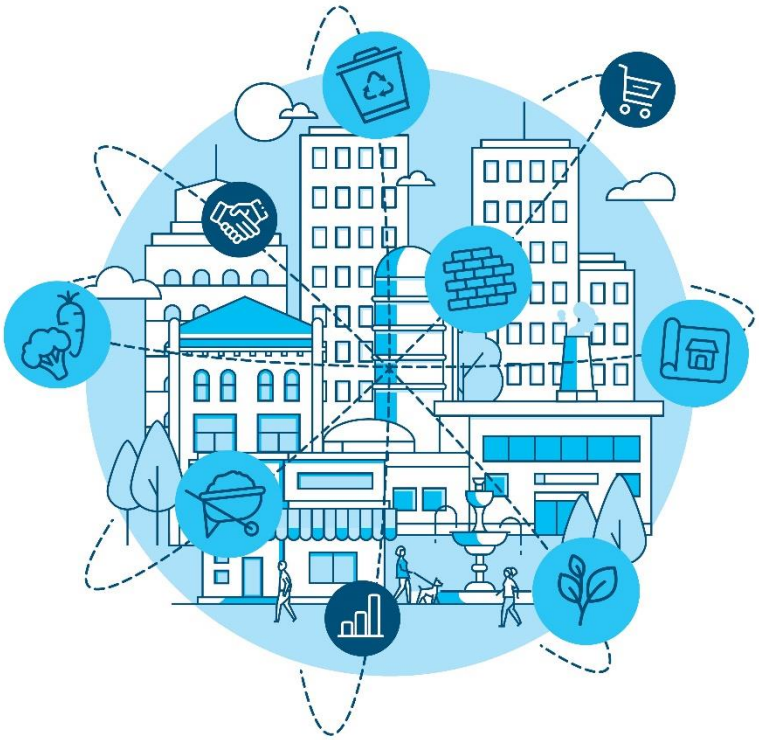
Business case in Roskilde

Description

Municipality of Roskilde and Danish Association of Construction Clients, Denmark



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This text describes Roskilde's business case in recycling concrete in a car park construction. The sections come from Roskilde's CityLoops demonstration report available here.

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National market conditions

The circular economy in the Danish building sector is growing, and some influencing regulation is on its way. The national regulation concerns primarily material (waste) flows to increase the transparency of CDW flows (soil are regulated already) and includes among other resource mapping (added to the already applicable environmental mapping) and demolition plan both connected to selective demolition. The new national regulation is expected to be implemented during 2023.

One of the issues regarding growing the circular market for secondary materials and product is the lack of end-of-waste criteria, which for the moment is individually and locally handled by the municipalities without a clear national consensus. It seems that the authorities are waiting for two EU-related initiatives; common end-of-waste criteria and the revision of the construction product regulation as secondary products and materials are expected to be included in this regulation. In addition, CE and/or ETA regulation must be taken into consideration.

However, the market actors including demolition and waste handling companies, consultants and clients are innovating and experimenting on demonstration level to get useful experiences for the future market. Few compagnies have succeeded with a full value / block chain implementation of upcycled CDW e.g., A:GAIN [Link] who upcycles e.g., fixtures as furniture, panels etc., NÆSTE (NEXT) [Link] who creates and deliver sheds made of recycled

construction wood, STARK/GENTRÆ [Link] who recycles construction site wood and Fischer Lighting [Link] who collects lamps and light fixtures and upgraded them with new technology for B2B resale.

Some Danish contractors and concrete suppliers are also capable to handle crushed concrete and/or elements as reused material in new constructions including screening, sampling, testing, (perhaps) temporary storing and mixing into approved recipes. Furthermore, there are several companies who are capable of handling and reusing excavated soil, gravel, and sand for new, typically landscape purposes.

Handling of both excavated soil and CDW are generally liberalized in Denmark. Depots must be approved by the authorities which includes temporary depots at waste handling companies, but handling of waste for energy production (e.g., construction wood) are mainly driven by public owned facilities. The liberalization of the last mentioned is however under negotiation for the moment.

There are no current plans for regulation of the circular market though it could speed up the adjustment pro-cess with e.g., taxes or other incentive stimulating elements. Politically it seems to be the attitude that the market should developed itself within consideration of access to resources and the prize development on both primary and secondary materials. However, there will be some obstructions regarding another aspects of sustainability as several analysis concludes that the number of demolished buildings should be decreased and that can affect the access to secondary resources.

Business case description

The demonstration project, “Indfaldet”, is an above-ground, multi-storey parking house with 240 parking spaces made as a steel structure. The construction was started by the wining contractor in April 2020 and delivered to the client (Roskilde Municipality) in 2022.

Recycled concrete remains from demolished previously concrete production facility has partly compensated new gravel fills for bottom protection of the new parking house, and as aggregate in new concrete in the ground floor deck. Both reuse processes were handled on site by using mobile crushing and separation facilities. Essential for this local transformation of the concrete was a far distance from the site to other facilities as e.g., offices and residences regarding *space*, *noise*, and *dust*. In most similar cases it is necessary to take these aspects into consideration differently.

These pictures represent different actions and situations during the demolishing, crushing, separation and recycling process transform-ing local concrete remains into gravel fill and aggregate in new concrete.

Business case characteristics

Tender process

A total contracting was offered as a *tender with negotiation* in accordance with the Public Procurement Act (Law nr. 1564 of 15.12.2015). The award criterion was the economically most advantageous offer with the best ratio between price and quality, where competition is based solely on quality. The Parking House

The total budget included all deliveries were tendered for a total of € 4,6 million, excl. VAT.

The contractor was selected based of the following allocation model:

- Architecture 50%
- Functionality 40%
- Process 10%

Among the criteria with a focus on circular economy in operation can be mentioned:

- Construction solutions with the highest reduction of materials as possible, including load-bearing structures, coatings, and installations.
- Material with a high degree of recyclability.
- Considerations regarding cleaning and operation clearly included in the design of the house.
- Considerations regarding total energy included as a parameter in the choice of materials.

In addition, demands were made in the tender material for recycling and circular economy e.g., reinstatement of crushed concrete and soil balance on the overall project.

Construction process

Even before the construction work started, the municipality (client) was aware that there could be obstacles in the ground, as the site is an old production facility for Unicon. For this reason, stricter requirements for notification of obstacles in the ground for the contractor were added. In addition, the geotechnical report pre-scribed pile foundations.

After approx. 2 months of work, obstacles in the ground were warned. Obstructions were inspected jointly by the involved actors and assessed to be mainly large, connected pieces of concrete.

A solution was decided jointly, namely that reinforced concrete piles should be rammed and trenches should be dug for approx. 1 meter depth to ensure fewer obstacles in the upper soil layers. In addition, foundation beams had to be excavated along the house in three lines.

This led to the excavation of a large amount of concrete mixed with soil, which was placed in an intermediate depot immediately outside the construction site.

From here, the normal procedure would be to obtain offers for the removal and disposal of concrete. This would both be costly and lead to large CO2 emissions in connection with driving the material. In addition, a large part of the excavated concrete and soil would have to be replaced by new gravel materials for filling around piles and foundations, as well as bottom protection. Again, this would be associated with costs and CO2 emissions.

It was therefore decided to handle the excavated concrete remains on site by crushing. A crushing plant was set up as a client supply and concrete residues were sorted into materials immediately suitable for re-incorporation into new concrete and that which had been mixed with soil. Pure concrete was crushed into 0-32 mm fraction, which was subsequently sorted into 0-4 mm and 4-22 mm fraction via soldering. This material amounted to approx. 100 tons. The remaining approx. 1000 tons material was crushed to 0-32 mm stable.

The general contractor now had the opportunity to pick up 0-32 mm stable immediately outside the construction site fence and re-integrate it directly as bottom protection etc. This ensured a good working process without delays.

If you consider the costs associated with the two scenarios described above, namely the scenario where the concrete remains are driven away and replaced by new gravel and the scenario where the concrete remains are crushed and rebuilt, the rebuilding of crushed material is associated with lower costs.

In the offer list, the price is for the cost of excavation, transport, and disposal of class 2/3 soil/gravel incl. de-posit fee indicated. In addition, delivery, and installation of new gravel fill as well. Finally, the price for break-ing up, loading and disposal of concrete residues in a thickness of 20 cm has been supplemented subsequently by the general contractor.

Based on the prices for the excavated concrete remains (1.100 tons), the following calculation can be made:

Drive-away scenario	
Demolition, loading and disposal of concrete residues	1,100 tons at € 33 per ton
Delivery and installation of new gravel fill	1,000 tons at € 25 per ton
In total	€ 61,700 excl. VAT
Scenario with re-integrating	
Installation and crushing of concrete residues incl. sold	€ 9,000 excl. VAT

Rebuilding of broken 0-32 mm stable	Included in contract offer
In total	€ 9,000 excl. VAT

The two scenarios have in common the excavation and handling of concrete remains. This was clarified as extra work offered at a fixed price.

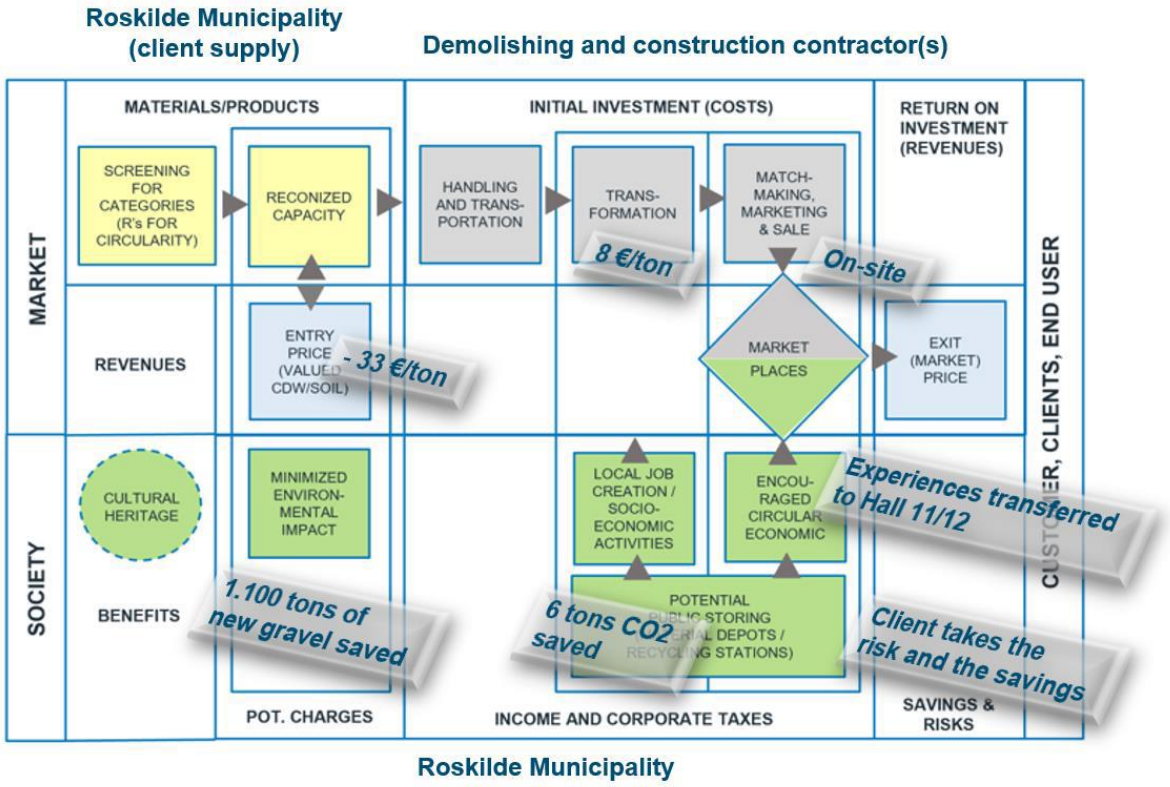

Fig.1: Model used for overviewing and evaluation of the business case[1].

Conclusions and lessons learned

The local circumstance according to space, noise, and dust on the site has without any doubt had substantial importance for the possibilities of handling and recycling the concrete remains locally, and the local handling has resulted in significant carbon and economical savings in this case. As mentioned above, it would often be necessary to consider these aspects differently as it depends on the local conditions.

Overall, the choice to crush concrete locally and re-integrate it during the construction has proven to be an ap-propriate solution in this case.

[1] https://bygherreforeningen.dk/download/13/filarkiv/51142/cityloops_circular_construction_business_case_model_final-1.pdf

The contractor has been able to keep the construction site running continuously and has had access to crushed piles at the site. Delays consisted solely by excavating obstacles in the ground, the rest was managed as client delivery.

Roskilde Municipality has – as a developer - been able to minimize costs associated with obstacles. The ad-dictional costs have been associated with the excavation of obstacles and various measures in connection with the ramming of piles. These extra works had to be carried out anyway. On the other hand, almost **€ 53,000 excl. VAT** has been saved on demolition, loading and disposal of concrete residues, as well as delivery and installation of new gravel fill, and at the same time the business case has been profitable for all parties.

Risk management

Risks are often a blind mate in construction projects, especially when the projects are including non-conventional methods, materials etc. In the case, “Indfaldet”, risk management therefor has been included as a central aspect in the planning process of the project and how the business case was assessed and evaluated, and the following description represent lessons learned and recommendations for handling this topic.

As a starting point, any risk elements must be identified as early in the process as possible, and this is car-ride out by the client (or in collaboration with an adviser) in the form of a risk mapping, where responsibility, risk and consequence are described.

Based on the risk mapping, it is assessed whether there is an opportunity to neutralize risks and whether re-possibility for risk management is placed by the right actor. It is often experienced that rigidly placed re-possibilities inhibit the possibility of proactive solutions and neutralization of risk elements. It is therefore crucial to maintain an open view of the nature of the individual risk and accept alternative placement of re-possibility if it is advantageous for the solution of the problem – not least financially.

It adds value to the project if the identification and handling as well as the allocation of responsibility and risk between the actors takes place proactively, transparently, and according to commonly accepted rules of the game, and often an open dialogue about potential risks can help to minimize any consequences of a trig-greed risk.

It is the type of risk that determines how and whether it can be eliminated or reduced. Certain types of risk can be neutralized through the provision of more knowledge, e.g., sampling. This typically applies to risk that relates to a lack of knowledge about scope and consequence. If a risk of the presence of environmentally hazardous substances is identified at an early stage, it is always advantageous to investigate this, in-stead of passing on the risk to a consultant or contractor, as they necessarily capitalize risk in an offer situation.

As part of the risk mapping, an early market dialogue is carried out with key actors. The key actors in the value chain in circular construction are - at least in a transition period - typically looking differently at risks than in traditional construction. Therefore, there is obvious potential

in placing responsibility for a given risk with the actor who has the potential to neutralize it. This way of thinking can advantageously be drawn into the tendering phase, where it is planned that bidders already in connection with tenders identify the risk elements that affect their responsibility and which they do not immediately have the opportunity to influence. This enables risk management to be dealt with already in connection with contract negotiations, and negative impacts on the bidder's business are minimized.

During the construction process, one may experience that new risk elements arise or known risk elements change in nature and must be handled differently. Therefore, in connection with offers, a process description must be included that explains how the risk that has arisen and/or changed risk is handled in the construction process itself - with respect for all parties involved.

Both a presentation of known risk elements and a description of the handling of emerging risk must be included in a proposal for a risk management plan when submitting an offer, so it can be included in the bidder's as well as the client's or procurer's business case estimation.

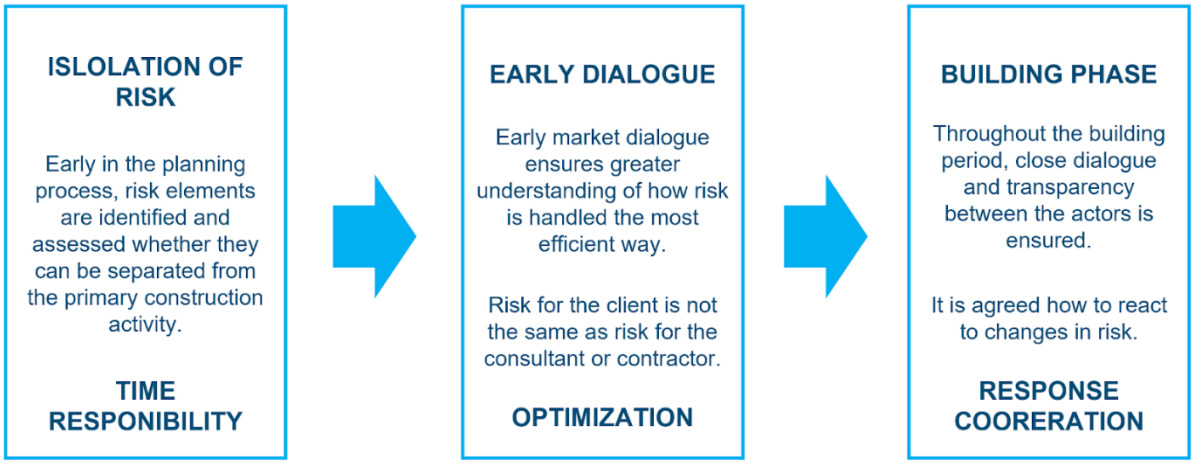

Fig.2: Isolation of potential risks in the early phase and managing risks in close and transparent dialogue between the involved actors in the process will have a positive effect on any business case[2].

[2] Kellermann, K., Roskilde Kommune (2022)

CITYLOOPS

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.

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