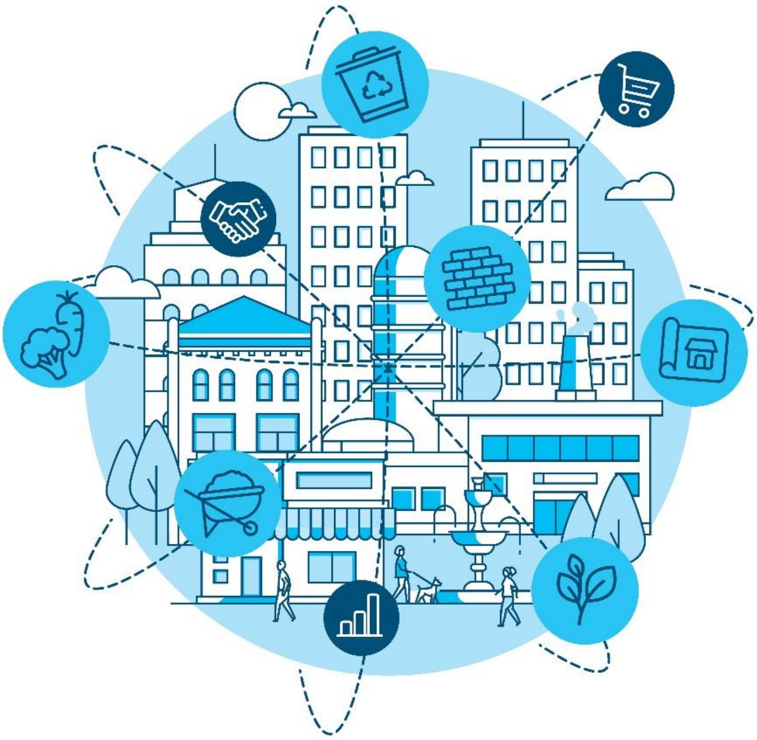
Circular demolition in Mikkeli

Extract from the Demonstration Report

Mikkeli, Finland



Contents

This text describes Mikkeli's experience in demolishing the Pankalampi health centre and the Tuukkala hospital. The sections come from Mikkeli's CityLoops demonstration report available here.

Introduction

In Mikkeli two buildings were demolished as demonstration actions.

Pankalampi health centre

The site consisted of three separate buildings: a health centre (A), a dental clinic (B) and a garage / storage room (C) (Figure 2). The health centre consists of an old part (A1, built in 1976) and an extension part (A2, built in 1992). The dental clinic (B) was built in 1979. The garage / storage building (C) was built in 1992.

Figure 2. Overview of Pankalampi health centre. (Photo: Esa Hannus, Xamk)

During the history of use, the buildings were renovated and repaired, and the surface materials of the premises were renewed. The floor areas of the buildings were as follows:

A. main building:	8399 m^2
B. dental clinic:	1416 m^2
C. garage / storage:	40 m^2
In total	9855 m^2

Tuukkala hospital

The old part (A) of Tuukkala Hospital (Figure 3) was built in 1960 and the new part (B) in the 1970s. The buildings were vacant since 2010.

Building A was 5-storey, of which the ground floor was partly underground. Construction B was a 4-storey building. The buildings had a reinforced concrete structure, the exterior walls were covered with brick. During the history of use, the buildings were renovated and repaired, and the surface materials of the premises were renewed. The total floor area of the two buildings was 5350 m².

Figure 3. Tuukkala Hospital. (photo Esa Hannus, Xamk).

The demolition process of Pankalampi Health Centre and Tuukkala hospital was managed by the Building Services Department of Mikkeli Municipality, which was not directly part of the CityLoops project. The role of the CityLoops team of Miksei, Mikkeli and Xamk was to observe and document the workflow, and to identify opportunities and obstacles in transforming the process towards increased circularity.

The demonstration included the testing and co-developing selected CityLoops tools/instruments and draft guidelines. The key findings of these testing activities are reported below and in separate annexes.

Procurement activities

The procurement activities included the procurement of demolition contracts for Tuukkala Hospital and Pankalampi Health Centre. Mikkeli's Building Services were responsible for the procurement. The demolition of Tuukkala Hospital and Pankalampi Health Centre were tendered as separate contracts, but contractors could also present their offer as a package for both. The demolition contracts included the demolition work of buildings including their foundations. The demolition contracts also included demolition of structures, equipment, technical systems and surface structures in the yard area.

The role of the CityLoops-team was to comment on the procurement documents and to make proposals regarding the incorporation of circularity issues in the procurement process.

The digital marketplace was procured by Miksei Ltd. The offer request was published in public procurement database in June 2020. Social responsibility reports were required as eligibility requirements in the procurement. Sustainability reference in the procurement criteria was awarded with 10 % of the total amount of points at maximum. References of previous solutions for circular economy was assessed with max 35 % of total points.

Miksei received two tenders, and Metatavu Oy was selected to deliver the digital marketplace program.

Circular economy objectives in tender planning

The following content in the tender documents and the demolition process was created directly through the interaction between the CityLoops project, the city, and the waste company:

- The tender document required that demolition work be carried out as selective demolition, with the different types of waste being separated primarily at the source.
- The contractor was required to present a waste management plan as part of the demolition plan. The request referred to the eight types of waste to be collected separately listed in the Waste Decree and required that the deviation from this sorting be justified.
- The contractor is required to provide a summary of the waste generated. In the past, this has been required, but only as a formality. No *ex-post* assessment of the report has been carried out.
- It was recorded in the contract program that the persons nominated by the CityLoops project will perform seepage water sampling at the construction site, personal occupational hygiene measurements during the manual dismantling phase and environmental measurements, drone monitoring and other demolition work documentation during the dismantling phase. The implementation of these measures is the responsibility of the CityLoops project.

The tender did not include quality criteria that would have promoted the circular economy and related innovations. One of the project's proposals was to include minimum requirements for soft stripping and indoor demolition or quality scores for source separation of wastes but these were not included because there was fear that it could increase the total costs or that the verification of quality criteria could be challenging. For example, the number of types of waste to be collected separately as a quality criterion could only be verified at the end of the contract. The actual recycling rate, on the other hand, cannot be decided by the contractor, as all wastes are delivered to the city's waste management company.

Based on lessons learned from the demolition cases, a useful discussion took place, which later led to the preparation of a procurement guide for demolition projects for future demolition projects.

Six bids were received for demolition of each of the two cases and six bidders offered the demolition of both sites. Ahosen Palvelut Ltd. from Jyväskylä was awarded the contract for Pankalampi and Terra Infra Ltd. from Kouvola won the tender for Tuukkala.

Screening of the buildings

Before and during the demolition of the demonstration buildings, screening procedures were carried out to find out the recycling and reuse possibilities of the demolition materials, to test 3D drone modelling to track material flows, and to monitor the health and environmental effects of the demolition.

Pre-demolition audits

A pre-demolition audit is an important part of planning a demolition project. The purpose is to assess the types and quantities of wastes, harmful substances, and the potential for the reuse of demolition materials and to suggest a material management plan accordingly. The pre-demolition audit is typically divided in two parts: 1) an audit of asbestos and other hazardous materials and 2) inventory on reusable and recyclable materials.

In case of Mikkeli demonstrations, City of Mikkeli commissioned an audit of asbestos and other hazardous materials from a pre-selected external consultant (Ramboll Finland Ltd) for both demonstration premises as a standard practice. As a requirement for applying for a demolition permit, the City used its own staff to provide the building permit authority with a notification of demolition wastes, where the amount of each waste fraction was estimated.

In the CityLoops demonstration, the main focus was on the inventory part of reusable materials which is a voluntary practice in Finland. Xamk ordered a pre-demolition audit for the Pankalampi dental clinic building as part of the CityLoops project. The inventory was made by Ramboll Finland according to Finnish Ministry of Environment Guide (Wahlström et al. 2019). The audit report was included in tendering documents of the procurement of demolition contractors. In addition, Xamk students made a detailed inventory of the reusable furniture, HVAC equipment etc. of the dental clinic building, on the request of the Mikkeli Activity Centre.

CITYLOOPS GUIDE FOR PRE-DEMOLITION AUDIT
This procedure explains how a pre-demolition inventory and material audit can be conducted to identify building components and materials with reuse or recycling potential. CityLoops Mikkeli team participated in the co-development of the CityLoops pre-demolition audit guide in co-operation with the Capital Region of Denmark (see box below). The Finnish Ministry of Environment Guide on Pre-demolition Audits (Wahlström et al. 2019) was translated in English and used as basis for CityLoops guide. The experiences from Mikkeli demonstration were utilized in the CityLoops guide for pre-demolition audit. Furthermore, the pre-demolition audit report of the Pankalampi dental clinic building (Eskelinen 2020) was translated into English for the use of other demonstration and replication cities. Practical experiences from implementing pre-demolitions audits were gathered by interviewing Finnish consultants and other projects.
Lessons learned The pre-demolition audit guide is an important tool that is suitable for replication in all demolition sites. Reuse of building parts cannot be promoted without a pre-demolition audit. Effective implementation still requires more experience. The pre-demolition audit should be done well in advance of the demolition and in cooperation with various stakeholders, so that the recycling of reusable materials can be connected to the design processes.
<Link to instrument> Microsoft Word - CityLoops_Pre-Demolition Guide_Final draft 15.3

3D drone scan and flow-tracking

Drone monitoring was carried out by Xamk at the Tuukkala and Pankalampi demolition sites during 2021. The imaging was performed mainly 1-2 times a week during demolition phase, (in Tuukkala demolition site 10 times and in Pankalampi 24 times). In addition, monitoring continued in 2022 at the Pellosniemi replication site (10 times), where four apartment buildings owned by Mikalo Ltd rental housing company were demolished. The aim of the drone monitoring was to demonstrate mainly CDW volume calculations using 3D modelling tool (Figure 4). The methods and results are explained in more detail in a separate report (Vihavainen et al. 2023a)

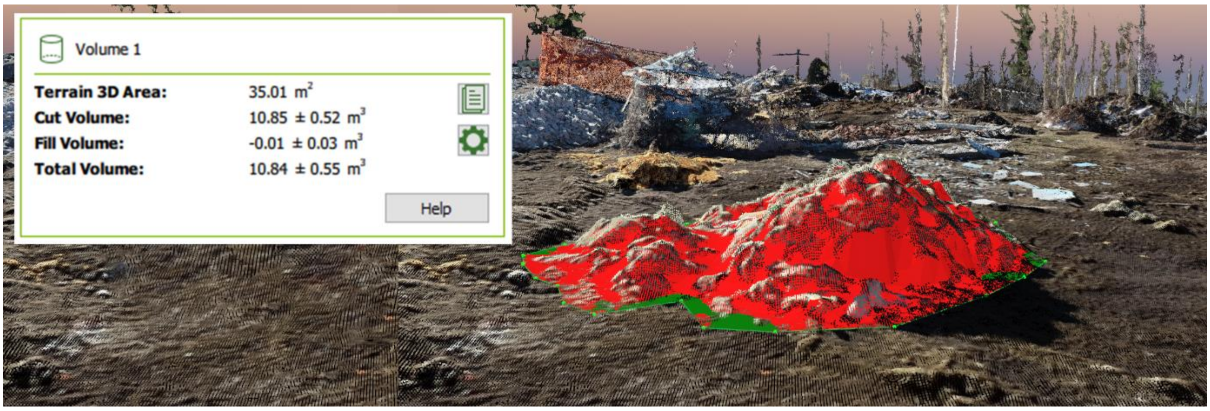


Figure 4 Volume calculation from a material pile based on drone imaging and 3D modelling (figure Juha Vihavainen).

3D MODELLING TO TRACK ONSITE CDW FLOWS

The 3D modelling tool for tracking the flows of on-site CDW is an operations model in which a camera drone and a photogrammetry software are used for modelling and monitoring demolition sites in 3D. The tool uses commercially available software and equipment: Pix4DMapper software and DJI Phantom 4 drone. Volumetric measurements of material piles performed with 3D tool were compared to traditional tachymeter technique. The project also explored the suitability of a multispectral camera for material identification.

Lessons learned

The use of 3D modelling tool to monitor demolition waste flows can be a cost-effective alternative in evaluating the amounts of material flows on-site when compared to traditional methods, e.g., tachymeter. Method can also produce useful data e.g., for the pre-demolition audit and planning of the demolition work. Volumetric measurements based on 3D imaging could be a useful tool for contractors, building owners, consultants, and designers especially in the future, when the reuse of building parts and materials are expected to increase.

Multispectral camera used by Xamk (Micasense RedEdge-MX) was not able to recognize different CDW materials. However, camera techniques should be further investigated for automatic material recognition.

<Link to instrument>

3D TOOL FOR FLOW-TRACKING CDW (cityloops.eu)

Environmental health and safety check

In addition to increasing the circular economy, the demolition of buildings has many other environmental and health aspects that must be taken into account in sustainable and responsible demolition work. For example, stormwater from demolition sites can cause a significant load of solid matter and harmful substances into receiving water bodies but when the CityLoops project started, there was only little national research data on the topic in Finland. Recently, more attention has been paid to the management of stormwater in construction and demolition sites in Finland. Bigger cities have created guidelines for monitoring and managing construction site water, and there have been national discussions about the needs for e.g., legislative changes. Furthermore, workers and residents of the surrounding area can be exposed to dust and harmful substances during the demolition work. As part of the Mikkeli demonstration action, Xamk monitored environmental and health risks during the demolition phase of the Pankalampi Health Centre and Tuukkala Hospital.

The occupational hygiene measurements were made during the internal demolition phase. The amount of total respirable dust, the concentration of PAH compounds bound to particles, and the VOC concentrations were measured from sampling points located inside the buildings and with personal meters from two workers at the demolition site. Real-time dust monitoring with DustTrak Aerosol Monitor was used to measure the total mass of particles in five different particle size classes based on light scattering (Figure 5). The samples were analysed in the accredited laboratory of the Institute of Occupational Health.

Figure 5. Real-time dust monitoring with DustTrak Aerosol Monitor during the internal demolition phase in Pankalampi demolition site (left), dust deposition collectors (middle) and water sampling (right) in Pankalampi demolition site (photos Juha Vihavainen).

The dust deposition from the demolition work was monitored by collecting samples in the yard area of the demolition sites in Pankalampi and Tuukkala (Figure 5). Dry matter and ash content as well as elements (As, Cd, Cr, Cu, Hg, Ni, Pb and Zn) were analysed from the samples in an accredited laboratory (Eurofins Ltd). In addition, fine particle content in outdoor air was monitored with a DustTrak meter.

Water samples were taken from three stormwater wells around the Pankalampi demolition site (Figure 5). A blank sample was taken before the demolition work. Other samples were taken during the demolition work in May and July 2021 and after the demolition work in November 2021 and June 2022. The metal content, sulphate, total nitrogen, total phosphorus, DOC (dissolved organic carbon), TOC (total organic carbon), fluoride and chloride concentrations were analysed in an accredited laboratory (ALS Finland). In addition, field measurements were made with a YSI ProDSS water quality probe, which measured water temperature, electrical conductivity, pH, ORP (Oxidation Reduction Potential), dissolved oxygen and turbidity. Solid matter content was analysed at Xamk's environmental laboratory.

In Tuukkala, vanadium was found in bricks in the inventory of hazardous materials carried out by Ramboll Ltd. By the CityLoops project, more material samples were taken from the bricks. Samples were taken separately from masonry mortar, joint mortar for vertical and horizontal joints, and bricks. Heavy metal concentrations were analysed from the samples in an accredited laboratory (ALS Finland Oy). The elemental concentrations were also analysed in Xamk's environmental laboratory using the X-ray fluorescence method (Niton XL3 950 GOLDD- analyzer).

Material samples were also taken in Pellosniemi replication site. Concrete and brick samples were analysed in an accredited laboratory (ALS Finland Oy) for heavy metal concentrations, PAH and PCB compounds, as well as certain POP and VOC compounds. The elemental concentrations were analysed with Niton XL3 950 GOLDD- analyzer in Xamk's environmental laboratory.

The methods and results of all environmental and health measurements are explained in more detail in the separate report (Vihavainen et al. 2023b).

Selective demolition procedure

Testing selective demolition guidelines

CITYLOOPS GUIDE FOR SELECTIVE DEMOLITION
This procedure explains how a selective demolition can be conducted to select and preserve value of building components and materials with reuse or recycling potential, following a series of chronological steps to dismount components or materials without damaging them. It can be applied when planning demolition projects, with sufficient time and coordination among actors, such that selective demolition be required in the procurement of a demolition contractor. The selective demolition procedure guide gives recommendations to manage material removal and treatment. The guide was developed by Capital Region of Denmark. Selective demolition was a requirement in the tender for demolishing Mikkeli's demonstration buildings. The implementation of the selective demolition by contractor was compared to the procedure described in the CityLoops guide and comments were given on the guide based on experiences from Mikkeli´s demonstrations.
Lessons learned In the case of Mikkeli's demonstrations, the demolition work was performed very well in accordance with the CityLoops selective demolition guidelines. Different waste fractions were sorted and at both demonstration sites, the amount of mixed CDW was minimal, as the legislation and waste prices guided sorting. However, it was found that there is some variation in the implementation of selective demolition between different contractors and demolition sites. The waste fractions that must be sorted at source

should be stated in the demolition contract and compliance should be monitored during the implementation. In Mikkeli, soft stripping was developed as one of CityLoops' business cases, in which the removal of materials for reuse could be further increased. The selective demolition guide can be easily replicated in all demolition projects in different cities to give information on selective demolition procedure and help to plan demolition process.
<Link to instrument> CITYLOOPS GUIDE FOR SELECTIVE DEMOLITION

Light dismantling

Soft stripping is defined in the CityLoops guide as removing of all loose items such as furniture, carpets and garbage to facilitate free access to possibly contaminated installations and structures. Stripping refers to the dismantling of non-bearing installations, electrical installations, heating installations, doors and windows, sanitation equipment etc.

In Finland the term “light dismantling” (*kevytpurku* in Finnish) has been proposed. The purpose of this concept is to focus on the movable items and easily dismantled items with the intention to reuse these. Light dismantling is often accomplished by the building owner or other stakeholders than the actual demolition contractor. It is understood as a separate step from indoor demolition.

Pankalampi case: The city recovered a fire escape from the site, which was delivered for installation in the city's new day care centre. The city also sold the health station's backup power plant for reuse. The city had already taken advantage of the site, e.g., shower curtain rods, storage rail systems and plumbing fixtures for in-house renovations.

Through the CityLoops project, a small number of windows were handed over to two individuals. The main contractor removed the windows intact without any additional responsibility.

A list of furniture and demolition parts dismantled and sold by the Mikkeli Activity Centre is provided in Annex 8 to this report.

Figure 6 shows examples of items that were discarded as mixed waste, although they could have been prepared for reuse.

Figure 6. Examples of reusable items that were discarded as waste (photos Raimo Lilja)

Buildings A and C of the health centre were not audited for reuse potential, so no list of items was obtained. Shortly before the demolition contract the premises had been provided to the law enforcement authorities for urban combat training using paint guns - as a result part of the furniture in the training area was not suitable for re-use.

Tuukkala case

Tuukkala Hospital had been vacant for more than ten years before the demolition phase. Pigeons had nested in the upper floors and contaminated them with faeces.

Copper pipes had been broken into and stolen in the basement, and the asbestos insulation around the heating pipes and in the enclosure had been torn down. Asbestos dust had spread to the basement.

For these reasons, no furniture or fixed furniture could be recovered for reuse.

In coordination with CityLoops and with the permission of the city, a few granite slabs were recovered from the yard by the South-Savo Vocational College´s circular economy project and delivered for use in the construction of the park in Mikkelipuisto. The project also recovered the oak planks used in the roofs of the balconies and in the building’s doorway. They were used in various wood products, for example to make a tabletop and cutting boards at ESEDU.

Decontamination and indoor demolition

Pankalampi case

The demolition worksite was established on March 22, 2021, and the work began immediately. The site was surrounded by a fence.

CityLoops Miksei team observed the demolition work visually on nine field visits during the demolition process which lasted from March 2021 till end of July 2021. Photos and video clips were taken, and workers and supervisors were interviewed on site. In addition, separate interviews were conducted with the contractor, the municipal waste company, and Building Services staff.

The demolition work followed the normal working procedures of the contractor. These practices were very well in accordance with the CityLoops selective demolition guidelines. The asbestos demolition sub-contractor isolated the asbestos-contaminated premises, removing asbestos-containing insulation, wind protection boards and asbestos-fibre cement boards.

After this, the main contractor's two stripping groups were set up for internal demolition, one in the dental clinic and the other at the health centre at the same time. The internal demolition teams dismantled the HVAC equipment, furniture, interior doors, partitions, the main part of the HVAC piping, internal insulation, etc. The windows were also removed and crushed before the heavy demolition. (Figures 7-8)

Figure 7. Indoor demolition (photo Raimo Lilja)

Figure 8. Waste from indoor demolition (photos Raimo Lilja)

Impregnated timber was revealed from around the windows. This was collected with non-impregnated wood and separated centrally at the Metsäsairila recycling centre.

Tuukkala case

The main contractor was Terra Infra Oy from Kouvola.

Asbestos removal was performed by the subcontractor Timanttiporaus Kaukonen Ltd. Discharge of contaminants was carried out in accordance with the safety plan for asbestos work. The supervisor commissioned by the Building Services inspected the performance of the work.

Figure 9. Asbestos waste at Tuukkala site (photo Raimo Lilja)

The indoors demolition began with the removal of furniture, fluorescent tubes, etc. The furniture in the building, the light partitions and the internal roofs were removed manually and mechanically, and the demolition waste was collected separately in waste containers. Working groups consisted of 2-4 men, a small (2 ton) excavator and skid steer loader. A stripping machine was used for removing floor laminate.

Hauling openings were made at logistically appropriate locations in the building walls. Sorting was done partly inside the building and during the loading phase outside the building. Demolition waste was sorted directly into containers.

Copper pipes were source separated but they were delivered as mixed metal, as the compensation for scrap metal at Metsäsairila Ltd. was the same for all types of scrap.

Heavy demolition

Pankalampi case

After pre-demolition work and asbestos demolition work, the excavators were used to carry out the heavier demolition of the bulk of the buildings. Machine demolition work was done as selective demolition. Demolition was done by beam spacing / construction type at a time and the resulting demolition materials were sorted directly in the waste containers, except for brick and concrete waste, which was collected in piles on the ground. If necessary, a manual worker was used in addition to the machine for sorting. The company used its own containers for transport to the waste centre.

The wood and brick structures were dismantled with a demolition grapple, the concrete structures were broken up with a pulveriser (Figure 10) and the largest reinforcement bars were removed from the concrete. Pure concrete was pulverized to a size of <500 mm and contaminated concrete to a size of <150 mm. An impact hammer was used to dismantle thick and strong concrete structures (e.g., civil shelters).

Figure 10. Pulveriser at work (photo Raimo Lilja)

In addition to the buildings, the asphalt pavement, district heating pipes, the electrical systems in the yard, etc. were dismantled during the machine demolition phase.

Tuukkala case

2-3 crawler excavators size range 28–50 tonnes were used with accessories: sorting grapple, pulverizing scissors, pick hammer, buckets. The transport of concrete waste was handled by Savon Kuljetus Ltd. Other waste was transported by Mikkelin Romu Ltd.

Demolition work was performed as selective demolition. The excavator demolished the building from the end and used the concrete waste piles to reach higher floors.

In collaboration with the CityLoops project and the UTK project, a few dozen perforated bricks were re-covered from the entrance façade for possible later re-use testing.

The contractor decided - on the recommendation of CityLoops team - to separately recover the bricks demolished from the façade due to the elevated vanadium content found in the bricks (Figure 11).

Figure 11. Separate demolition of brick facade (photo Raimo Lilja)

Mixing the brick waste with concrete could have prevented the later use of the aggregate in earthworks. The project owner did not require this separation of brick and concrete waste. The contractor had obtained the results of a solubility test on aggregate samples of bricks: the test result confirms that the vanadium content exceeds the limits (6 mg/kg) in the Decree on the use of waste in earthworks. Therefore, the bricks were taken to Metsäsairila as slightly contaminated waste. However, based on analyses later conducted by Metsäsairila, the brick waste did meet the conditions for landfill eligibility.

A significant finding was that separate dismantling of the brick facade with an excavator into a separate pile did not cause significant additional work. Some of the bricks were damaged, but a large part remained intact and could be recovered.

After the building was demolished to the basement level, the basement floor and foundations were demolished.

Assessing source separation

Pankalampi case

In this case the waste quantities were verified from two sources: the internal waste report of the contractor and the automatic weighing system of Metsäsairila Ltd. The latter is more reliable, but the former reflects the contractor´s source separation practices and interpretations of classifying the waste. The differences between the two points out some possibilities of improving source separation and using economic policy instruments.

Comparing the verified quantities with estimates, the estimate provided by the contractor for concrete waste was only about 10% of the actual. The contractor's estimate was only 13% of the client's own estimate. It is not known whether the contractor used an incorrect estimate in their budget calculation. This example illustrates that waste statement in the preparation of a demolition project is only a formality and the data is not actually used in the preparation of the project.

The amount of concrete that was defined as slightly contaminated concrete was more than 20 times higher than that estimated by the contractor. This suggests that the Haz Mat survey did not provide sufficient assistance to the contractor to make a proper cost assessment. The amount of contaminated concrete was 13.5% of the total amount of concrete waste.

The waste estimate carried out by the consultant used by the Building Services was reasonably close to the actual figures for most waste types. However, the estimate for wood waste was less than 10% of the actual quantity and the amount of gypsum waste and roofing felt waste was also underestimated.

The contractor sorted the wood waste at the site into treated (painted wood, etc.) and untreated wood waste. This was evident from the contractor's own waste monitoring and visual observations by CityLoops team. At Metsäsairila, the waste fee for both types of wood waste is the same, so they are classified and recorded in the same category. At Metsäsairila, clean wood (Figure 12) is not treated different from surface treated (painted) wood, because all wood waste is crushed into energy recovery. In this case, sorting work on site was futile.

Figure 12. Source separated untreated wood (photo Raimo Lilja)

The contractor's own classification and reporting differed from Metsäsairila's classification in several other respects. This caused differences in the amounts of waste reported by the contractor and the waste company. This can lead to disputes over billing.

Metsäsairila's waste report included a notification that in four waste loads chemically preserved wood (copper-chromium-arsene, CCA) was found among the wood waste. It has a multiple waste charge compared to normal wood waste. Metsäsairila informed CityLoops that the chemically preserved wood was sorted afterwards in the sorting hall.

It would be advisable to calculate and report the amount of waste per floor area, because then it would be easier to notice deviations from the typical amount of specific waste (kg / floor-m2) by comparing it with similar demolition projects.

A pre-demolition audit of the dental clinic was prepared in accordance with the guide of Finnish Ministry of Environment (Wahlström et al. 2019). The results show that the quantities of waste predicted by the consultant in the pre-demolition audit were very close to the verified quantities. The difference was high only for the scrap metal (estimated at 216%) and for insulation mineral wool. Apparently, a significant part of the wool has been mixed with concrete. Unsorted construction waste (Figure 13) was generated about 10 times more than forecast in the survey, but still accounted for only 0.4% of the total waste.

Figure 13. Example of mixed demolition waste (photo Raimo Lilja)

The purpose of the pre-demolition audit is to indicate the types of waste that can and should be sorted separately. At this site, brick and ceramic waste or glass waste was not sorted separately. They were mixed with concrete waste.

Of the eight waste fractions listed in the Waste Decree of 2012 (eleven fractions in the renewed Decree 2021), the following *were not* delivered separately: glass waste, plastic waste, wastepaper and cardboard.

Plastic waste was sorted separately but delivered as “energy waste” for energy recovery. The fragments of the window glass were likely to end up as a contaminant in a load of wood waste or scrap metal or crushed concrete. Separate recovery of glass waste cannot be considered realistic, as it is not possible to separate the glass from the window frames. In principle, windows could be re-used if such an operator was available. Separate sorting of wastepaper and cardboard waste may make sense on a construction site, but not on a demolition site.

Tuukkala case

According to the waste report submitted by Metsäsairila Ltd to the city after the contract, the following amounts of waste were generated from the demolition:

A total of 9,019 tonnes of waste was generated, of which more than 8,000 tonnes (90%) was concrete and brick waste. Other separately collected waste fractions were wood waste, scrap metal, asphalt waste. In addition, bitumen-contaminated concrete waste, slightly contaminated brick waste and heavily contaminated brick waste were sorted. 58.26 tonnes or 0.65% of miscellaneous construction waste was generated. In other words, more than 99% was sorted into separately collected waste fractions.

Of the eight waste fractions listed in the Waste Decree of 2012, the following were not delivered separately: gypsum-based waste, glass waste, plastic waste, wastepaper and cardboard.

The windows were not dismantled intact, but the glass was crushed during removal and can be assumed to have ended up in the concrete. According to the contractor's estimate, approximately 10 t of glass waste was generated at the site. It was unclear from the waste report where the insulation wool (estimated amount of 40 t), gypsum board (estimated amount of 10 t) and energy waste (estimated amount of 40 t) had ended up. According to the contractor, fewer gypsum boards were found than expected. Some mineral wool was included in sheet metal scrap loads because thermally insulated piping was not manually handled to separate the wool.

The contractor's waste estimate predicted that nine different types of construction waste in excess of 10 tonnes will be generated at the site*. In practice, only four types of waste listed in the Waste Decree were collected separately at the site*. In addition, asphalt waste and contaminated concrete and brick were sorted separately. This example raises the question of whether the sorting was complying with the Waste Decree and the procurement contract requirements.

The estimate of the amount of concrete and brick waste presented in the contractor's waste report proved to be very accurate. If all the mineral wool and glass estimated has entered the concrete, this means about 0.6% of impurities in the concrete waste, which cannot be considered particularly significant. Some impurities can increase the generation of harmful dust during crushing and use. Preventing this dust emission risk can be considered as one of the advantages of a separate stripping phase.

Contaminated concrete (with bitumen content) and bricks accounted for about 2.8% of the total amount of concrete and brick waste, which can be considered quite a small fraction. This suggests that the concrete structures with contaminants have been well identified and separated at the site. The amount of asbestos in the contractor's waste plan was estimated at 10 tons. The actual amount was 18 tons. Impregnated wood was identified in the structures of the window frames. It was not delivered to Metsäsairila as a separate load. According to the information received from Metsäsairila Ltd, the impregnated wood has been recovered from the wood loads in the sorting hall.

CO2 calculations of selected waste management options

The CO_2 calculator developed by Roskilde Municipality was tested on Mikkeli demonstrations. Realized or estimated amounts of different CDW fractions from demolished sites Pankalampi Health Care Centre and Tuukkala Hospital were used as input values for calculator. In the case of Mikkeli's demonstrations, the CO_2 calculator could not be used in the planning phase of the demolition, because the demolition of the buildings had already begun when the calculators were developed and available. However, the calculator was tested afterwards and the emissions in different circular scenarios were hypothetically calculated. The tool includes three separate calculators: 1) CO_2 calculator for Demolition and Renovation Sites, 2) CO_2 calculator for concrete and 3) CO_2 calculator for soil transport. All of these were tested on Mikkeli demonstrations.

Concrete was the largest waste fraction in Mikkeli´s demolition sites, and the CDW calculator showed well that the reuse of concrete elements has by far the greatest emission saving potential. CO_2 calculator for concrete showed that in Mikkeli, recycling concrete as aggregate in the production of new concrete does not necessary save emissions because the transport distance for virgin aggregate is typically short in Finland and recycling of crushed concrete does not save emissions from the manufacturing of cement, which has the greatest effect on the carbon footprint of concrete. However, recycling concrete save the use of virgin stone material. CO_2 calculator for soil transport was used to estimate the hypothetical emission saving potential if the concrete had been utilized on earthworks on demonstration sites. The results showed that by using crushed concrete in earthworks on site, it is possible to save transport emissions and virgin aggregates, but the savings are small compared to the reuse of concrete as elements. The calculations and results have been described in more detail in a separate report (Malk 2023).

LIFECYCLE CO_2 CALCULATORS FOR CONCRETE, SOIL AND MIXED CDW
Roskilde Municipality has developed CO_2 calculators for Demolition and Renovation Sites to calculate the lifecycle CO_2e impact of concrete, soil, or mixed CDW. The tool includes three separate calculators: 1) CO_2 calculator for Demolition and Renovation Sites, 2) CO_2 calculator for concrete and 3) CO_2 calculator for soil transport. The calculators can be used in planning processes for building demolition and renovation projects to aid in decision making and in procurements, with lower emissions as an award criterion. The tool supports the reduction of CDW and soil waste, as well as the associated carbon emissions, by allowing comparison of possible actions for informed decision-making.
Lessons learned All three calculators illustrated well the emission saving potential of different recycling and reuse scenarios and they were very simple and easy to use. The calculators can be used in decision making process when planning construction and demolition projects or when looking for ways to achieve cities climate goals in construction sector. The tool has great potential for scalability and replicability because the use of the calculators does not require lot of resources or expertise. If possible, the CDW calculator could be adjusted so that input values could be given in different units and that local conditions (like distances to recycling facilities) could be taken into account.
<Link to instrument> CityLoops_Tool_factsheet_Lifecycle_CO2_calculator.pdf CO_2 calculator for concrete: CO2-Beregner

Replicability

Many tools developed or tested in CityLoops in Mikkeli can be easily replicated in other cities. For example, drone imaging and 3D modelling is a useful technology to track CDW flows especially in pre-demolition audit phase and when planning the utilization of materials on site or at another construction site. We also recommend paying attention to the monitoring and management of stormwater at construction and demolition sites to prevent load of solid matter and harmful substances to receiving waters.

CityLoops pre-demolition audit guide and the selective demolition guide are useful tools for replication, although good practices are constantly developing as more experiences are gained. The LCA tool developed by Roskilde municipality is a good tool for the preliminary evaluation of the CO_2 emission effects of reuse and recycling of CDW materials, which cities can use e.g., when planning how to achieve the climate goals of construction sector. The tool was already replicated in Mikkeli and was found to be easy to use and eye-opening, so its use can be recommended to other cities as well.

Business case: soft stripping and internal demolition as separate service

Selective demolition is described in the CityLoops Guide for selective demolition as a systematic work method for maximizing the quantity of demolition materials delivered for reuse and high-quality recycling (Figure 14). Soft stripping is the first step of selective demolition and covers the removal of movables, easily dismantled indoor fixtures such as storage structures, HEPAC-installations. Stripping or indoor demolition is the mostly manual demolition phase of removing all or most non-bearing indoor structures.

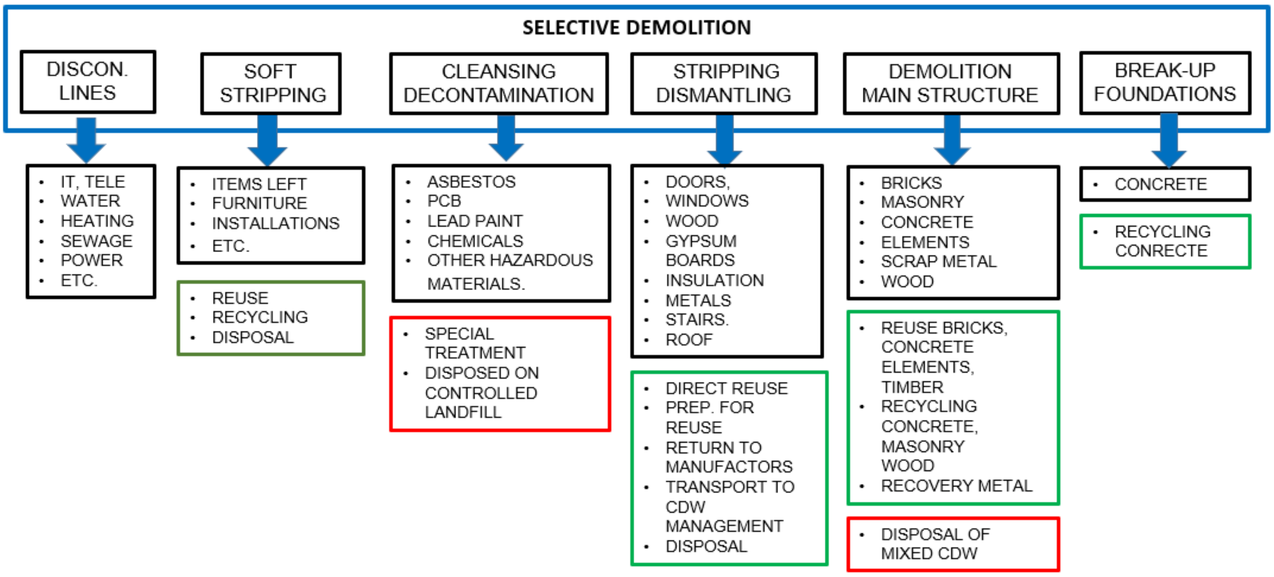


Figure 14. Phases of selective demolition (Lauritzen 2022)

This business case studies the opportunities and obstacles for developing these soft stripping and actual stripping phases as a commercial service in the context of Mikkeli municipality. The concepts presented here emerged from the qualitative research of the demonstration case of demolishing the city owned Pankalampi Health Centre in 2021. The new business options were not applied in the demonstration, but they have been the subject of various interactions with relevant potential beneficiaries.

A pre-demolition audit was commissioned by CityLoops-project for the Dental Clinic, a separate building that was part of the Pankalampi Health Centre demonstration site. The audit was conducted by Ramboll Finland, Mikkeli Unit. In addition, a group of XAMK students conducted an inventory of reusable items within the Dental Clinic, in cooperation with Mikkeli Activity Centre (Mikkelin Toimintakeskus ry). Some recovered items were advertised using the digital marketplace www.kiertoon.fi developed as one of the CityLoops tools.

The soft stripping and stripping work in Pankalampi and Tuukkala demonstration sites were conducted by the demolition contractors, correspondingly Ahosen Palvelut Ltd. and Terra Infra

Ltd. The indoor demolition was conducted according to their normal practices. No specific targets were set by the procurer, except for a reference to the source separation requirements in the waste regulations.

The concept, barriers and opportunities for establishing business cases related to stripping and reuse of construction items has been discussed in the following CityLoops workshops and webinars:

- Market engagement event regarding demonstration sites 27.8.2020.
- From demolition to circular economy 9.12.2020.
- Reuse of Building Parts 11.3.2021.
- Planning and Procurement 31.8.2021.
- Planning and Decision Making 24.9.2021.
- Knowhow Needs and Challenges 18.2.2022.
- Joint workshop with Circuit-project 23.5.2022.
- Procurement workshop for Demolition and Construction 29.4.2022.
- Market engagement event with potential contractors 22.6.2022.

In addition, several demolition contractors and other actors in the field have been interviewed one-to-one. As a summary of these findings the following business options have been identified:

1) Soft stripping and organizing reuse of dismantled parts.
2) Stripping and upcycling as a separate demolition service.

Business case characteristics

Soft stripping and organizing reuse of dismantled parts

Soft stripping generates the following types of items with potential for reuse:

- usable furniture (movable or easily dismantled).
- other equipment left by the last user of the premises: office equipment, equipment specific to the type of building (school, health care, workshop etc.).
- easily dismantled HEPAC items such as sinks, taps, sanitary ware, air conditioning equipment, heating equipment, radiators, lamps (indoor/outdoor).
- unusable items often consist of many different materials and are classified as mixed demolition waste.

Economic aspects and benefits

The business income consists of the following elements:

- fees for the dismantling and clean-up of the premises.
- income from the sales of recovered items.

The expenditures consist of the following elements:

- low-skill manual labour cost for dismantling items and logistics, basic checking and cleaning of items.
- protective clothing and masks, hand tools.
- vehicles for logistics, drivers.
- warm and dry temporary storage.
- waste management cost for items that could not be sold.
- medium skilled supervisor for conducting the audit for reusable items, supervising staff, ensuring work safety, interaction with building owner.
- medium skilled staff for quality control and eventual maintenance of sellable technical equipment.
- sales staff for pricing of items, organizing sale (pop-up sale, digital marketplaces, permanent second-hand shops, business to business sales).
- advertising costs of sales.

The sale of furniture and easily removable construction items is so far a very occasional and small-scale activity. At the Pankalampi demo site, the Activity Centre took a small number of products from the Pankalampi dental clinic for sale. The estimated market value of these was 3700 € and the work input was estimated at 90 person-hours. 70 % of the sales value was allocated to a mechanical garage door. With a typical salary and social care cost of a low skilled construction worker the staff cost would be about 1560 €. Estimated other costs listed above could bring the total cost to 2500 €. In this case the gig was economically feasible for the Activity Centre, because they could take the items for free, and they could choose only those items that were considered easy to sell. They had no further obligations towards the Municipality, for example reporting or cleaning of debris.

A significant amount of furniture remained unused due to lack of time, human resources, and lack of storage space. No inventory was made in the main building of the health centre. In Tuukkala, all furniture was broken or spoiled due to vandalism.

Cities that have municipal recycling centres or partnerships with third sector recycling centres report some success stories of soft stripping operations, for example open house events where soft stripping items have been sold to private consumers. These events have been framed rather as circular awareness activities rather than business activities[1]. In Mikkeli a similar pop-up auction day was held at Urpola school in 2021 (Mikkelin Toimintakeskus 2021). The Mikkeli Activity Centre provided 4 workers and two drivers. Examples of items sold were 400 chairs, cloths racks, cupboards, musical instruments, tables, books, teaching equipment etc. The

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[1] Personal communication with HSY (Environmental Services of Helsinki Metropolitan area) and Espoo City

buyers were private citizens, especially alumni of the school. The income from the auction was 6500 €, so the event was profitable for the Activity Centre, because they received all items for free.

The critical question regarding the role of Mikkeli Activity Centre is whether it should be given the monopoly for soft stripping phase in city owned demolition projects. The experience in Pankalampi demonstration case showed that they have very limited capacity to conduct the work in due time. They don't have the network for conducting business to business activities. The workforce is continuously changing. The monopoly, informally provided by the city administration may obstruct the creation of commercial business and permanent jobs.

Risain Ltd. is an example of a new business concept. The company calls itself "recycling operator". The business logic is based on two elements[2]:

1) the company conducts a pre-demolition audit of reusable items with a fixed fee. The audit provides a full report to be used in corporate responsibility reporting, including list of reusable items, their classification, estimated market value and carbon footprint of logistics. The company is specialized in reuse, so the audit is probably more realistic and cost efficient than when using an engineering office. In one example case the fee for this reuse audit was 9000 €.
2) the company provides turn-key services for finding buyers and organizing the dismantling and logistics, including the procurement of waste management services. The reusable items are photographed and announced in digital marketplaces. Risain collects the income from sales and shares the net profit with the client sharing the profit with an agreed percentage. Risain can also arrange a pop-up auction on site if requested by the customer.

This model has the potential of maximizing reuse, because the reuse auditor earns most of her/his profits from selling of the items. Also, this model minimizes logistic costs because all items are sold on-site without need for temporary storage.

Risain is offering these services to municipalities and businesses (e.g., retail chain) in demolition cases, in cases of moving to new locations and cases of refurbishing existing premises. Risain Ltd is in partnership with Purkupiha Ltd. one of the biggest demolition contractors in Finland.

The outcomes of CityLoops business case activities have so far been:

- development and publishing of a digital marketplace for used building items.
- demonstrating models and reporting schemes for reuse audits
- proposal for an agreement with Mikkeli Activity Centre regarding soft stripping

[2] Sirpa Rivinoja, Risain Ltd. director, interview 7.6.2022

- promoting cooperation between Mikkeli Social Housing company (Mikalo Ltd.) and Mikkeli Activity Centre
- interaction with Mikkeli Consortium companies in circular procurement issues and market engagement.

Social aspects and benefits

Mikkeli Activity Centre (Mikkelin Toimintakeskus ry) is an NGO that was established in 1991 to activate unemployed people and help them to acquire counselling, education and work experience to promote their path to permanent jobs. Mikkeli Municipality has outsourced this work to the Activity Centre and pays annually more than 1 M€ for these services. To provide work experience to their unemployed customers Activity Centre is operating recycling centres, second-hand shops and repair workshops. In 2022 130-150 people were working in these activities with 100 % salary subsidy from the labour administration. The salary subsidy generally applies only for 6 months, after that the people must be rotated. The number of such workers associated with circular economy was about 70 in 2019, including permanently employed supervisors. In addition, Mikkeli Activity Centre is providing rehabilitation activities to about 500 people, who have health and social issues that currently prevent them from entering the labour market.

According to Activity Centre, EU regulations are threatening the continuity of this model because it does not allow subsidies to distort competition with commercial businesses. 100 000 € turnover is planned to be defined as the lower limit of commercial repair and reuse, after which the subsidy restrictions would be applied. If the drafted Finnish regulations enter into force, the Activity Centre could only employ 4-5 people per year in total compared to the current 130-150 (Ranta 2022). However, if the salary subsidy is smaller than 100 % the regulation of market distortion is more lenient.

Informant A is project manager in the municipal employment demonstration in Mikkeli. In the demonstration project the labour services are transferred from national authorities to the local level. The informant pointed out that that in the long run circular construction cannot be implemented with government subsidies. The activities must bear the reasonable salary costs. Subsidies should only be used in demonstrating new concepts. He supports the CityLoops proposal of procuring the stripping phase separately from total demolition. This would make possible the participation of local smaller companies that could then recruit unemployed people locally. Partial salary subsidy can be used in the start-up phase by companies to reduce the risk of employing new staff. In his opinion, the role of the Activity Centre is not to provide such permanently needed workforce – such services should be provided by businesses. The role of the Activity Centre is to provide a transition period for unemployed people to train and rehabilitate them to be ready to enter the free labour market.

Soft stripping activities and the related maintenance and repair of recovered items for sale fit well into this concept of employing low-skill workers. Mikkeli Activity Centre could support unemployed people to enter the permanent labour market by providing training with support from the Mikkeli Municipality. This requires partnership with the local or national level contractors.

Environmental aspects and benefits

The main environmental benefit of a systematic reuse audit and a separate soft stripping service is the potential increase of reuse of building items and the associated prevention of waste and the saved carbon and material footprint of producing an equivalent product.

Cultural aspects and benefits

As pointed out in the case of Urpola School pop-up auction, the inhabitants value items from the past decades and have the interest to reuse rustic furniture and other items which have cultural and personal significance for them.

Separate stripping service as business

The market engagement events in Mikkeli indicated that small and medium sized companies that operate mainly in refurbishing of buildings are potential candidates for separate stripping contracts. Another group of such candidates are asbestos demolishing companies. They could expand their work from asbestos clean-up to all aspects of stripping and selective indoor demolishing.

Economical aspects and benefits

Company B is a local demolishing contractor that has a license for asbestos removal from buildings. 40 % of the turnover (about 1 M€) comes from asbestos work, 40 % from other types of stripping work and 20 % from diamond cutting and drilling. The business is usually based on sub-contracting. The company participated as subcontractor for asbestos removal in the Tuukkala demonstration case.

Informant C, the owner of Company B assessed that combining asbestos removal with stripping work could reduce the total cost of demolishing. In the current practice, where asbestos removal is provided by a sub-contractor, but the remaining stripping work is conducted by the main contractor, the scheduling of the work is not as fluent as it would be if the asbestos contractor could shuffle between asbestos removal and normal stripping[3]. Offering small contractors, the possibility of separate contracting for stripping work could also reduce total costs, because of increased competition with big total demolition companies.

The duplication of costs of fencing, when dividing the contract into separate stripping contract and heavy demolition contract can be avoided, according to the interviewee. The stripping

[3] Informant C, interview 20.4.2021.

contractor can transfer the rental of the fencing and construction site barrack to the next contractor (assuming that there is little delay between the phases).

The company has 11 staff, five of them have a certificate to conduct asbestos removal. It is difficult to recruit asbestos workers that have the appropriate attitude required in this hazardous work. The company has used Estonian workers when needed. Unfortunately, the company was sold in 2021 to a company located in another city and the company is no longer operating in Mikkeli.

Company C is a local demolition contractor with a turnover of 1…2 M€ and 19 workers. 50 % of the turnover comes from diamond drilling and asbestos removal work, the remaining from other demolition work. The company is licensed to do asbestos audits and it has several authorized asbestos removal workers. It has adequate equipment for indoor demolition work but not heavy demolition. It also provides waste transport services. Informant C, the owner of the company considered subcontracting to total demolition companies as unfeasible. They provide too little time for the indoor demolition. Asbestos removal must be conducted before indoor demolition. Partitions, doors and windows cannot be removed before asbestos work, because the working space must be insulated, and negative pressure induced. The informant is for separate tendering of indoor demolition. This would lower the price of heavy demolition and the total cost would probably be lower. Indoor demolition does not require considerable costs for fencing. Demolition materials can be discharged from windows without removing the window. The company does not consider the reuse of building parts.

Company D is a construction company located in the Mikkeli region. The business consists of construction, renovation and earthworks. It has experience of stripping work as part of renovation. It expressed interest in separate contracting of stripping services. The challenges for reuse are related to the short timeframe allocated for the stripping phase, storage costs of items that are not immediately sold, overstatement of the risks linked to indoor air quality and approval procedures required for building materials[4].

The separate procurement of stripping works would probably benefit local businesses, because of cost savings compared to nationally operating companies that must bring workers from other locations with associated cost of lodging and per diem. In cases of subcontracting the stripping work by the main contractor there will be added cost to the customer from the margin taken by the main contractor.

Social aspects and benefits

Contracting local businesses for the stripping phase as alternative to total demolition would benefit local employment and the increased experience of local skilled workers specialized in demolition work. The stripping work would probably not provide permanent work alone, but it would be a new source of income for companies in the construction and renovation field.

[4] Informant D in the market engagement event. 22.6.2022

Socially this would be better than recruiting temporary migrant workers from e.g., Estonia. Work safety is probably better when using permanent staff than temporary staff.

Local businesses could form partnerships with the Activity Centre and offer opportunities for permanent employment to the customers of the Activity Centre. They could also find synergy with the local Vocational school by recruiting students, student entrepreneurs and newly graduated people.

Environmental aspects and benefits

Engaging local enterprises in soft stripping and stripping contracts could have environmental benefits in promoting reuse of building items. Building a local network of buyers would reduce transport costs and would enable on-site sales.

Building parts that have cultural and historical value to Mikkeli inhabitants would more probably find buyers locally than nationally.

Business case impact indicator calculations

Indicator 22 in the CityLoops evaluation plan sets the goal of introducing eco-innovations: new products, service concepts and business models relating to the reuse/recycling and upcycling of the specific material flows established, leading to new business opportunities.

Indicator 23 monitors the quantitative impacts of each eco-innovation in monetary terms.

In this Mikkeli business case A two eco-innovations have been studied: one is the soft stripping and reuse operation business and the other is the indoor demolition or stripping phase where the soft stripping operations can be included or excluded.

In this report the soft stripping business is selected as the basis of the impact indicator.

The soft stripping business can be roughly assessed using the example of the dental clinic in the Pankalampi demonstration case. The turnover that Mikkeli Activity Centre calculated was 3746 €. The floor area of the dental clinic was 1416 m2, so the realized selling value was 2,65 €/m2. During 2018-2021 the Municipality has typically demolished about 10000 m2 of municipal public buildings per year. The demolition projects managed under Mikalo (municipal rental housing company) and Naistinki (manager of city owned business premises) or other city owned companies are not included in the estimate.

If the dental clinic case is used as a benchmark, the value of reusable soft stripping items from city owned buildings would be about 30000 € per year. Based on observations from the demo site the potential would have been much more, but due to constraints in time, human resources, and lacking sales channels the potential was not realized. The pre-demolition audit only covered the dental clinic.

The impact indicator 23 is tentatively given the value 30 000 €. There is potential for much more.

The total sales of reusable items in the New Life shop of Mikkeli Activity Centre were 423926€ in 2021 (Mikkelin Toimintakeskus 2022). Most of the income obviously came from sales of furniture, used household items and household appliances donated by private citizens. Compared to these sales the share of items that could be recovered from to-be-demolished municipal buildings would be 7 %. Most of the recovered items are currently furniture, not actual building parts such as water fixtures.

Lessons learned and replication opportunities

Reuse cannot be promoted without pre-demolition audit

The process and roles of demolition actors are proposed by the Mikkeli CityLoops team is depicted in figures 15 and 16.

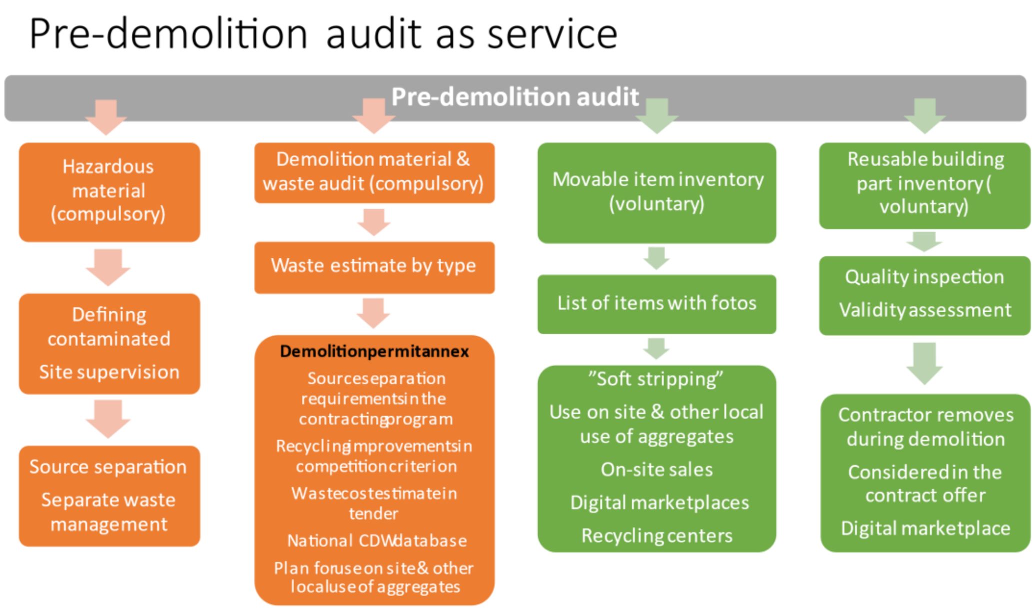

Figure 15. Components and outputs of the pre-demolition audits (figure Raimo Lilja and Jenina Luotolampi)

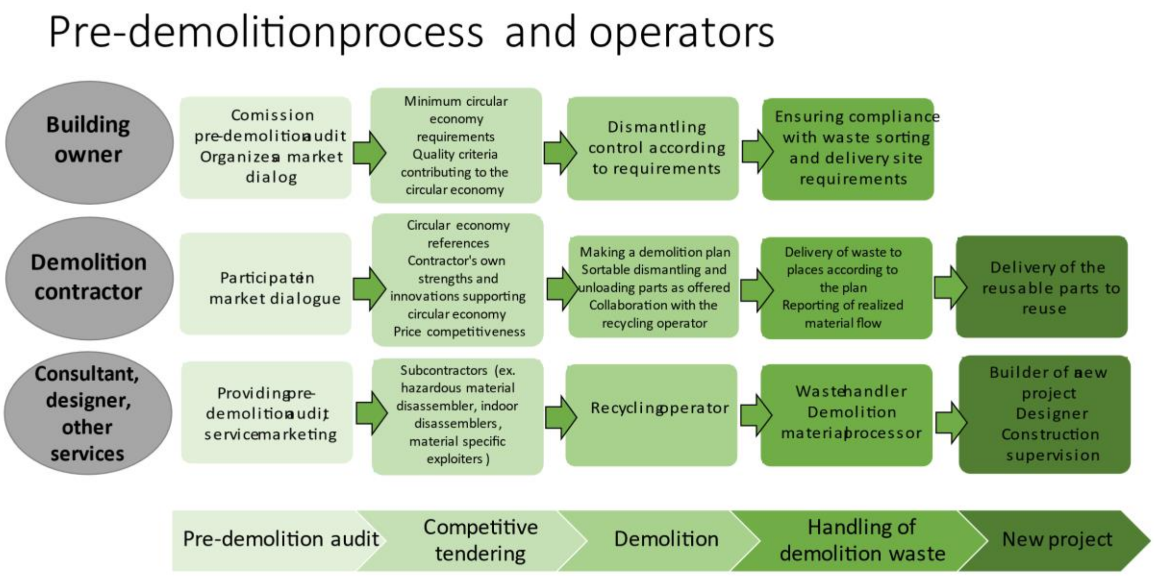

Figure 16. Visualization of the pre-demolition process and the roles of different actors (figure Raimo Lilja and Jenina Luotolampi)

CityLoops Mikkeli team proposes that the Mikkeli City Consortium would adopt a practice that a pre-demolition audit is performed for all demolition cases exceeding 250 m2. In addition, the City Consortium organizations should consider creating a “pipeline” of future demolition cases within 5-10 years scope by creating a database of basic data of the material masses and reusable construction parts.

CityLoops Mikkeli team has contributed to developing a CityLoops guide for pre-demolition audits and selective demolition. The use of these guidelines and the use of the pre-demolition audit reporting software can be replicated by any European city.

Appropriate timing of soft stripping and stripping

At least the soft stripping phase must be executed promptly after the last user of the premises has moved out. Soft stripping and organizing the reuse of items should occur before moisture and vandalism ruins the items.

In Mikkeli it is common that city owned building can stand empty for years, even more than 10 years, because there is low pressure for new construction in Mikkeli. This means that also the materials that could be recycled or reused from the stripping phase will probably be ruined.

The benefit of a separate stripping contract is that the timeframe for the work could be more relaxed and would allow on-site sales of items and temporary storage of dismantled parts.

After the stripping phase there would be less risk for vandalism. The tendering for heavy demolition would be more transparent because it would be clearer to the contractor what materials will have to be transported and managed.

The stripping phase does not need a demolition permit, which reduces the bureaucracy and time. The separate contracting would benefit local companies.

The concept of separating the soft stripping, indoor demolition and heavy demolition contracts can be replicated by any city, taking into considerations the optimal timeline for each phase and available tenderers.

Clear definition of roles and duties

The demolition procedure must be formalized with clear roles and duties for each participant. For example, in the Urpola case the headmaster of the school was expecting that the income from the pop-up auction would be accounted for the Education Department. The Activity Centre was allowed to start the soft stripping operation only five days before the demolition contractor started the demolition work.

There are too many actors in the soft stripping phase and their rights and obligations are improvised case by case. The last users of the premises leave behind their property, for example confidential archives, hazardous wastes or valuable equipment that end up being managed by the demolition contractor. The municipal construction department may or may not use some selected building parts, such as fire escape stairs in new construction. The Activity Centre and the Vocational school teachers scavenge for selected items. Private households ask for windows or other items and sometimes end up in the restricted area where the demolition is already on-going. Hazardous situations have occurred where for example the electricity has not been switched off as expected[5].

At the initiative of the CityLoops project, a written agreement on re-use was drafted in March 2021 between the Municipal Premises Centre and the Mikkeli Activity Centre (the NGO). A process description was drafted as an annex to this agreement. Up till now (July 2022) the agreement is still not signed by the parties. An important part of the proposed agreement is the obligation of the Activity Centre to conduct and report an inventory of all potential items that could be recovered in the soft stripping phase. This would fulfil the missing (voluntary) part of the pre-demolition audit that Mikkeli administration has not yet adopted.

Another option is to outsource the reuse audit and reuse operations to a private operator as outlined in the business concept above.

Creating demand for reuse and recycling through procurement criteria

[5] interviews with informants representing Mikkeli Activity Centre and Vocational School (ESEDU)

Waste legislation sets general targets and requirements for waste prevention, waste hierarchy and source separation of CDW. These are not reflected in demolition permits, because the building permit authority is not an expert in waste management and the environmental authority rarely involved in individual demolition or construction permits and is mainly involved in regulating waste management companies.

This emphasises the role of the public procurement units. Public procurement should set ambitious targets for promoting circular economy. The minimum requirements should clearly define what is the minimum level of source separation, based on the estimate of waste generation by type in the pre-demolition audit. Measurable recycling rates could be used as qualitative criteria in tendering or ex post verified and higher than minimum recycling rates could be awarded with bonuses.

Setting minimum targets for reuse in procurement is difficult because the market price and demand for reusable items is so item specific. It may be practical to separate soft stripping and reuse of easily dismantled items from the demolition tendering.

Second, all major demolition tenders should set qualitative criteria that encourage reuse and upcycling and innovative solutions. In Mikkeli the demonstration of such criteria was not possible, because of the in-house position given to the Municipal Waste Company (Metsäsairila Ltd), virtually requiring the contractor to deliver all the demolition material to the Company. Reuse and upcycling of CDW are not part of the business strategy of Metsäsairila Ltd.

This practice in in conflict with the City Climate Program goal that the “City will promote and execute circular economy and will establish an operation model based on cooperation between the municipality and companies.”

The Mikkeli Activity Centre has been informally given a similar in-house position, even though it is an NGO, not a part of Mikkeli administration. It has the preferential right to soft stripping, but in practice it does not have the human resources and business contacts to organize systematic reuse audits and sales. Such an in-house position should be questioned and new partnerships with private sector reuse operators should be demonstrated.

The issue of hazardous material assessment is essential to guarantee work safety and safety of the reused items. Asbestos waste management is well organised in city owned demolition sites, but the procurement of hazardous material audits needs to be improved in other organizations and chemicals other than asbestos are often neglected.

The Mikkeli CityLoops team was not successful in incorporating circular criteria in the procurement process in the demonstration cases, because there was not enough time and enough political ambition to change the standard procedures. Other cities may replicate the proposed actions, but they must be implemented in the unique context of each organization and country.

CityLoops is an EU-funded project focusing on construction and demolition waste (CDW), including soil, and bio-waste, where seven European cities are piloting solutions to be more circular.

Høje-Taastrup and Roskilde (Denmark), Mikkeli (Finland), Apeldoorn (the Netherlands), Bodø (Norway), Porto (Portugal) and Seville (Spain) are the seven cities implementing a series of demonstration actions on CDW and soil, and bio-waste, and developing and testing over 30 new tools and processes.

Alongside these, a sector-wide circularity assessment and an urban circularity assessment are to be carried out in each of the cities. The former, to optimise the demonstration activities, whereas the latter to enable cities to effectively integrate circularity into planning and decision making. Another two key aspects of CityLoops are stakeholder engagement and circular procurement.

CityLoops started in October 2019 and will run until September 2023.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 821033.