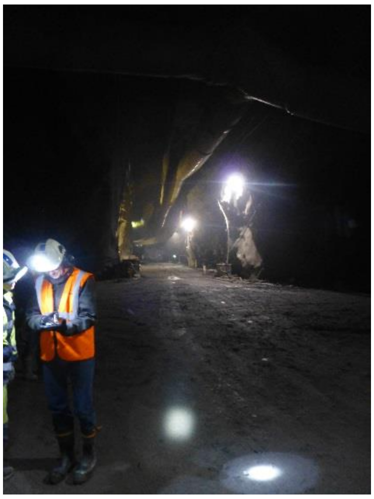
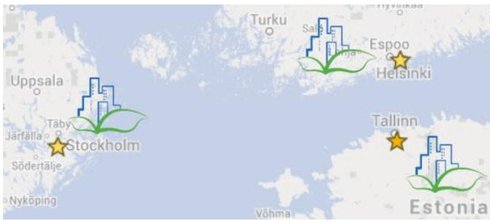
SIMM-Center – Report

MARKET SUMMARY AND DEVELOPMENT OPPORTUNITIES





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Date:	2014-11-18
Authors:	Graham Aid, Bo Svedberg, Kata Kreft Burman
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Cover Photos:	Svedberg B (left), Erlandsson Å (down right)

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1. INTRODUCTION

This market summary aims to look at how efficient markets for the management of SIMM Center focus materials (see Figure 1) have developed in the construction, demolition, and land development sectors in Europe and Sweden and how these markets might further develop in Sweden. Within the SIMM Center cluster, several development projects which have been performed are summarized in this report and attached as Appendixes. These include studies on mechanical technology in general, information communication technology (ICT), high value upgrading technology, and stakeholder opinions.

The SIMM Center focus materials include soil and aggregates from development works (excavation material) as well as secondary construction, demolition and infrastructure materials. Specific examples are, excavating soils, tunnel ballast, and demolition concrete.

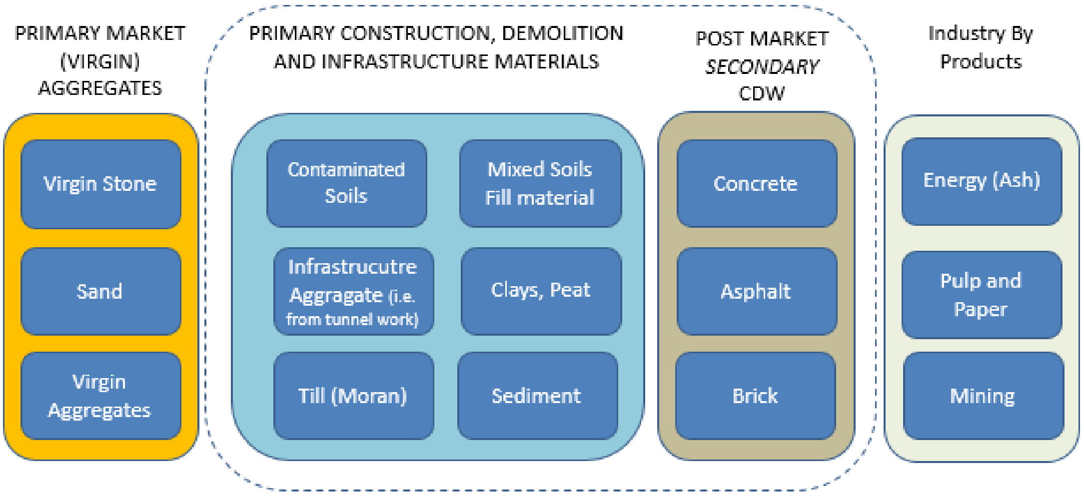

Figure 1 - Focus materials of the cluster (inside dashed lines) and related materials

The summary report and its associated reports looks to answer the following questions in short:

- How have similar markets developed elsewhere?
- What best practice technologies are available?
- How large is the market potential in Sweden?
- What new business opportunities might there be in the form of both service and material supply?
- What are the bottlenecks and opportunities for the development of such business in Sweden?

2. CURRENT MARKETS IN EUROPE AND SWEDEN

Markets for the efficient sourcing, use, and cycling of these materials have organically developed in various ways around Europe. In this section we take a look at what the production and flows of such materials look like in the EU27 countries as well as highlight a few countries that have reached higher levels of material cycling through recycling and technology.

2.1. SIMM Center Materials in Europe and Sweden (Numbers and Estimates)

As shown in Figure 1, SIMM Center focuses on excavation and secondary construction and demolition (C&D) materials. However these material markets are strongly interconnected to natural aggregate markets and even industrial by-products. In this section the European status of aggregates, C&D materials, and excavated materials are summarized respectively.

2.1.1. Aggregates

Aggregates in Europe

Aggregate production is widespread industry with over 24,000 production facilities (quarries and pits) in the EU27. Natural (virgin) aggregates, a granular material used in construction, include gravel, crushed rock, and sand. Aggregates may be an end-product in themselves (such as railway ballast) or raw material used in the manufacture of other products such as asphalt (made of 95% aggregates), ready-mixed concrete (made of 80% aggregates), pre-cast products, etc. In the European Union’s 27 member states (EU27) total production of aggregates in 2012 was 2.86 billion tons and the industry has a turnover of more than 15 billion Euros (UEPG, 2014c). Of this 2.86 billion tons, 189 million tons (6.6% of the total) was listed as recycled (post market) supply. Statistics show a 10% decline of production from 2011 to 2012 and it has been declining since 2007 due to the recession (UEPG, 2014a)

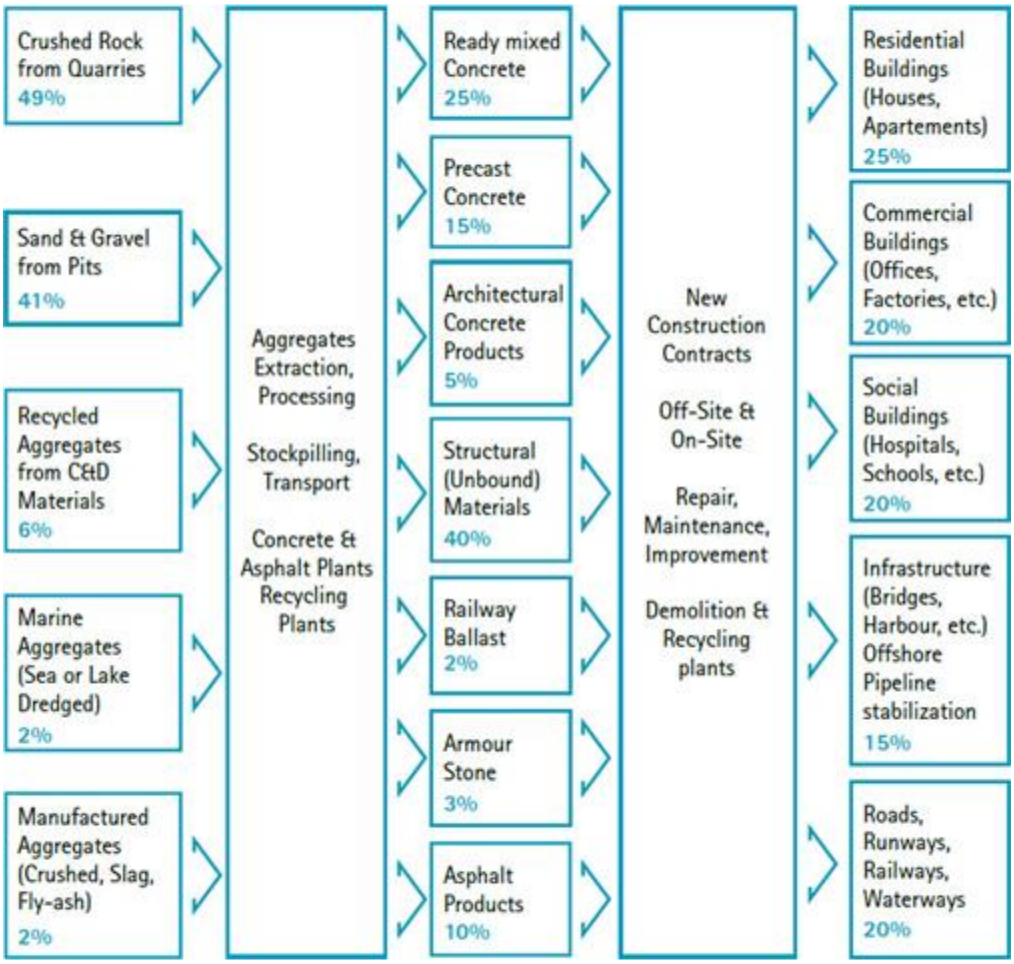

Figure 2 - Sourcing, Production and Use of Aggregates in Europe (UEPG, 2014b)

Aggregates in Sweden

According to Sveriges Geologiska Undersökning (SGU) 79.3 million tons of aggregates were produced in 2013 in Sweden (SGU, 2014). UEPG reports a similar figure of 81 million tons from 1,575 production sites in 2011 (UEPG, 2014a). Of this 1 million tons were recycled material, which means only 1.2% of produced material came from recycled material. This number for the EU countries is 189 out of a total of million tons amounting to 6.6% meaning that Sweden's recycling rate is lower than the EU average. Belgium, Denmark, Germany and the Netherlands have the highest rate lying between 10 and 25% with the Netherlands in the top (UEPG, 2014a).

Moreover, it is estimated that Stockholm will soon experience a shortage of aggregates, especially of gravel, and therefore it is crucial to increase the rate of recycling and re-use of construction material to maintain the level of development (Länsstyrelsen i Stockholms Län, 2000)

2.1.2. Construction and demolition waste

C&D Waste in Europe

Construction and Demolition waste is one of the heaviest waste streams generated in the EU27. It accounts for approximately 25% - 30% of all waste generated in the EU27 on a weight(European Commission, 2014a). C&D waste consists of several materials, including concrete, bricks, gypsum, wood, glass, metals, plastic, asbestos, etc. It is estimated that in 2012 there were 816 million tons of C&D waste in the EU27 (European Commission, 2014b). This number excludes excavated soils and aggregates. Of this C&D material 60-70% is estimated to be concrete and masonry (489-571 million Tons) (European Commission, 2011). Comparing this to the above EU27 production statistics of recycled aggregates, one can estimate that less than half of the mineral C&D material flow is being recycled. Additionally, it is uncertain the source of all the 189 million tons of recycled aggregate and therefore there is a chance that part of the secondary material going into recycled aggregates is not directly coupled to those generated in C&D activities.

C&D Waste in Sweden

Naturvårdsverket (The Swedish EPA) reports 7.7 million tons of C&D waste in Sweden 2012 (Naturvårdsverket, 2014). Some of these figures do include ‘excavation’ materials as described in the next section, but these numbers are expected to be grossly understated. Of the 7.7 million tons 6.3 million tons is estimated to be excavation materials (discussed in the next section) by Naturvårdsverket. Of the non-excavation material, 1.2 million is classified as non-hazardous. It is this 1.2 million tons of material that should reach 70% recycling by 2020 as put forth in the European Waste Framework Directive (European Commission, 2008). 60% of this 1.2 million tons is Simm Center focus material ‘Post market – secondary material’ as shown in Figure 1.

Naturvårdsverket’s estimation of current treatment of the whole C&D material stream is shown in Figure 3 below.

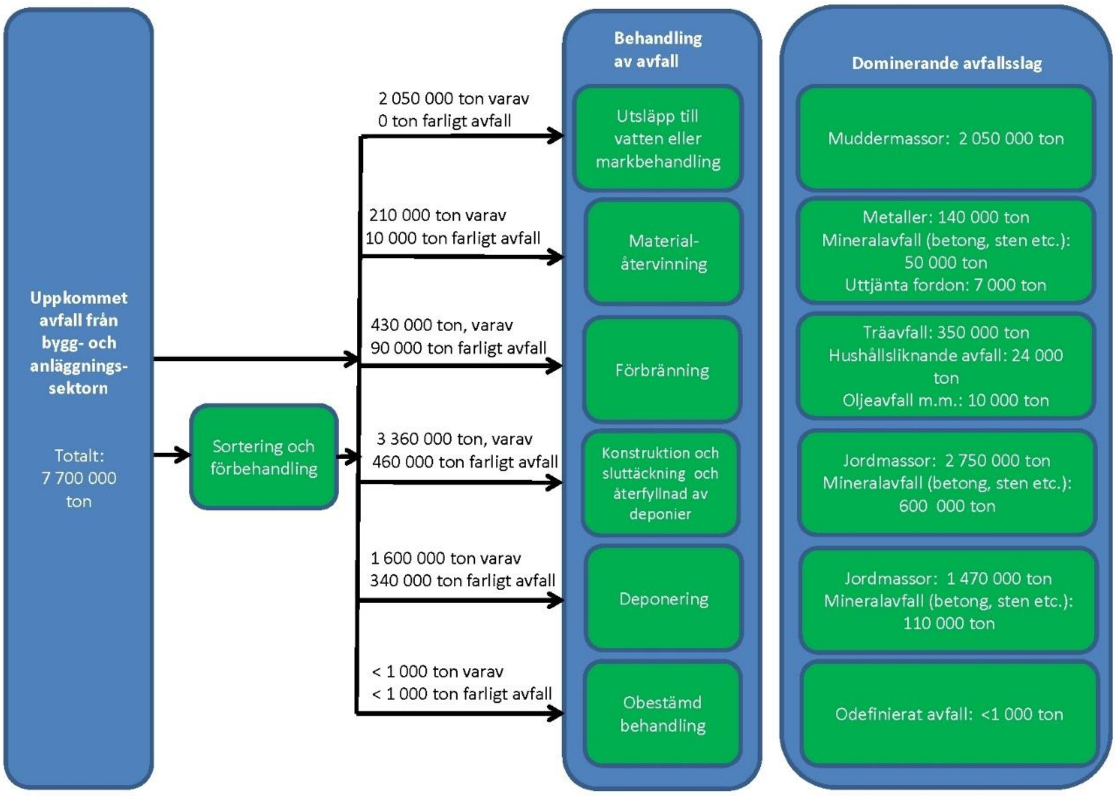

Figure 3 - Waste and treatment paths from the C&D sector 2012 - Swedish EPA (2014)

2.1.3. Excavated materials

Excavated Materials in Europe

Potentially one of the largest, and yet least well followed and documented flows of material from Figure 1 is that of the "Primary construction, demolition and infrastructure materials", summarized here as excavated materials. Excavated materials consist of soils, sediments, infrastructure waste such as rubble from tunnel work, etc. These materials are not included in most C&D waste statistics and are also excluded from the European Waste Framework Directive's (2008/98/EC) goals for reuse, recycling, and material recovery of C&D waste (European Commission, 2008).

There are no known statistics on a European level, but as can be seen below in the Swedish statistics it is estimated that these masses can reach 20-75% of the natural aggregate production.

Excavated Materials in Sweden

An estimate of excavated materials has been done within the HMFS (Sustainable Material Supply Stockholm) project. For road works, building construction, and infrastructure works, the report estimates that Stockholm County (Stockholms län) generates inbetween 4.8 and 15.4 million tons excavation material yearly(Lundberg, Frostell, & Svedberg, 2012).

In 2013 Stockholm County accounted for ca 25% of all planned construction space (m3) in Sweden (Statistics Sweden SCB, 2014). Therefore a very rough estimate of national amounts of excavation material can be set between 19 and 62 million tons yearly. In any case, 3-10 times larger than the 6.3 million tons reported to the Swedish EPA.

Using this approximation method, estimated excavation material is between 20-75% of the total yearly tons (81m) produced in the natural aggregates sector. In any case, this seems to be a massively under studied flow of materials in society.

2.2. Secondary Material Development timeline

The development of techniques, processes, and policy for the efficient use and cycling of aggregate material has progressed over the last decades in the various EU27 member states. The Fédération Internationale du Recyclage (FIR) which places focus on C&D materials attributes much of this progress to clear supporting steps that have been taken in member countries. These supportive steps are shown in Figure 4 and proceed from industrial initiatives to market acceptance.

In addition to these supportive actions, other specific requirements to lift the markets for secondary materials given by FIR are (FIR, 2014):

- No illegal dumping
- Prohibition of C&DW landfilling
- Selective demolition
- Standards for recycled aggregates
- Recognition by clients of recycled aggregates as a product
- Prescription of the use of recycled aggregates in public procurement

2.2.1. Country example: The Netherlands

FIR has given an example from development in Holland.

1980’s
There was almost no official recycling of C&D waste in the 1980’s. It was to be brought to the recycling plants, but there were no markets available.

1990-2000
The administration formulated an implementation plan and waste management action plan, instituted landfills taxes and bans, standardization and certification of recycled material, made a soil quality decree, and prescribed the use of recycled aggregates.

2000-2014
Of the 25 million tons of total C&D waste every year 96% is recycled. Additionally, 99.8% of the inert (mineral) fraction of this waste (20 million tons) is successfully recycled.

2.3. Development and Technological Status in Sweden

The SIMM Center Cluster has conducted two specific projects focusing on deepening and expanding the knowledge within 1) material flows and existing processing technologies, and 2) potential service opportunities through ICT solutions. The aim of these works is to increase understanding of the current technology and processes in use and to further explore the market potential in regards to the cluster's focus materials. Subsequent objectives were developed within the respective projects concerning communication, environmental consequences and economic benefits. See the Appendix titled "Enabling Technologies for Sustainable and Innovative Material Management" for details on these projects.

2.3.1. Material flows and existing processing technologies

In addition to detailing the processes and flows of material in construction and excavation works this project looked deeper into technologies and applications per material (see Section 2.4 in the Appendix report).

In conclusion this report shows that there are many technologies that can be used in order to increase the recycling and re-using of materials that are produced during construction chains. However, the flow of material in the construction industry is rather complex and therefore there is a need to engage actors and give them support based on their premises and situation. To achieve this, relevant actors must be gathered to share knowledge and experiences. This would imply to gather the technology suppliers, which to a great extent are SME's, and build a platform. While there may be a barrier to engaging such a broad range of actors, new ways of thinking (and specific business model formulation) can elicit new opportunities for these actors in efficient material management.

2.3.2. Potential service opportunities through ICT solutions

The focus of this sub-project was on ICT (Information and Communication Technology). What is the role of ICT in the construction sector, and how can ICT contribute to reach the stated goals in regards to reuse and recycling of heavy construction materials? Several relevant ICT tools exist in Sweden and around the world. However such tools looking to increase communication and trade of surplus construction material between different actors in the industry, have experienced limited success. This project investigated the potential of investing further resources in developing the idea, by evaluating specifically the potential environmental, economic and social benefits.

Environmental

This study performed analysis on 6 current and future scenarios as described below:

1. Current situation (2012)
   This is the situation as described in statistics for 2012.

2. ICT (2012)
   The implementation of the ICT tool can have an impact on the recycling rate of aggregate waste/C&D waste, but can also optimize the logistics of transporting aggregate material. The estimated recycling rate is 40%, the load increases to 63.5% and the distance decreases by 5%.

3. ICT and Medium-Term Storage (2012)
   In the ICT solutions a local 'Medium Term Storage' (MTS) system could be included. MTS already exists in the Stockholm area, however in a limited number compared to the amount of projects ongoing in Stockholm. By implementing more local storage areas, the transport could be reduced and loads percentages could be increased, as more material will be transported to the MTS which is often closer to the construction site, than a waste treatment. This local buffer could also allow for timely order delivery and local storage and treatment while space is limited on the actual construction site.

4. Business as usual (2020)
   Here it is assumed that average distance to virgin material supply will be further in 2020. This is based on the projection that several of the quarries around Stockholm will be exhausted and closed in coming years, and new quarries will be located further away from the city. The quarry distances are increased by 25 % which will mean around 5 km for all 2020 scenarios. This distance is moderate and is chosen due to the fairly short time span.

5. ICT (2020)
   Same as ICT 2012 but with distances adjusted as in BAU 2020.

6. ICT and medium term storage (2020)
   Same as ICT and medium term storage 2012 but with distances adjusted as in BAU 2020.

The results of the life cycle impact analysis is detailed in the full thesis report (Juhl, 2014). Below in Figure 5 an overview of the impact of greenhouse gas (GHG) emissions in the various scenarios can be seen.

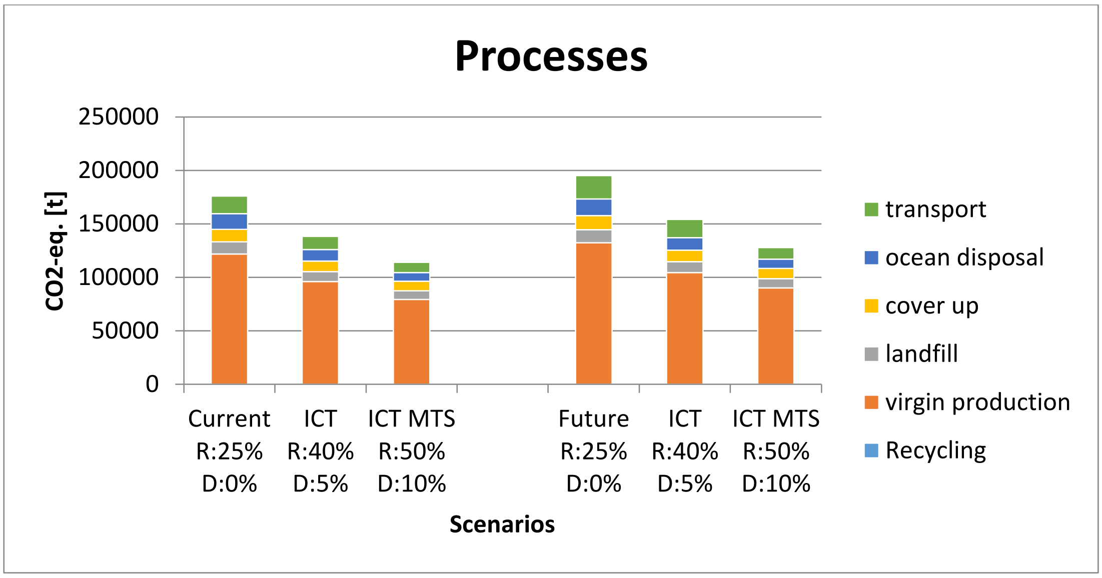

Figure 5 – GHG Impact from scenarios by process. R: % recycled material used, D: Decrease distance % (Julh, 2014)

It is interesting to note that the largest change in GHG emissions in these scenarios comes from the reduction of virgin production (via substituting with recycled material) and not so much from reduction in transportation.

More detail into these impacts and data sources can be seen in Juhl (2014).

Economic

Juhl (2014) also looked into some potential economic impacts of implementing ICT systems for efficient material management. While the savings can be significant over the system as a whole, specific actors could stand to gain or even loose more than other depending on their future approaches and business models toward the management.

According to the calculations, both ICT and ICT+MTS scenarios are profitable in regards to potential savings. Most actors benefit from the suggested scenarios, except transportation companies, which seems to lose business. However, the scenarios is optimizing the flows and transportation companies might have an opportunity to rethink their business plan. Detailed calculations are given in Juhl (2014) and a general outline of potential economic gain and loss are given below in Table 1 - Economical Gain/Loss vs. Benefit (Juhl, 2014).

Table 1 - Economical Gain/Loss vs. Benefit (Juhl, 2014)

Actor	Economic Gain	Economic Loss	Benefits
Governments	- Potential rent of areas - Cheaper construction offers	- Funding of project	- Generation of statistics - Reducing environmental impact - better living environment
Clients	- Potential ownership of material - Cheaper construction offers	- Funding of project -	- Better corporation between their contractors - Larger insight in planning
Contractors and Sub-contractors	- Less raw material cost - Less secondary material cost - Less transportation - Less disposal cost - Financial gain on selling more material	- Funding of project - Higher secondary material cost	- Finding new business partners - Better management of material - Higher transparency internally and externally - Area for unwanted material
Transportation companies	- Fewer paying hours	- Driving less kilometers/losing work	- Being more efficient - Predicting demand - Finding new business partners
Recycling Companies	- Increase earnings on recycled material	- Less material to landfilling and backfilling	- Less material to landfilling and backfilling

3. OPPORTUNITIES FOR MARKET DEVELOPMENT

3.1. The Lack of a Holistic Perspective Today

Today there is no single "owner" of the task to institute improved management of soil and aggregate materials. The problem is currently solved on a per project basis. Respondents believe this is a result of the lack of a holistic understanding. The diversity of participants is shown in Figure 9. The need to find some kind of core node has been expressed in this project as well as in the HMFS (Sustainable Material Supply Stockholm) project (Lundberg et al., 2012). At the same time that, attitudes toward the use of recycling technologies are increasingly positive.

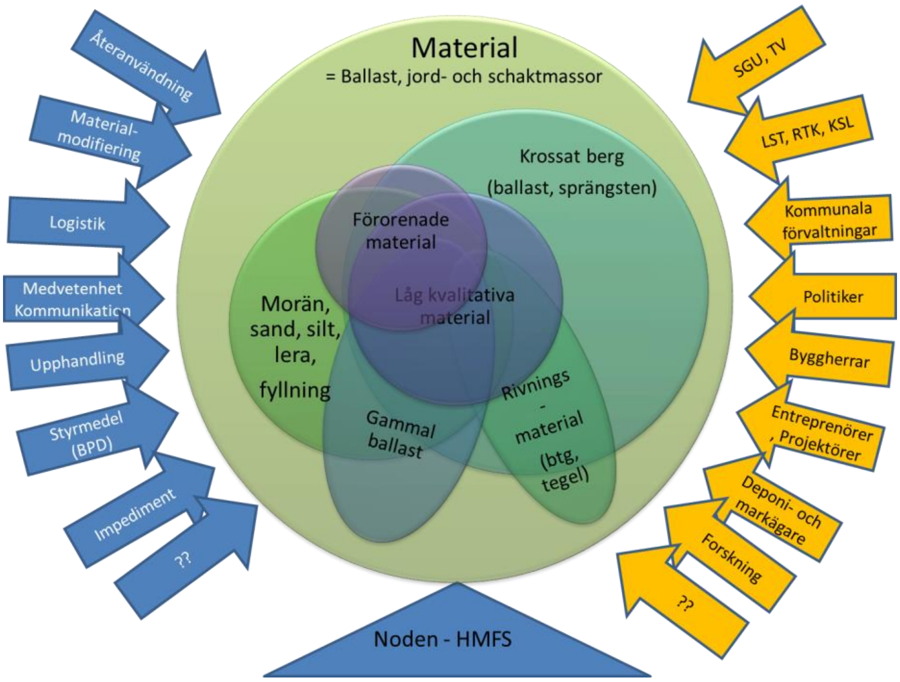

Figure 6 - Schematic illustration of the complexity of the aggregate management field and the need of a coordinating node. Depending on the parties involved and their tasks and opportunities a node can be anything from a collaborative group to one or several actors whom structure development and knowledge exchange. (Lundberg et al., 2012)

3.2. Integration of a Project Oriented Construction Industry

Landin et al (2011) argue that, put simplistically, there are two models for how we achieve competitive advantage and efficiency in production. The first model achieves efficiency through competition for individual relatively short-term tasks. Procurement is done to contract someone who will handle something for an individual project or deliver a service for a short period.

There are a number of arguments for this model, but at the same time, we note that in terms of efficient companies like Toyota in the automotive industry the classical models is not at all employed! A result in outsourcing theory and game theory is that it is much easier to create strong incentives under potentially long-term relationships, continues Landin et al (2011).

Leading companies in the private sector are striving to build long-term, but constantly evaluated, relationships with a limited number of suppliers. In these arrangements, partners can collaborate on product development and implementation through continuous improvement. Companies (interviewed in this project) normally do not procure new contractors from project to project. Contractors are incentivized to do a good job through the knowledge that a good job usually leads to the next project.

3.3. Realizing Regional Value

The focus materials as seen in Figure 1 - various fine and mixed particle size aggregates, soils, and industrial by-products – are today underutilized and undervalued on a systems level. During our various events within the SIMM Center cluster it has become clear that knowledge on the material amounts and types can be sufficient in individual construction projects or individual industries. However, when a project shall begin, there is seldom a clear plan for how the material shall be handled on location, transported to a material terminal, or transported to other local actor for material use and value creation. Suddenly, at this point in a project a strong need is realized for taking a wider systems perspective outside of the specific project, especially in large developing regions such as Stockholm County.

3.4. Legislation, steering and opportunities

Common practice along with regulation tightly governs today's practice, however there are opportunities for development of these in regards to systems wide material efficiency. Some of the potentials pointed out by participants in SIMM Center activities were:

National level:

- Tax on inefficient primary resources,
- Legislation and policies regarding material supply plans for national, regional, and municipal levels,
- Development of guidelines and praxis examples
- Education for planning

Project portfolio level:

- Legislation and policies to enable flexible material terminals

Project level:

Price is often the dominating factor when comparing alternatives, however affordable and alternative solutions are often disqualified because these are not directly comparable with "normalized" or the developer's planned solutions. SIMM Center participants therefore see the development of new contracting paths which enable suggestions for alternative solutions as a development potential. This is illustrated, for example, in their views on procurement in the learning and development process, see Figure 8, in the Stakeholder Analysis PM Report (Attached).

3.5. Suggestions for Suppliers Of Recycling Technologies

This section collects various concrete suggestions for suppliers of recycling technologies within the SIMM Center focus.

- Developed interaction with the construction industry
    - Intensify product development and continuous improvement work with the primary customers, i.e. contractors, under the umbrella of SBUF (Svenska Byggbranschens Utvecklingsfond)
    - Develop partnerships with final customers and contractors to introduce new technology and develop a tool for procurement, for example, within a Vinnova strategic platform
    - Establish a platform for technology providers to establish new practices and common approaches to primary and final customers, for example, http://www.construction21.org/

- Focus on technology for:
    - Upgrading of ”problem soils” such as clay, dusty and mixed soils
        - See the Appendix titled “Enabling Technologies for Sustainable and Innovative Material Management” for details on such technologies
        - See the Appendix title ”Efterbehandling av gråbergsupplag med morän modifierad med grönlutslam” for an example of upgrading of ”problem soils”
    - Improve the recycle of asphalt, concrete, and contaminated soils
    - Classification and localization of material for potential exchange between regional projects
        - See (Juhl, 2014) and the Appendix titled “Enabling Technologies for Sustainable and Innovative Material Management” for details on such tools

4. CONCLUSIONS

More efficient markets for the management of SIMM Center focus materials are possible, resulting in the potential for reduced environmental impacts, and larger market potential. Resulting in more opportunities for SME companies working with planning, technology development, providing contractor services, etc. On a systems level, there is much room for improvement in the economy of the market. How various sectors and organizations position themselves through business models and market adaptation will determine how large an impact these potential changes will have on their respective businesses.

It has been shown that the construction, demolition, and land development sectors in Europe and Sweden have been and will be under development for some time. Within the SIMM Center cluster, several development projects were performed to further explore how interested companies and public organizations might lead these adaptations. These development projects are all attached as Appendixes. These include studies on mechanical technology in general, information communication technology (ICT), high value upgrading technology, and stakeholder opinions.

While the SIMM Center project deepened knowledge in these areas, there is still much coordination and collaboration required to achieve some of the potential uncovered. In this continued improvement works, regional and inter-regional demonstrations are planned, legislative knowledge exchanging panels suggested, collaborative work with improved statistics required, and a collective goal for improved resource management paramount.

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The SIMM-Center cluster project has developed and established a platform concerning technologies for upgrading, recycling and management of excavated soil and mineral materials. The platform is a cooperation between clusters in Sweden, Finland and Estonia that have been funded by the participants and Innovation Express.

In this mature market report a summary of the material markets, yearly flows, current practices, and best practices are presented. In addition, introduction opportunities for development through technology, systems integration and policy have been laid out.

www.simmcenter.eu

Ecoloop AB

Mosebacke Torg 4

116 46 STOCKHOLM

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www.ecoloop.se, www.simmcenter.eu, www.optimass.se