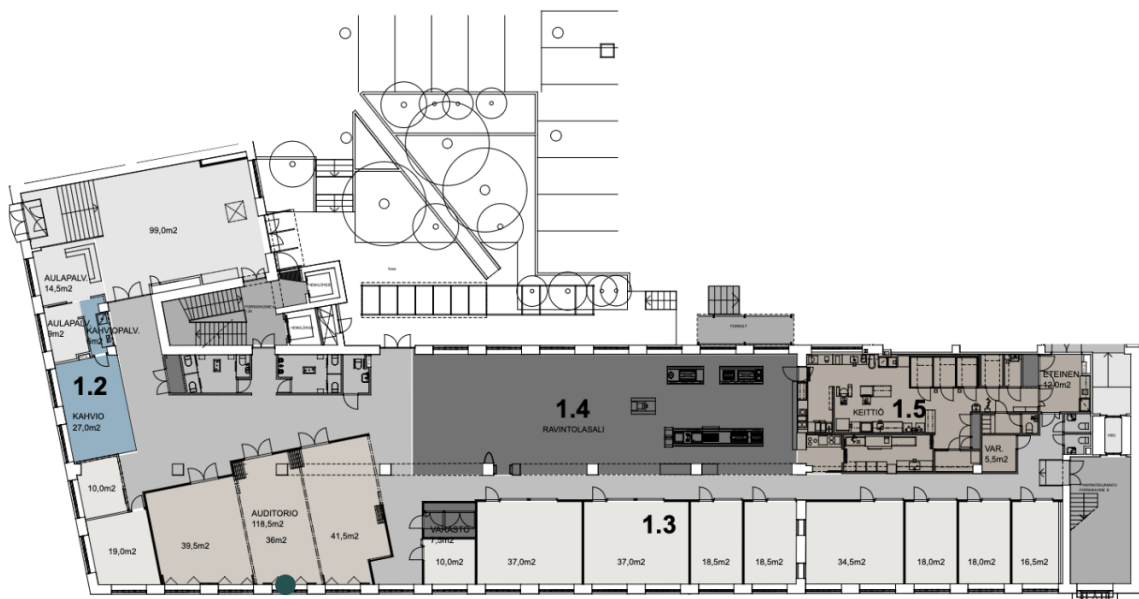


Figure 1. Floor plan of project area as distributed by the Renovation project team.

## 2.2 Project objectives

**Purpose:** The main purpose of this project was to develop, implement and test a circular economy approach as an additional scope of work to the Lindstrom Talo renovation project and share the lessons learned and knowledge to a broader audience within the City of Helsinki for the benefit of the industry and its transition to more sustainable practices .

**Objectives:** The main objectives of the circular economy pilot project were:

A. For the benefit of the Renovation project in particular:

- Implement a digital platform and experiment how to manage the circular economy pilot project to ensure transparency and efficiency during the course of the project.
- Conduct a resource mapping exercise fit for purpose for the circular economy pilot project and general renovation project.
- Selection and development of material or product innovations (called hereafter “circular innovations”).
- Establish a recommendation strategy for remaining products and materials not selected as circular innovations during the renovation project.
- Create a digital representation of the newly renovated area in the form of material passports.
- Provide data towards general compliance reporting.

B. For the benefit of the building industry in the City of Helsinki and its transition to more sustainable practices.

- Development of a general guidelines manual for building projects following a circular economy approach to be distributed online as open source.
- Distribution and communication activities related to the project and developed manual.

It is to be noted that the circular economy pilot project was scoped as a result of the innovation challenge for circular economy in the building industry organized by the City of Helsinki. This is the main reason why there are two client customers with unique objectives.

**Success Metrics:** The established success metrics before the project were:

Measurable success metrics:

1. % of resources following a circular strategy (kept in building, circulated, new, etc) vs total wasted resources in this specific renovation project
2. % tonnes of waste (kg) avoided vs benchmark
3. Total value (EUR) saved vs new
4. CO2 embedded saved vs benchmark

These metrics were tracked in zupply’s digital platform in the best possible manner based on the data provided by stakeholders and the project management from the renovation project.

Other success metrics:

1. Knowledge sharing via the Handbook preparation.
2. Setting a framework for circular economy practices in the building and construction industry particularly for renovation projects.

# 3. Project implementation and execution

## 3.1 Implementation timeline

### *Preliminary activities (Dec 23 to January 24):*

The project was derived from the Innovation challenge for circular economy in the built environment organized by the City of Helsinki. Spolia Design Oy and zupply were awarded as winners to implement and execute a project within the circular economy as a partnership where both companies knowledge, tools and expertise are to be combined in the benefit of a customer and in general for the building industry in the city of Helsinki.

### *Project selection (January 24):*

LINDSTRÖM TALO renovation project was selected to implement and test the circular economy approach by Spolia Design Oy and zupply due to Castellum's interest in prioritizing innovative and sustainable methods driven by circular principles. It was also advantageous that the renovation project was still in the design and development phase, providing an excellent opportunity to integrate the circular approach as an additional component of the ongoing project.

It was also beneficial that the appointed interior design and architectural studio (Mint & More), has collaborated before with Spolia Design Oy.

### *Project scoping and KOM (Jan - Feb 24):*

Preliminary scoping meetings with the Castellum and the City of Helsinki were conducted to finalize the scope of work and establish an implementation and stakeholder management plan. The Kick-off meeting (KOM) and alignment workshop was conducted in the project Area on 6-February-2024.

As part of the main outcomes of the alignment workshop was the agreement on the final scope of work, which is described in this report.

### *Digital Platform set-up, onboarding and training (Feb 24):*

As part of the kick-off activities zupply's team set-up the platform to fit for purpose for the pilot project scope of work. It also provided a series of onboarding sessions to all stakeholders plus to the Spolia Design Oy team.

### *Resource Mapping (Feb-March 24):*

The area resource mapping prior to renovation was completed during Feb and March 2024, the resource mapping included a matterport scan plus a detailed description mapping in zupply's digital platform. It also included calculations on carbon accounting and selected cost metrics. As part of this exercise, it also included recommendations to define and select the potential circular innovations.



*Circular Innovations design and development (Feb-May 24):*

A total of 15 circular innovations were proposed to be further studied within the renovation project. The list of the proposed circular innovations was gathered in a joint exercise between Mint & More, Spolia Design Oy and zupply. It was also shared with the Project management team and Castellum to ensure proper alignment on the selection process for circular innovations to be detailed further.

Further details to be described in following sections.

After selecting the circular innovations to be detailed further within the renovation project, a design and prototype strategy was proposed by Spolia Design Oy in alignment with Mint&More. Detailed deliverables per each circular innovation were defined and aligned upon. The deliverables included 3D modeling, physical testing or prototyping, detailed drawings, dismantling instructions, product cards, among others.

Further details on the process and the deliverables created per each circular innovation to be described in following sections.

*Establishing an alternative circular flow strategy for surplus resources (June-Aug 24):*

For the products and materials that were not used within the renovation project a recommendation for an alternative circular flow was provided to the renovation project management team, Mint & More and Castellum. Support in their execution as decided by them was provided.

*Support and site supervision in the execution of renovation project (May-July 24):*

As part of the scope of the circular economy pilot project tendering support and site supervision for the circular economy or resource efficiency on the renovation project was included. This was undertaken on-demand basis from the Renovation Project Management team and/or Mint & More focal points.

*Documentation, Reporting, Presentation and Handover (July 24-Aug 24):*

An exercise of workshops and interviews were conducted to analyze the progress, performance and results of the circular pilot project. This was done with the purpose of presenting the results to customers, sharing the lessons learned and developing the manual for circular economy practices included as part of the scope of work. A digital representation of the next

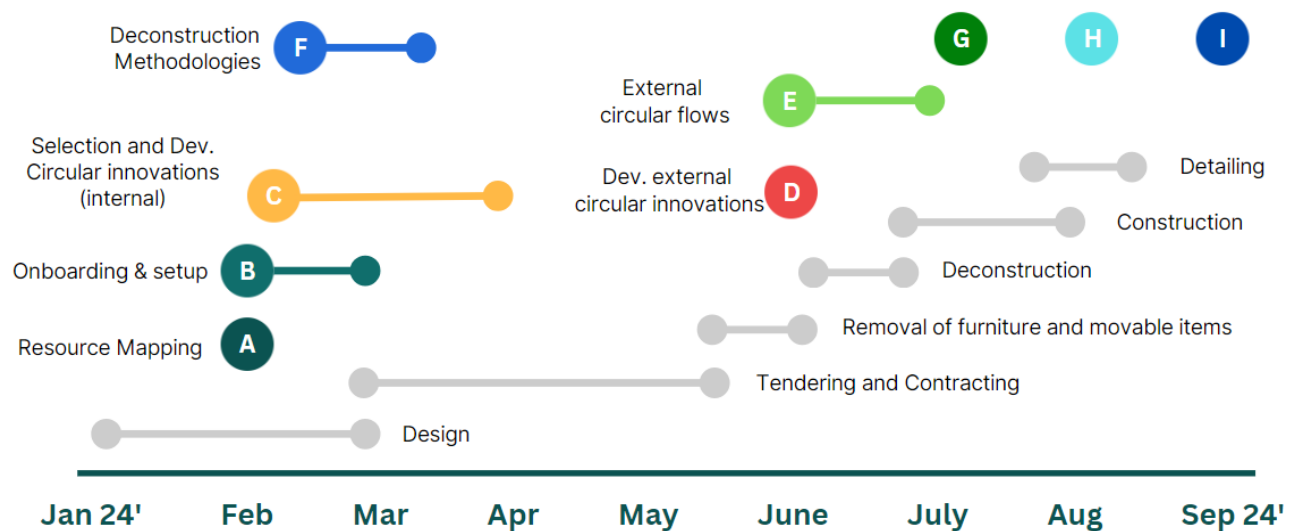


Figure 2. Presentation of the implementation timeline. G. implies site monitoring, H. the post renovation mapping for future reporting and benchmarks and I. the development of Best Practice Manual for renovation projects with circular economy

Work-packages are defined in section 3.3.

### 3.2 Circular pilot project design philosophy

Zupply and Spolia Design approached the project with the aim to facilitate circular activities in the property facelift, where the highest priorities were to reuse the products with as little change and treatment as possible, in the premises, and where possible, to make as few changes as possible. Hereby, the principles of waste hierarchy were translated into a hierarchy that suits the specific context of the property facelift and its activities, as presented in figure 3. Regarding the CO2 footprint, economic value for the real estate owner and general material value, the most preferred alternative is to not do anything, followed by processing products on site, for example by painting or grinding them, and reusing or repurposing them in the same property. The least favorable alternatives are reusing or repurposing the products in another project or property by the same real estate owner and, lastly, to sell the products to external parties or arrange take-back by the product manufacturer.

The principles are applied in the different project work-packages. The circular innovations (presented in section 3.3, work package C) developed and proposed to be included in the facelift project cover the principles of 'process at site', 'reuse/repurpose internally' and 'reuse/repurpose externally'. The circular strategy (see section 3.3, work package E), on the other hand, utilizes the 'external flows', i.e., the selling of products to external stakeholders and using take-back systems that manufacturers already have in place or creating new ones. 'Don't do anything' was applied most notably in that some materials were left in place, such as the wooden parquet in the canteen and meeting rooms, as well as white false ceiling panels in the meeting rooms.

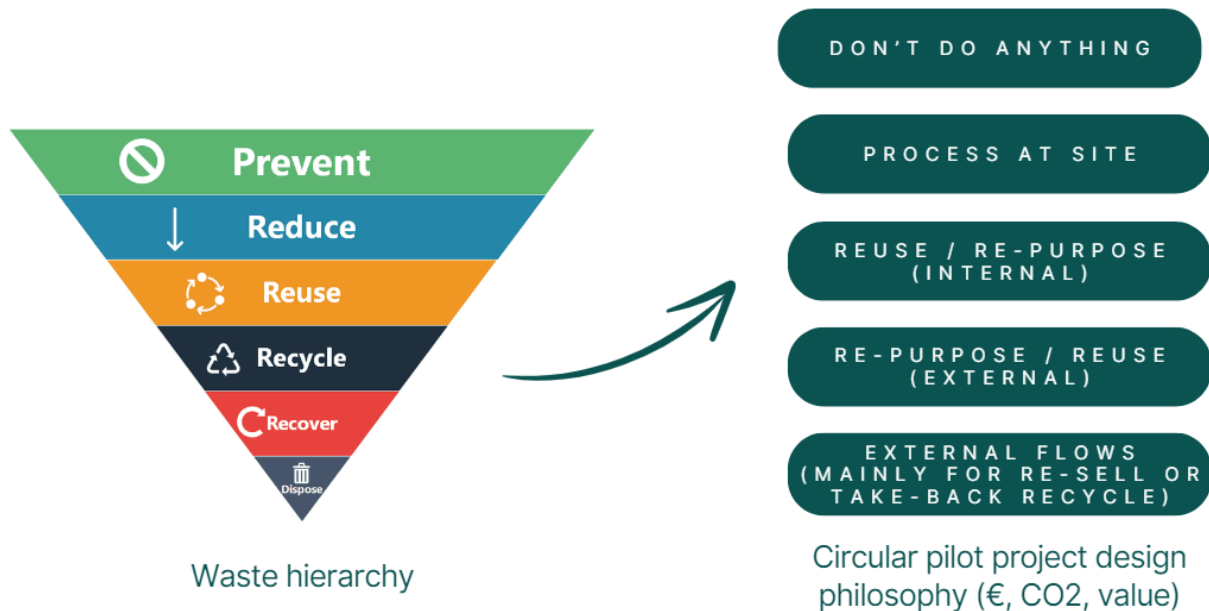


Figure 3. Presentation of the philosophy applied in designing the circular innovations, and its origin, the waste hierarchy.

### 3.3 Deliverables / work-packages

#### A. Resource mapping and establishment of a resource strategy based on circular economy principles.

A resource mapping exercise was conducted for the project area. The resource mapping was conducted with the zupply platform including the integration with point cloud scan (matterport) and 2D drawings as there was no 3D Model available.

Refer below for few screenshots of the resource mapping exercise reflected in zupply platform:

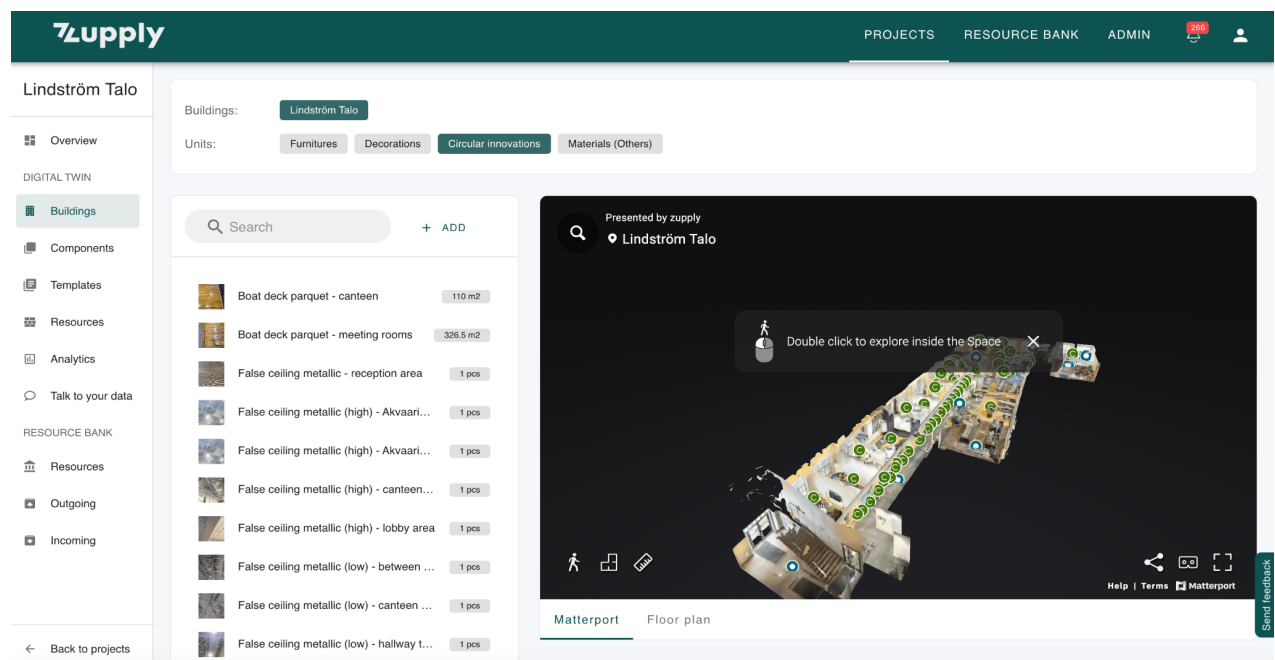


Figure 4. Screenshot example of Matterport scan integration for resource mapping.

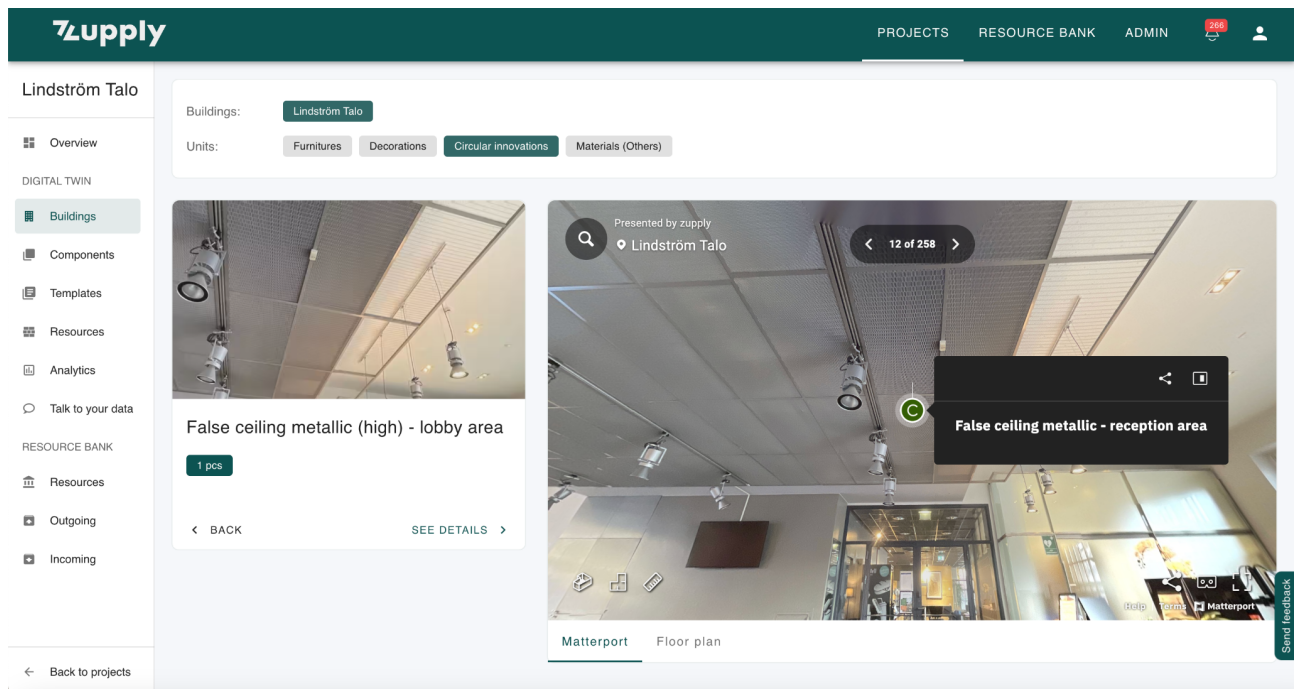


Figure 5. Screenshot example of Matterport scan integration for resource mapping.

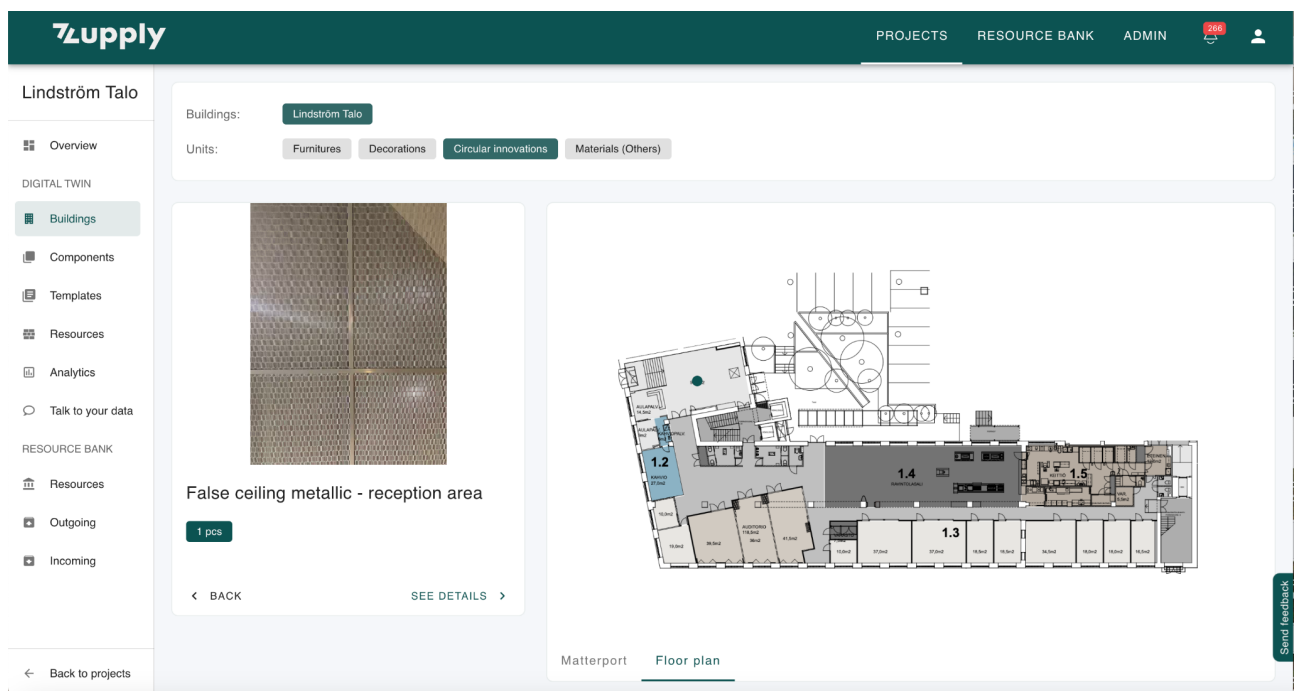


Figure 6. Screenshot example of resource mapping in 2D drawings.

The resource mapping exercise was limited to interior items (like furniture) and lighting

## B. Onboarding and Set-up

The onboarding and Set-up work package focused on ensuring that all project stakeholders were properly introduced to and equipped with the tools needed to manage and execute the circular economy aspects of the Lindström Talo Renovation pilot project. The primary goal of this work package was to integrate zupply's digital platform into the project workflow, enabling effective collaboration and real-time data sharing among all involved parties.

The onboarding process began with tailored sessions for different stakeholders, including Castellum, Mint & More, the City of Helsinki, and Spolia Design. Detailed onboarding sessions,



lasting approximately eight hours, were conducted on-site for the Mint & More team, providing them with hands-on training in utilizing the platform's resource mapping and inventory management modules. Shorter, quick onboarding sessions of about 90 minutes were offered to Castellum representatives and City of Helsinki personnel to familiarize them with the platform's key functionalities and ensure seamless participation in the project.

zupply's team also handled the complete set-up of the platform, including linking existing project data, uploading site information, and configuring the digital twin (pre and post renovation) of the Lindström Talo project area. This set-up allowed for accurate tracking of materials, circular innovations, and project progress. By the end of the onboarding and set-up phase, all stakeholders had access to the platform and were prepared to engage with the project through zupply's digital ecosystem, ensuring transparency, efficiency, and real-time collaboration throughout the renovation process.

### **C. Selection and development of internal circular innovations**

Circular innovations were developed over the course of the project to study the materials available in the property and to produce solutions suitable for the facelift project as well as other projects of the property owner and beyond. With the offered solutions, Spolia Design aimed to highlight specifically both the economic and functional values in the existing materials and the range of opportunities these values enable.

The development of the circular innovations took place in three main steps:

- 1. Selecting resources to be studied based on resource mapping**
- 2. Developing (internal) circular innovations that were proposed to be included in the property facelift**
- 3. Developing (external) circular innovations that were proposed to be implemented in the property owners other properties**

These steps, that build on each other, are elaborated on below.

#### **1. Selecting resources to be studied based on resource mapping**

The resource mapping was conducted by zupply with the help of Spolia, to create an understanding of the products, their amount and condition, located in the building. Additionally to 3D model and Matterport information and pictures of the resources were added directly to zupply's platform during the mapping by Spolia Design as per design needs.

Based on the catalog collected on the zupply's platform, 15 different materials were selected by considering their amount, measures, condition, CO2 footprint and the potential to be reused. The materials were veneer wooden panel, parquet, white false ceiling panels, glass structures, false ceiling lighting and all other lightning fixtures in the facelift area, different types of doors, metallic false ceiling grids, furniture and decorations.

#### **2. Developing circular innovations that were proposed to be included in the property facelift**

Four materials of the 15 were selected to be further studied, based on which four different types of innovations were designed and proposed to be included in the property facelift. In designing the products, the principles of the circular pilot project design philosophy, as presented in section 3.2, were followed. In practice, this meant selecting materials with considerably high CO2 footprints and turning them into modular solutions with as little need for treatment as possible. The materials selected were veneer wood panels, false metallic ceiling grids and glass structures. Besides CO2 footprint, other criteria for selecting the materials were

1. the amount of the materials in the property to go under facelift

2. their potential to be reused not only in Lindström Talo but also beyond, as it was not certain that they would be included in this specific project. This involves considering features such as modularity, condition and treatment requirements.

The developed circular innovations are following:

- A. Windbox canteen and windbox lobby**
- B. Glass partitions of several types**
- C. Living wall**
- D. Acoustic wall panels of two types**

For the developed products, the market price as new and the costs for the reuse scenario were estimated and compared to determine the economic profitability of using the materials in the designated form. The market price as new is an estimation of the price of the product, retrieved from similar products as new on the market, including the materials as new and the needed labor. The costs of reuse scenario, on the other hand, involves the prices of the materials as used and the labor required for producing the product.

The proposed products, however, were not implemented in the facelift project due to time constraints that are further elaborated on in section 3.4, on the project challenges. Some of the products were similarly proposed by Spolia and Mint & More, such as the living wall.

The circular innovations are presented below:

- A. Windbox canteen and windbox lobby**

The designers proposed new windboxes for canteen and lobby areas, for which Spolia Design drafted a design where both used and new glasses and structures are proposed. The used parts were from the meeting rooms in the self-service cafeteria with glass walls. The figure 7 presents the initial glass structure to be deconstructed ('Purettava lasirakenne') and the two drafted windboxes in red and other colors. The red parts are those that are suggested to be acquired as new. The structures that need to be obtained as new are presented in the leftmost images with red lines.

The two windboxes produced from used glass structures are estimated to cost, including labor costs and 20 % margins, 605 €/m<sup>2</sup>, while as new, they are appraised as 450 €/m<sup>2</sup>, making the new product 26 % less expensive alternative. The estimation for the product as new is based on an internal calculation, whereby information from web results was utilized.

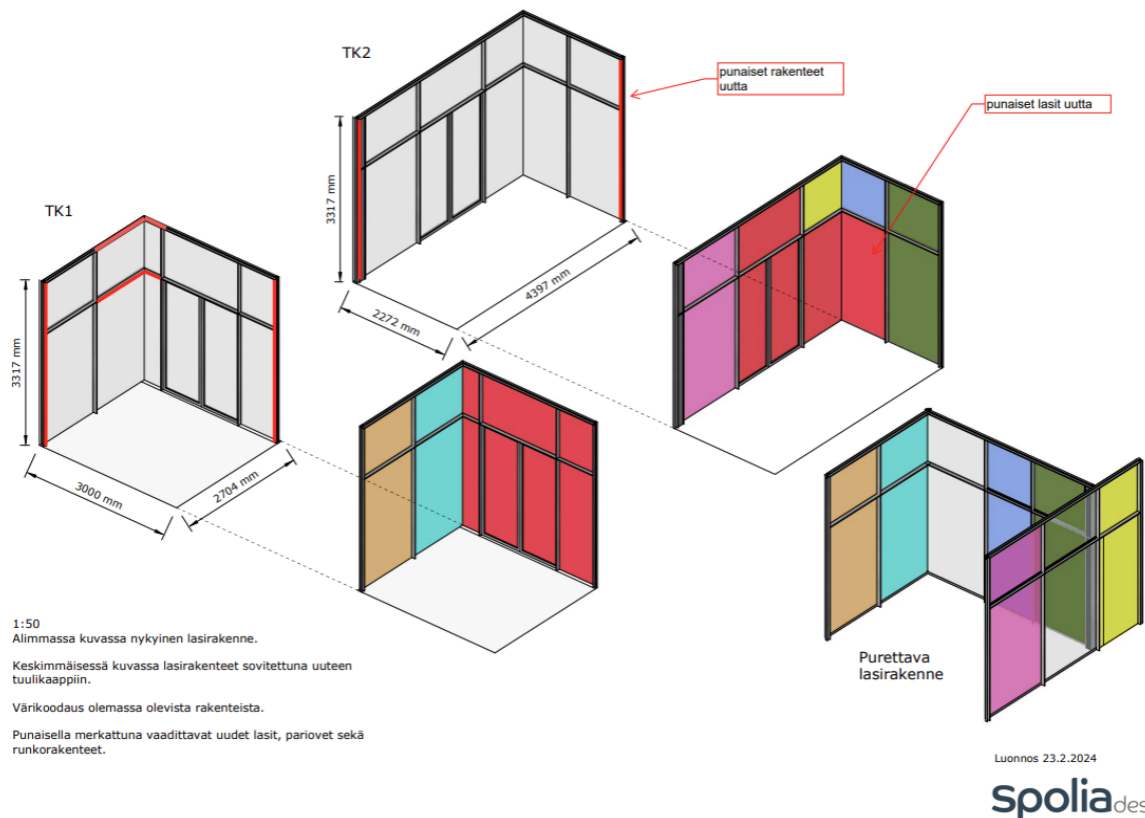
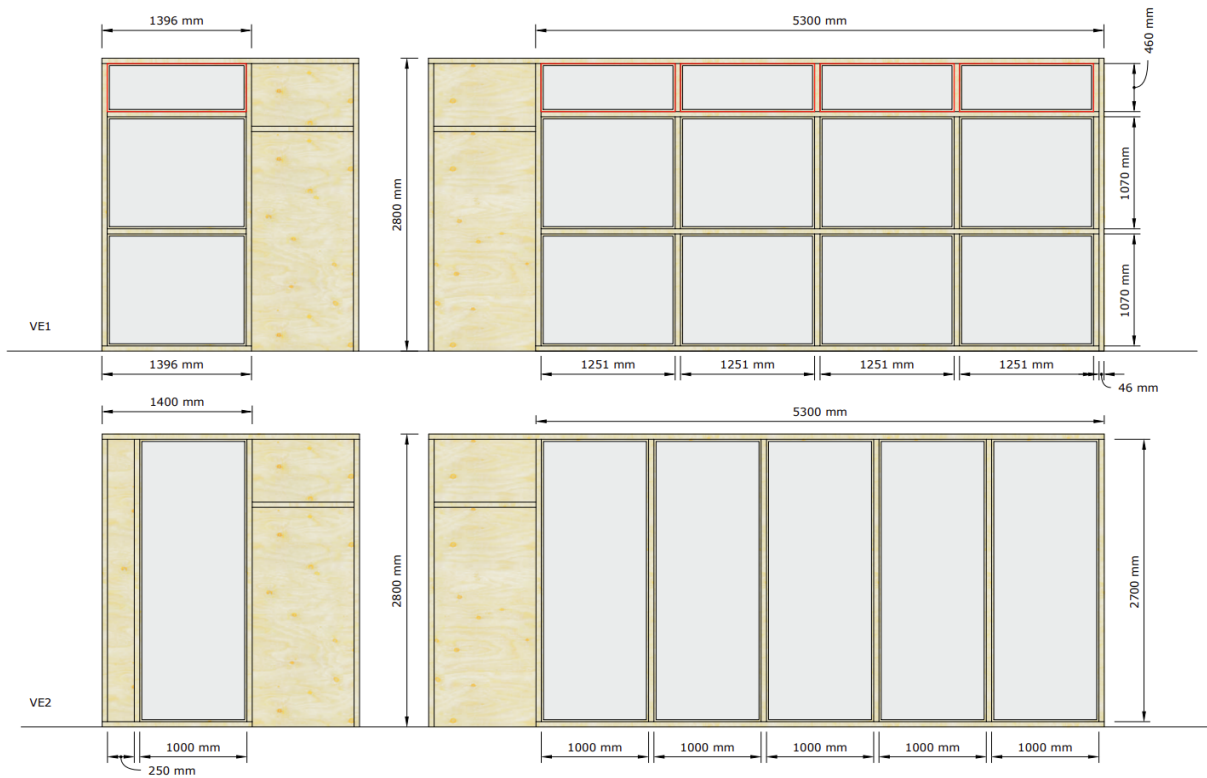


Figure 7. Drawing of the windboxes for the canteen and lobby. In the red the new glass and structural components needed for the two windboxes. In other colors the components to be deconstructed and reused. The picture is not in scale.

## B. Glass partitions of several types

Spolia Design further designed different types of negotiation room walls on the request of the interior architects. For this, glass partitions either from Spolia's stock or from Castellum's another location, were planned to be used. The wooden frames, fillings and fastenings would be obtained as new. In figure 8 the used wood type is birch, whereas the frames presented in figure 9 are composed of oak. In VE1, the glass partition is constructed from a glass found in another property of the owner, whereas the glass in VE2 is stored in Spolia Design's storage.

The total costs in the case of reusing the materials, including labor and 20 % margins, are 442 €/m<sup>2</sup> for the figure 9 with oak frames. It further involves a detailed cost estimation for the products built from used components. In comparison with the price as estimated for a new glass partition, it was estimated that the costs for the new one (450 €/m<sup>2</sup>) would be approximately 2 % higher than those for the reused one (442 €/m<sup>2</sup>). The estimation for the product as new is based on an internal calculation, whereby information from web results was utilized.

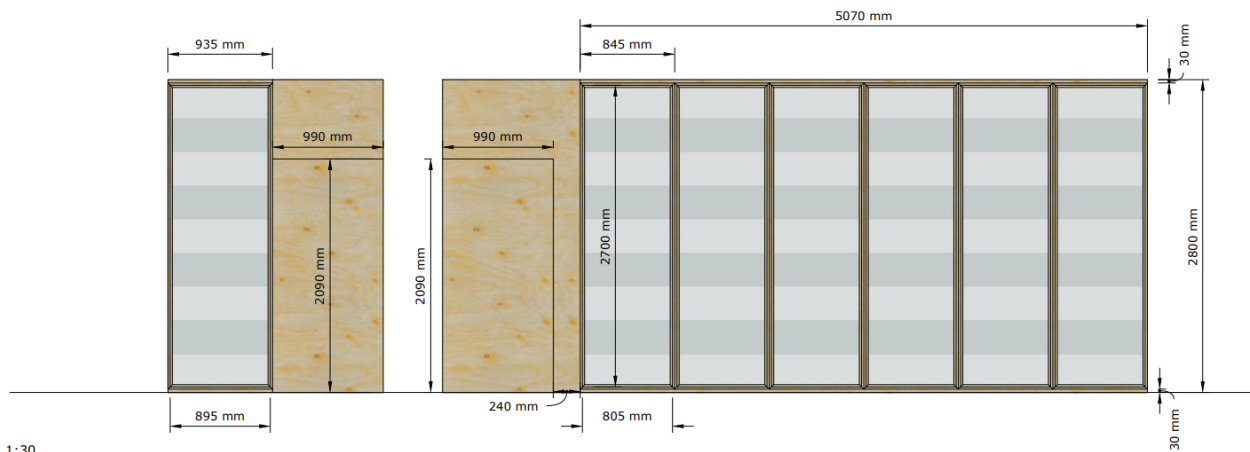


1:30  
 -Rungot mallinnettu luonnoksessa 50x100 mm puurakenteella.  
 -Punaisella merkattu vaadittavat uudet lasit.  
 -Ylempi VE1 mallinnettu aiemmin esitetyillä lasilevyillä.  
 -Alempi VE2 mallinnettu Spolian varastosta 2700mm korkeilla lasilla. Mitat täytyy varmistaa varastolta.

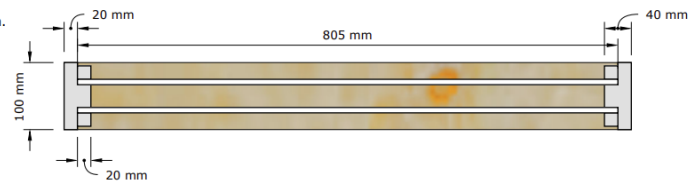
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spolia design

Figure 8. Two types of glass partitions with birch frames. The VE1 one has bars as filling to pace the surface, whereas the VE2 illustrates a blank glass surface. The picture is not in scale.



1:30  
 -Laseissa hiekkapuhallettu raidoitus.  
 -Lasilevyt 805x2700mm ja yksittäinen levy 895x2700mm.



1:5  
 -Lasin reunaprofiilin leikkaus  
 -Runkopuu, kiinnityslistat ja lasit

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spolia design

Figure 9. A glass partition with oak frames and sandblasted stripes on the glass surface to reduce the visibility. At the bottom of the image there is the image of the cutting of the glass edge profile from above, showing the frame wood, mounting strips and glass. The picture is not in scale.



### C. Living wall

The metallic false ceiling grids were selected, besides for their significant quantities in the area to go under facelift, also for their perceived reuse potential that lies in their modular nature. Their form allows for interchangeability, flexibility and scalability in that they can be easily utilized as, for example, a combination of two or 200 pieces. Moreover, they are both products that require relatively few modifications to be reused.

The metallic false ceiling grids were proposed to be used as a living wall as it can be used as such with relatively few modifications, only fastenings and wooden frames need to be obtained as new. The metallic grids can be easily painted if another color is wished. Plants from the existing property can be reused and placed on the grids.

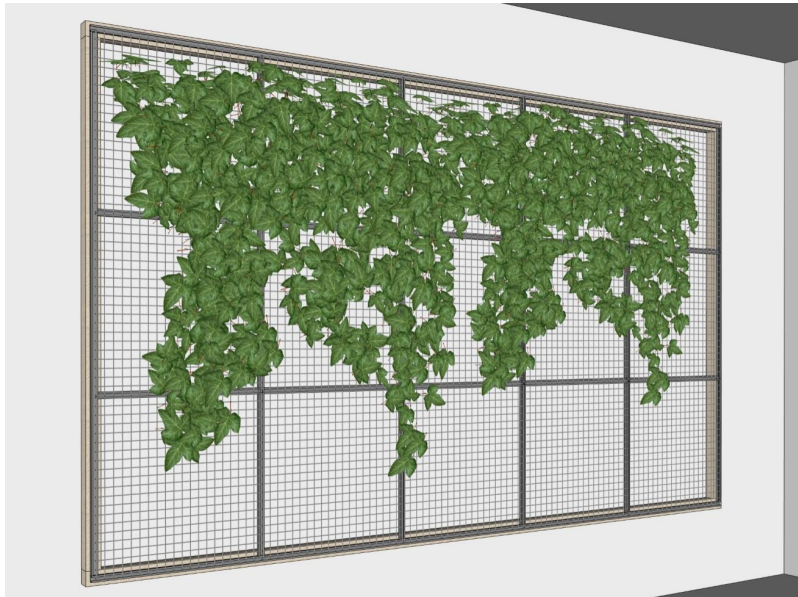


Figure 10. Visualization of a living wall made from metallic false ceiling grids.

Comparing the cost estimates for a 6 m<sup>2</sup> living wall as fabricated from used and new materials, it is found that the price as used (508 €/m<sup>2</sup>) is 15 % less compared to the price of new (600 €/m<sup>2</sup>). Both prices include component and labor costs, yet no margins. The estimation for the product as new is based on an internal calculation, whereby information from web results was utilized.

### D. (Acoustic) wall panels

Similar to the metallic false ceiling grids, the veneer wood panels make up a large quantity of the materials coming from the property's area to go under facelift. Furthermore, the modularity and minimalistic nature of the panel flexibly gives in to multifaceted uses, going beyond those proposed here.

The veneer wood panel is suggested to be reused as (acoustic) wall panels, whereby the panel is placed on the top and an acoustic panel underneath. The acoustic panel can be reused as well or obtained as new, depending on the acoustic requirements set by the room and its intended use. In this case, it is suggested to use carpet tiles to improve the acoustics of the space.

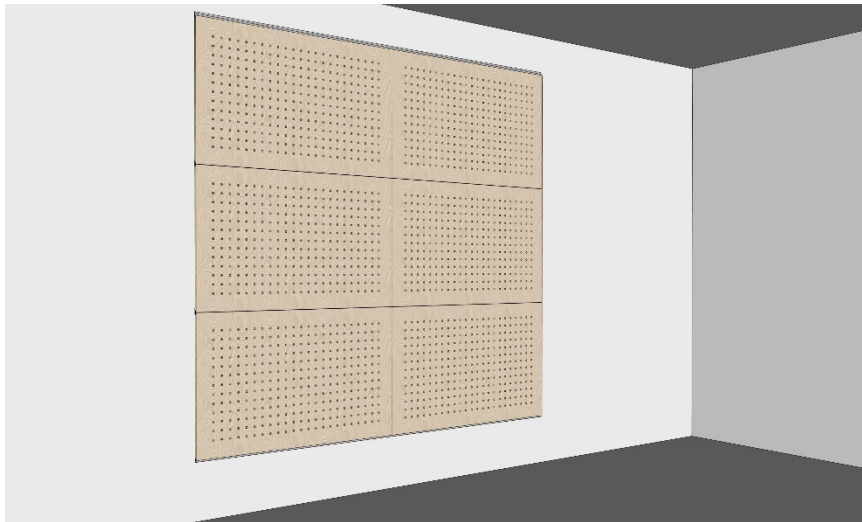


Figure 11. Perforated veneer wood panel.

In order to modify the surface of the panels, to conform it to a modern look, three treatment methods are suggested. Two of them were tested over the course of the project. The one proposed without testing is the perforation of the panel surface, whereby the surface is firstly grinded to remove the yellowing caused by the sun, followed by its perforation with regular intervals, as illustrated in figure 11. Those tested during the project are the laser treatment and surface grinder treatment. While the laser treatment was tested on a piece of parquet, due to the timing of the deconstruction, the surface grinding was tested on the actual veneer wood panel, making it challenging to compare the two processings in regard to the material qualities. Yet, both are estimated to suit the purpose of removing yellowing, dirt and grease from the panel surface, with the surface grinding treatment further being capable of removing shallow cracks.

By combining different treatment types, a lively surface can be created on the panels, as illustrated in figure 12. Here the first column from left is treated with grinding, whereas the two others are varnishing and painting, respectively.

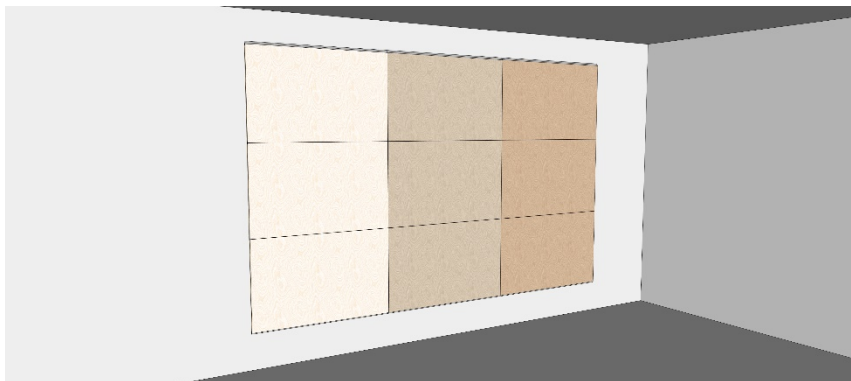


Figure 12. Veneer wood panel with different types of treatments: grinding, varnishing and painting.

A 6 m<sup>2</sup> acoustic wall panel is estimated to cost 467 €/m<sup>2</sup> as reused, whereas the price for equal but new is evaluated as 300 €/m<sup>2</sup>, making the reused a 36 % more expensive option. The prices include the costs of components and labor but exclude the profit margins. The estimation for the product as new is based on an internal calculation, whereby information from web results was utilized.

## D. Selection and development of internal circular innovations

Further circular innovations were developed and proposed to be implemented in the property owners' other properties. This was done as some of the so-called innovations were developed later and not proposed to be included in the project tendering and others, such as a storage cage could not be included in the project since the storage space was not part of the project scope.

The following two types of circular innovations were proposed and elaborated on below

### A. Storage cage

The storage cage built from false metallic ceiling grids, offers a promising match, since large volumes of metallic false ceiling grids can be expected from renovation and transformation of office premises, similar to that at Castellum's Lindström Talo. On the other hand, the demand for the grids in constructing a storage cage, in terms of quantity, is vast as the surface area of the storage cages is large and it is composed solely of the metallic grids. Moreover, transferring grids to another location is easy due to the lightweightness and compactness of the product, enabling their utilization in another property.

The storage cage consists of reusable metallic false ceiling grids as well as wooden frames and fastenings that are sourced as new. The thick metallic grids provide a robust storage frame to preserve the items inside. The surface of the grids can be painted to modify the appearance of the cage, if wished.

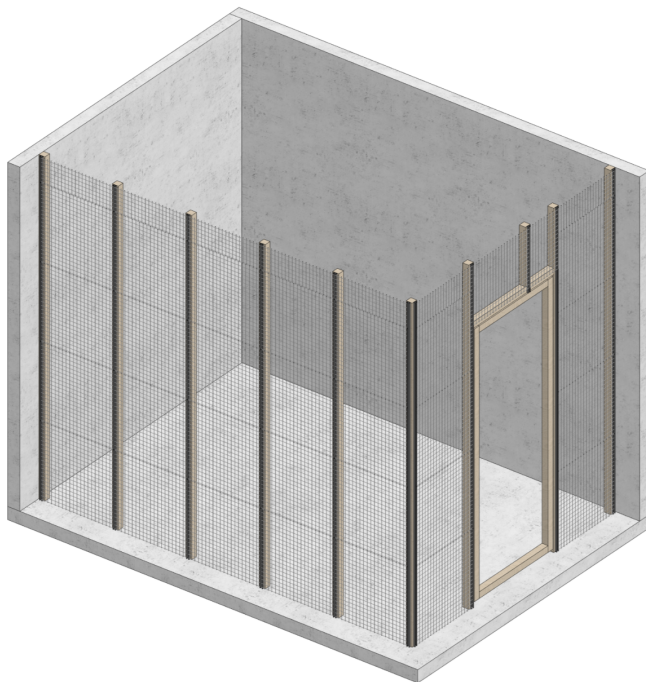


Figure 13. Visualization of a storage cage made from metallic false ceiling grids.

It is estimated that the cost of the storage cage, composed of reused metallic false ceiling grids (132 €/m<sup>2</sup>), is 12 % cheaper than that of a new one (150 €/m<sup>2</sup>). The prices include both the costs of components and labor, but exclude the profit margins. The estimation for the product as new is based on an internal calculation, whereby information from web results was utilized.

## B. Recessed ceiling light

The project scope included around 200 integrated false ceiling lights, making them a significant product in terms of quantity, alongside the metallic false ceiling grids and veneer wood panels. Furthermore, since the lamp frames were deemed to be in good condition, the several lamps could be reused in multiple premises of the client. In order to reuse the frames, their source of light would need to be changed and their outlook modernized. To do so, the lights are designed as pendant lights. Hereby the grid attached to them was removed and four cords were attached to the lightning frame, allowing it to hang elegantly from the ceiling. The initial frames are gray silver and they are proposed to be painted, for example in white, to better suit the interior design.



Figure 14. Visualization of the integrated false ceiling lights (right) turned into hanging lamps (left).

The costs of the recessed ceiling light as new (250 €/m<sup>2</sup>) is estimated to be 15 % cheaper than the costs of the reused one (294 €/m<sup>2</sup>). The cost estimates include the costs of labor and components. The estimation for the product as new is based on an internal calculation, whereby information from web results was utilized.

## E. External circular flows

A circular strategy was developed for the surplus components that were excluded both from the facelift's furniture plan and the selection to be developed into circular innovations. Based on the broader list of all the products, Spolia Design, in cooperation with Zupply, determined those products for which either sale or take-back could be arranged, in case the real estate owner agrees to proceed in this manner. The products that were selected for sale were chosen based on the following criteria: estimated high market price, widely used product for which there is demand on the market, unique item and significant quantity.

Based on the different types of products, four types of actions are suggested. All of the actions aim at preserving the product's or component's initial value, thereby avoiding the creation of additional CO<sub>2</sub> and ecological impacts. The actions are as follows:

1. **Re-sale of surplus products in an open marketplace developed by zupply and Spolia,**
2. **Re-sale of surplus products in other market places,**
3. **Arranging a take-back of products and materials by manufacturers via zupply platform**
4. **arranging a pick up of surplus products by Kierrätyskeskus (Recycling Centre).**



Depending on the project context and the will of the real estate owner, the actions can be deployed either in combination with all or some of the actions, or individual actions can be selected to be executed. As the real estate owner ultimately decided to keep the products and store them instead for future uses, the circular strategy, or parts of it, remain to be applied by the owner in other property facelifts and projects.

The strategy's actions are described as follows.

### 1. Re-sale of surplus products in an open marketplace developed by Zuppy and Spolia

A connection from Zuppy's digital platform to the Spolia Store was designed, and an execution proposal was drafted. The connection allows linking the determined surplus products from Zuppy's platform to the Spolia Store (see Figure 15), where they can be viewed by potential customers and others interested. The execution proposal involves joint marketing efforts for increased attention on the surplus products from the Lindström Talo. After the products have been sold, they can be picked up by the customers on (a) defined date(s), after the operations in the building or space have ceased and before the interior demolition begins. In case the products in question are interior finishers that need to be deconstructed, those can be picked up by the customer after the deconstruction has begun. Another option to arrange the pick up and draw more attention to selling the items would be to arrange a pop-up sales event. Marketing for the event should be done prior to it, while the event itself can be arranged at the Lindström Talo, with the agreement of the property owner.

Since the property owner decided to keep the products and store them instead for future uses, it was decided not to execute the plan or any of the following solutions at this moment. The open marketplace initiative remains as a future endeavor of the collaboration between Zuppy and Spolia Design.

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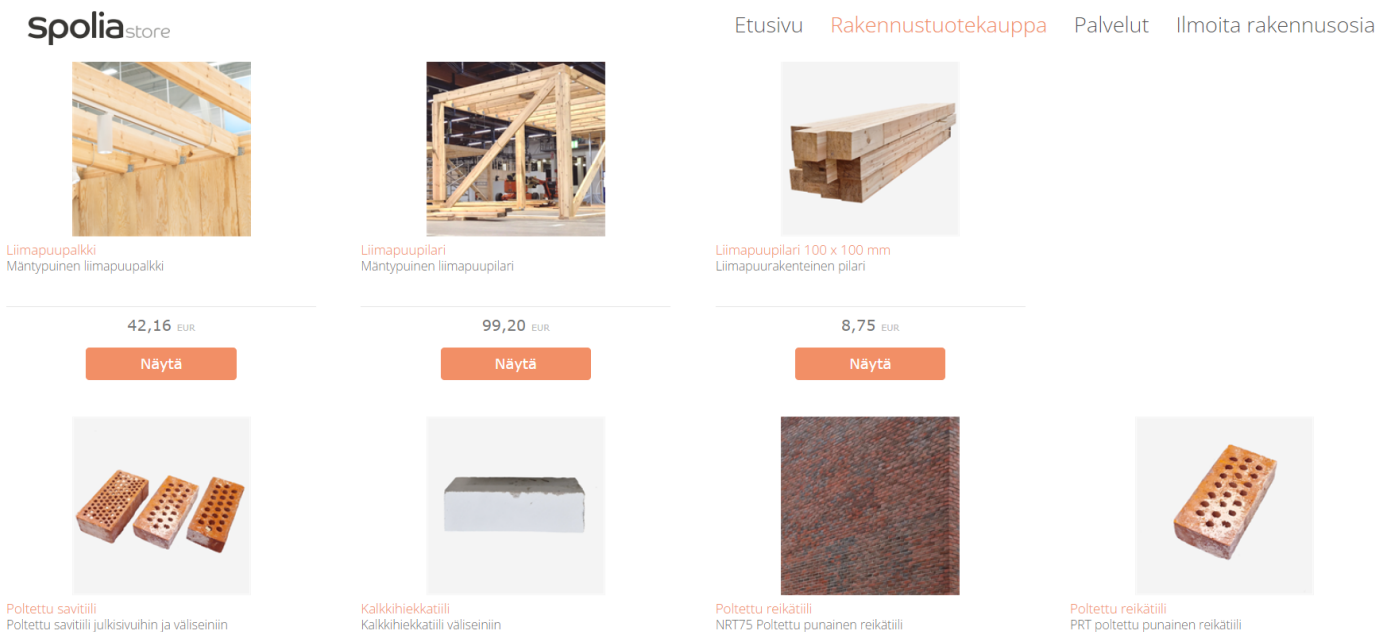


Figure 15. Illustration of Spolia Store - a webshop for reusable construction components.

### 2. Re-sale of surplus products in other marketplaces

Two further digital sales platforms were identified as potential marketplaces for selling surplus products. The digital platforms allow reaching a large audience of which some actors can be on the lookout for the products one aims to sell. The platforms are Tori.fi and Huutomylly.fi.

The former is a marketplace where seller gives a price for products and customers negotiate with sellers for closing the deal. Huutomyly.fi, on the other hand, is an auction platform where the actor that offers the highest bid within a defined timespan can buy the product for the offered price. However, when using this channel, it must be noted that the product cannot be on sale on other platforms as the price will necessarily differ across the two platforms.

Here the products are to be published on the sales channels as early in the project as possible to ensure sufficient time for marketing and selling them before the pickup date between when the operations in the building or area have ceased and before the interior demolition begins, similarly as presented in option 1.

### 3. Arranging take-back for surplus products by manufacturers with zupply platform

Take-back of determined surplus products was considered during the project. The take-back is enabled by Zupply’s platform that has a take-back function that manufacturers, willing to establish take-back processes and practices, can register for. On supply side, project managers, contractors and consultants working on reuse of construction materials and products, can register the materials and products to be taken back by the manufacturers. The products are then either picked up by the manufacturers or sent by the contractors.

Arranging take-back for surplus products can be particularly useful in situations where the product brand is known by the project team and the brand manufacturer already possesses a take-back system. This can be a relatively low-effort means to allow the products a reuse through refurbishment and resale, carried out by the manufacturer.

Within the context of this project, connections were built with Knauf and the Danish Fischer lightning for the take-back of gypsum boards and ERCO lightning, respectively. The late decision to use the take-back on zupply’s platform and the limited project period made it challenging to build new take-back partnerships that would operate via the platform.

Take-back tasks should also be part of the tendering documents, so that process will go smoothly in action. In the future, when these kinds of solutions are widely offered, it is going to be contractors, who are going to purchase the best and the most profitable partner.

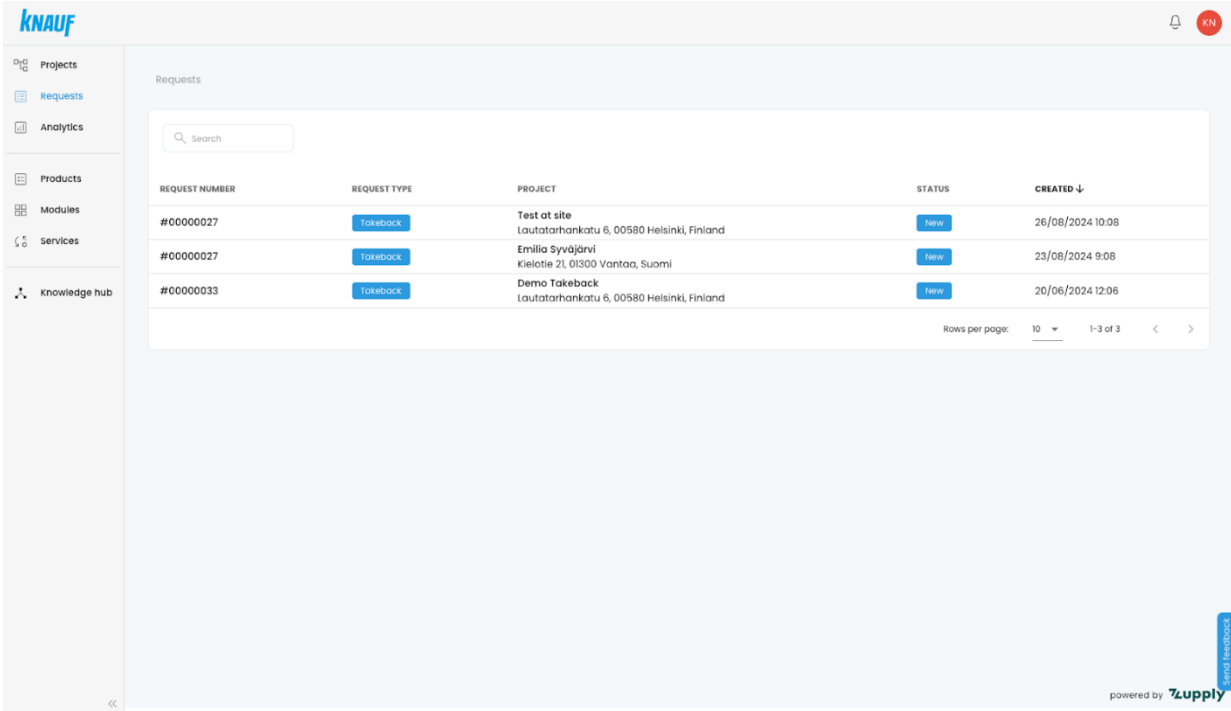


Figure 16. Illustration of zupply platform’s take-back function that allows the project coordinators to arrange the take-back of products and materials to manufacturers that are registered on the platform.

#### **4. Arranging a pick-up of surplus products by Kierrätyskeskus (the Recycling Centre)**

Arranging a pick-up of surplus products by Kierrätyskeskus (the Recycling Centre) is proposed as the fourth practice to enable the reuse of products. This could be carried out for the products such as the furniture, lighting fixtures and decorations but also for the construction components, with the condition that they are in good condition and suitable for reuse (Kierrätyskeskus, n.d.). The pickup costs 99€ and the products need to be donated.

#### **F. Deconstruction methodologies**

Product cards were drafted for those materials that were proposed to be reused in the facelift project. These include both those materials that were planned to be reused by the interior designers, such as white gypsum board false ceiling and metallic false ceiling and those that were allocated to be reused in the circular innovations.

The product cards involve information about the specific product or material in question, such as veneer wood panel, its manufacturer, measures, the amount of the specific material available in the area to go under facelift, description of the material and elaboration of its qualities. Furthermore, it includes step-by-step deconstruction instructions, written based on deconstruction tests conducted in parallel to the resource mapping. Here, one or two of the products/materials were deconstructed to investigate how or with which fastening they are attached, for example to the wall, and to gain an understanding of how is the fastening system that structures and holds the materials in place. Based on this information, it was examined how the material can be deconstructed in a manner that keeps it intact and enables its reuse. Lastly, a proposal for refurbishment of the product was included in each product card to give suggestions of how the material can be treated to improve its qualities and thereby the reusability in the same or another function. The minimum refurbishment performed on each product is wiping away dust from the material surfaces, whereas in other cases, where visible treatment is necessary, grinding and painting were recommended, for example.

The product cards were used in the facelift project to guide, firstly, the contracting parties and secondly, the designers. The designers attached product cards to the tendering documents to inform the main contractors about the activities related to the deconstruction of the selected materials and thereby provide valuable information needed for the tender calculation conducted by the contractors.

Secondly, the product card's deconstruction instructions informed the deconstructing contractors in how the materials and products are fastened and how they can be deconstructed while keeping them intact and fit for reuse. In order to improve the product cards and their instructions, the deconstructing party was interviewed for feedback. The demolition workers reported that they had actively used the deconstruction instructions to find the most suitable way to deconstruct the materials to be reused. They found the A4 paper format of the product cards practical in the construction site setting and the demonstration of the deconstruction practices of different fastening types as useful. As critical remarks they noted, for example, that the product card contains plenty of information of which not all is relevant to the deconstruction workers. This implies that solely the information relevant to the deconstruction workers should be included in the product cards that are addressed to this party. In such a case the format could be named as deconstruction instructions. In addition to the written instructions, the deconstruction workers stated the need for occasional oral guidance, giving them either confirmation of correctly deconstructed parts or feedback on how to enhance the practices of deconstruction to obtain the desired outcome. The provided comments and improvement suggestions will be integrated in developing the product cards. They are further completed and updated with the information extracted from the project to ensure the information is passed on for future projects.

A third function of the product cards in the facelift project is to serve as information of product origin, measures etc., for the real estate owner and property managers. Thus, it is recommended for the owner to store the cards for the products that were reused in the project in their building management program to ensure the product information remains available for when it is needed.

The product cards are updated with the actual data after the project is completed, to ensure that information is passed on for future projects.

Tuotekortti	EHJ_1325_001_SM	27.2.2024
Tuotekategoria	Tilapinnat Seiniin pintarakenteet	
Valmistaja	Tuutematon	
Tuote	Puinen sisäseinäpaneeli koivuviilu pinnalla, paksuus 12,5mm, jossa lakattu pintaviilu 0,5mm	
Tuote ID	SS.022-LT.CI.002	
Kohde	SS.022-LT.CI.002-001	
Määrä	15,2 m <sup>2</sup>	
Mitat	690 x 800...1400 mm	
Materiaali	MDF kovalevy, koivupuinen pintaviilu	
Kuvaus	Jatkuvaksi asennettu puinen sisäseinäpaneeli koivuviilu pinnalla. Tuote voidaan puhdistaa ja pinnoittaa uudelleen. Levytyksen pinta jatkuva, säännölliset saumat. Levyn pönteissa on urat, joista levy on kiinnitetty alumiinilistaan. Alumiinilista on kiinnitetty runkoon ruuveilla. Tilan väliseinä puretaan. Levyt ja kiskot irrotetaan ehjänä jatkokäyttöä varten. Huom! Kuvat alumiinilistasta eivät ole tästä kohteesta, mutta ovat oletettavasti kiinnitetty samalla periaatteella.	



Figure 17. Part of the product card for veneer wood panel (in Finnish).

Figure 18. Deconstruction workers removing the veneer wood panel as instructed in the deconstruction instructions.

## G. Site monitoring and other activities

Spolia Design conducted site monitoring over the renovation period from 24.6. until 1.8. The monitoring took place mainly at the beginning of the project, during the deconstruction (24.6.-5.7.), since the reuse of selected items depended most on the activities performed here. Moreover, Spolia Design was not part of the execution design. In order to support the execution of reuse activities in the facelift project and beyond, the following two types of measures were performed:

1. interviewing contracting parties and other project stakeholders, and
2. documenting the renovation process.

The activities are further described below.

### 1. Interviewing contracting parties and other project stakeholders

The project stakeholders were interviewed to gain a holistic understanding of how the reuse process flow was perceived and how the reuse process in the case of such a project should look like. For this, the contracting parties were interviewed, both the main- and subcontractors, the interior architecture office representative and the representative of the property owner and client, Castellum. The interviews took place both in presence and on Teams, depending on the interviewed stakeholder. The format of the interview was semi-structured, which allowed the space to deviate from the predetermined question protocol. The questions are presented in Appendix.



The interviewed contracting parties were the representative of the company that undertook the deconstruction, two deconstruction workers and the representative of the main contractor. The objective of the interviews with this group of stakeholders was to gain insights into the perspectives of those responsible for the execution of the deconstruction (and construction) and thereby, for the realization of reuse in practice.

Towards this goal, the questions investigated

- how product cards, especially regarding their content and format, can be improved to suit the needs of the deconstruction workers (see section 3.3, work package F for an elaboration)
- which information should be added to the tendering documents to ensure a successful execution of reuse activities
- how the removal of furniture, lightning and decoration should be arranged prior to the deconstruction depending on the way they are proposed to be reused, deconstruction of finishing components, packaging and logistics should be arranged at the construction site to enable reuse; in other words, the process flow, its challenges and successes as well as how the reuse process should be arranged in a similar facelift project in the future
- communications in the process



*Figure 19. Deconstruction worker cutting and taking down T-lists was interviewed on their intact deconstruction and subsequent reusability. The metallic false ceiling grids that laid on the T-lists were taken down earlier.*

The interview with the representative of the interior architecture office aimed at gaining an understanding of how the reuse process should be arranged in such a facelift project from the perspective of the interior architects. Thus, the questions addressed mainly

- the challenges that occurred in the project regarding inclusion of reuse practices and solutions
- the needs in and solutions for including reuse practices and reused products in a similar facelift project in the future

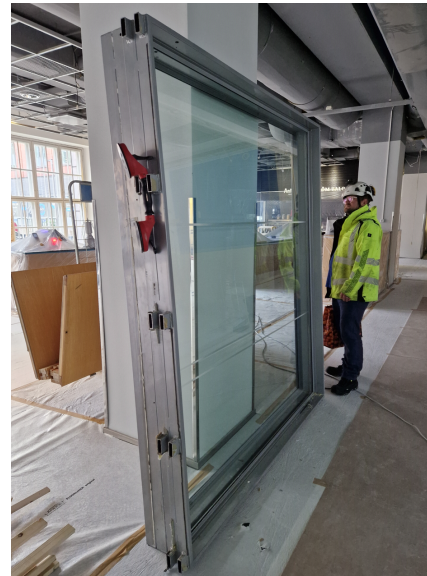
Lastly, the representative of the property owner and the client of the project was interviewed to inquire about the perspective of the property owner on the implementation of reuse practices in a facelift project. The discussion touched upon

- the project management and how it should have been arranged in this specific project
- how reuse activities should have been included in this specific project
- which factors influence the decision of the real estate owner to choose to reuse a product or component instead of buying new ones
- project challenges, learnings and successes

The results of the interviews are presented partially in this report, mainly under sections 3.3, work package F and 3.4 on project challenges. In order to present the findings in a coherent and comprehensive manner, a manual will be published that describes how the process of reuse should take place in each of the project phases in a similar facelift project execution.



*Figure 20. The contracting parties were interviewed, among others, about how the collection and packing of the materials should be arranged.*



*Figure 21. Inspecting a deconstructed glass structure for its reusability.*

## **2. Documenting the renovation process**

The renovation process was documented by taking pictures and notes of the different steps of the process. Furthermore, information about the suitability of specific products for deconstruction was gathered to evaluate their reusability. Observations on a few materials are presented below.

The glass structures of the negotiation rooms were welded, making it difficult to dismantle them intact. While technically feasible, timelines can be exceeded and costs rise significantly due to the amount of manual labor required. In the future, similar structures should be assembled with screws and bolts. Furthermore, the same structures extended under the floor slab and were hence hard to detect. For the future, it is recommended that a more thorough investigation would be undertaken prior to the project start, ensuring nearly a 100% certainty of the type of fastening points.

A type of floating ship deck-style parquet flooring (covering the canteen area and negotiation rooms) where the planks are connected with rubber seams was at first planned to be grinded. Yet, it turned out that the material was warping, and sanding with a large disc sander was not feasible, as the surface would wear through and the seams could not be reached. In the future, a test sanding before tendering would confirm the viability of the method.

The false ceiling gypsum boards can have complex attachments, which is why practicing and ensuring a proper removal is essential for dismantling the panels intact. Those handling the



gypsum boards should wear clean gloves to avoid dark fingerprints on the white board. The frame structure is sensitive to twisting during removal, hence selecting the right tools and following the proper disassembly order is key. The deconstruction should start from the edges, first removing short intermediate hangers, then longer hangers, and finally the main hangers.

## **H. Post renovation digital twin / mapping for future reporting and future benchmarks**

The post-renovation digital twin and mapping conducted by Zupply were crucial elements in ensuring that the outcomes of the Lindström Talo Circular Economy pilot project were accurately documented and could be used as a benchmark for future circular economy initiatives. Following the completion of the renovation, Zupply utilized advanced 3D modeling techniques and Matterport scanning to create a comprehensive digital twin of the renovated area. This digital twin provided a precise visual and data-driven representation of the space, capturing the final condition of the building, the materials that were retained, and those that were removed or replaced. By mapping each product and material, the platform offered a clear view of the circular strategies implemented, allowing stakeholders to analyze what was reused, refurbished, or newly added to the building.

In addition to creating a detailed digital representation of the site, the platform also tracked key sustainability metrics, including CO2 savings and comparisons between different circular and traditional approaches. This data allowed for a thorough assessment of the environmental impact of the renovation, highlighting the reductions in resource consumption and CO2 emissions achieved through circular practices. The post-renovation digital twin will serve as a valuable resource for future projects, providing a benchmark for tracking progress in implementing circular economy principles. It will also enable ongoing facility management to maintain the transparency of material flows and help understand the lifecycle of products used in the building, supporting future reuse or refurbishment efforts. This integration of digital tools ensures that circular practices are not only implemented but also sustained in the long term.

The integration of both pre- and post-renovation data within Zupply's platform offers significant long-term benefits for compliance reporting and sustainability tracking. By comparing the mapped resources, materials, and products before and after the renovation, Castellum can use this data to automate compliance reporting in future projects. Zupply's platform is equipped to generate detailed reports on material flows, waste reduction, and CO2 savings, which can be directly aligned with regulatory requirements for sustainability and circular economy practices. This automation will streamline the reporting process for Castellum, ensuring that they can easily meet both local and international standards for environmental performance without the need for manual data collection and analysis. Additionally, this capability provides ongoing transparency and accountability, supporting Castellum's commitment to sustainability in future renovation and construction efforts.

A figure below presents the screenshot of the post-renovation digital town created by Zupply.

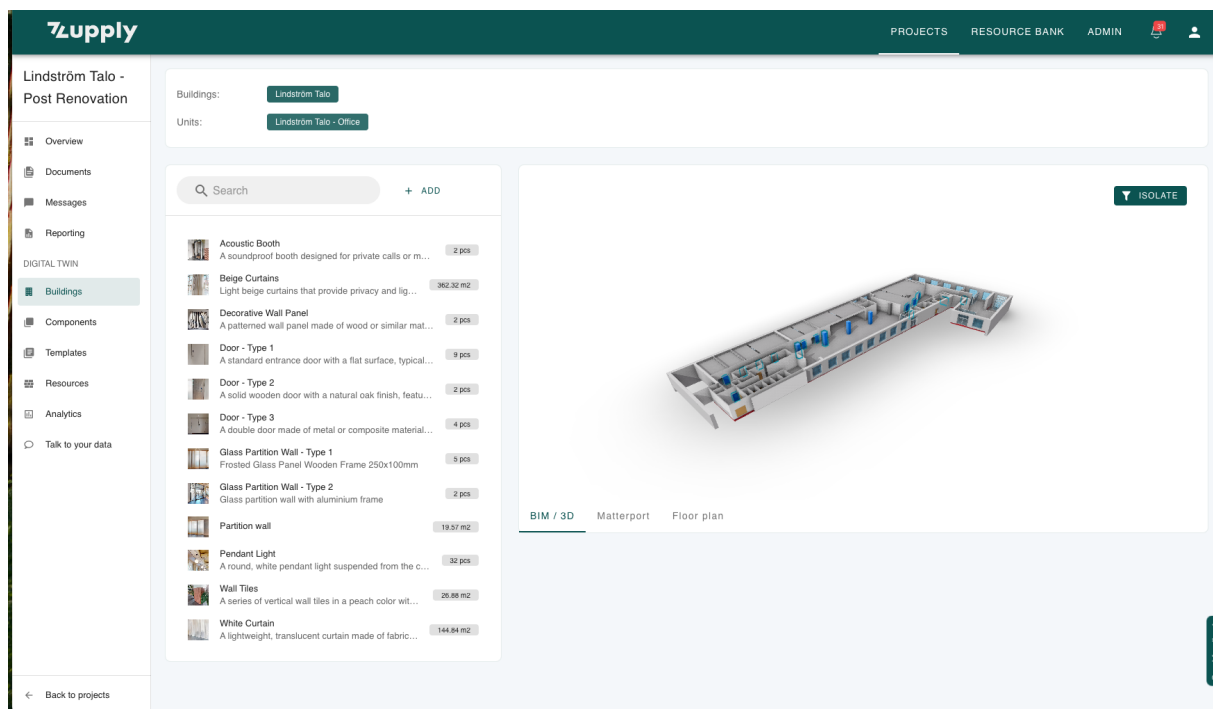


Figure 22. Post-renovation digital town.

## I. Development of Best Practices Manual for renovation projects with circular economy

Sharing knowledge and experiences is one of the project's top priorities. Thus, a best practice manual will be published in October 2024. It involves the key learnings of the project team gained throughout the project and describes how a similar facelift project with reuse aspirations can look like to ensure success. Similarly to this report, the manual will be published by the City of Helsinki and shared through its networks.

### 3.4 Challenges

Challenges emerged mainly at the beginning of the project. Firstly, during the setup of the project organization and project timeline, defining objectives and deliverables, followed by the design phase and lastly, during tendering and contracting. These are the stages where the type and extent of reuse activities and practices deployed in the project are defined, how they are implemented and with which resources.

#### Setup of the project organization and project timeline, defining objectives and deliverables

The late start of the pilot project in relation to the tight timeline of the property's facelift project led to insufficient time for creating circular innovations to be implemented in the facelift project. Furthermore, the facelift project's designated project manager's responsibilities did not include the supervision of implementation of reuse activities of the pilot project. These factors created a situation where the two projects ran in parallel, whereby the reuse activities could not be implemented in the facelift project. Besides, communication between the two projects was disorganized, taking place mainly via email and not through the Zupply's platform, where the materials regarding the proposals were uploaded. Responsibilities were unclear and clear leadership would have been needed to guide the activities and discussion. Lastly, objectives and deliverables should have been clearly defined and jointly agreed on at the beginning of the project.

### **Implementing reuse in the interior architecture design**

Large volumes of construction components and other products resulting from office renovation projects in general, provide products to be reused en masse. This, however, conflicts with the objectives of interior architecture where culture idealizes unique spaces and artisanal works instead of replicating solutions and using large volumes of the same products and materials. Another factor hindering the reuse of components is the lack of resources at small interior architecture offices, to sift through a large number of products on platforms like Zupply to find the ones they want to reuse in the project. Lastly, the risk of products, such as glass structures, breaking between their deconstruction and installation can be too high, especially if there is no guarantee that equivalent one can be found within the project budget and schedule.

### **Informing tendering and contracting**

In order to successfully implement reuse actions, those need to be elaborated on in the tendering documents. However, some of the reuse activities were not clarified by the tendering phase, hence they were not realized in the project. In addition, some initiatives emerged during the deconstruction that, eventually, could not be implemented as there was no budget allocated to them.

# 4. References

Kierrätyskeskus (n.d.). *Rakennustarvikkeet*. <https://kierratyskeskus.fi/lahjoita-tavaraa/mitavoim-lahjoittaa/rakennustarvikkeet/>

# Appendix

Interview questions posed to the different project stakeholders are presented below. The objective was to interview the project manager as well and a questionnaire was sent by email. However, no response was obtained.

## **Main contractor**

1. How should the quality requirements for products that need to be removed intact be presented, for example, the corners and sides of gypsum ceilings must remain undamaged, the surface must stay clean, etc.? (This is the responsibility of Spolia/the contractor)
2. What improvements are needed in product cards?
3. Has the content of the product cards matched the actual situation?
4. What kind of circular economy monitoring and practical guidance would be beneficial on-site?
5. What is the clearest way to separate products that need to be preserved? A separate space like the 5th floor or auditorium, or another solution?
6. How should the worker be encouraged to focus on product removal?
7. How could the future installer be utilized in the dismantling process?
8. At what stage should the implementation of the circular economy be reviewed with the contractor? During the tender phase, after the contractor's selection, or is there no need if the plans are well-prepared?
9. How should packaging and similar tasks be organized? Would it be beneficial if the packaging materials are already prepared?

## **Subcontractor**

1. General thoughts on the reuse of building components?
2. Have the product cards been utilized? What improvements are needed?
3. Has the content of the product cards matched the actual situation?
4. What kind of information is most helpful during dismantling, and what speeds up the work the most, e.g., known fastenings, manufacturer, etc.?
5. What is the best format for implementing circular economy solutions: product cards, plans, work descriptions?
6. How could communication be improved on-site?

7. How could the intact removal of materials be improved, e.g., gypsum ceilings?
8. How long did it take to remove components like the stainless-steel-framed glass structure, gypsum ceiling, grid ceiling, wall panels, lighting fixtures, large glass panels?
9. What kind of practical guidance in circular economy would be useful on-site?
10. What is the clearest way to separate products that need to be preserved? A separate space like the 5th floor or auditorium, or another solution?
11. How should packaging, etc., be organized? Would it be beneficial if packaging materials were already prepared?

### **Interior architecture agency**

Products from office renovation projects in general

1. Which products are most commonly found in office renovation projects in terms of quantity? Does the Li Talo project differ from this in any way?
2. From your perspective, which of these products has the greatest reuse potential: both within the same project and in other projects?
3. From your point of view, how could these products be best utilized in the same project? What phases/steps are needed in the process? How should this be approached in terms of scheduling?

Process perspective

4. How should the process have been managed from the designer's perspective if the product innovations we proposed were to be implemented in the Li Talo renovation project?
5. What role do you think Spolia should have taken in such a project from your point of view?
6. What should be considered from a design perspective if products are to be reused in a renovation project?
7. How can reuse be promoted from the project's perspective?

### **Property owner (and project client)**

1. Is there anything you would like to say about the course of the pilot project in general? Ensure to first keep the open question and if he does not touch upon the layers, ask him.
2. What is your feedback on taking the pilot project separately from the into the actual renovation project? Is there a feeling that this was a challenge that made the project not have the best success? In the future, would you recommend scoping the circular strategy as part of the project?
3. In which forms could the circular solutions find their way to such a project, e.g., in the form of a separate procurement? Or, in other words: how should they be sold to this kind of a project?
4. What factors influence the client's decision-making the most when implementing this type of project?



5. How could circular economy strategies become a business of choice in Castellum's renovation projects?
6. What has been the project's challenges from your perspective?
7. How could these challenges have been avoided?
8. Where do you see the successes of the pilot project? (explain not too much about performance)
9. What have been the most significant lessons for you, as extracted from this pilot? (we are not asking about performance of the team but other project. Try not to divert into feedback.

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