Construction industry market segmentation: Foresight of needs and priorities of the urban mining segment

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Executive Summary

Problem/Opportunity

KPMG reports that 96% of global firms expect significant or moderate impact on business performance from raw material scarcity. Furthermore, construction & demolition (C&D) waste accounts for 25-30% of all waste generated in the EU countries alone, according to the European Commission. Resources, especially C&D waste, found in urban areas can be procured for reuse and recycling.

Two facts are clear:

- There is clearly a market demand for raw materials due to material scarcity and increasing cost of raw materials.
- There is a huge amount of resources found in urban areas not yet efficiently procured, exploited and capitalized upon.

These facts highlights new business and market opportunities in what can be defined as Urban Mining.

Markets are ever-changing and an explosion in people moving to cities can be expected. According to United Nations, the proportion of the world population living in cities will grow from 54% (2014) to 66% by 2050. Considering the continuously growing world population, exceeding 7 billion people as we speak – these circumstances can have significant impact on the industry and the future urban mining market segment. Thus, making it an unknown and risky target for those going into the market.

An issue emerging from this is:

How can we move into an untapped yet unknown market such as the urban mining segment of the construction industry?

A way to approach this issue is to identify the needs and priorities that represents the urban mining segment today, and in the future (2030). This information provides long-term strategic guidelines to concerned actors and stakeholders in taking on the urban mining segment challenges starting from today.
Findings

A list of needs and its relative importance was generated from studying 54 different firms operating within the urban mining segment in Sweden today. This information can be used as input in designing and implementing strategies toward targeting customers in the segment, as well as in marketing, and decision-making. It can furthermore be used as input in the development of new products and services in order to capitalize the market segment. They are further concluded in the table below (table 1).

Table 1. The market needs are listed from top to bottom based on how important they are according to firms operating in the urban mining segment.

<table>
<thead>
<tr>
<th>High priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevents spread of hazardous waste</td>
</tr>
<tr>
<td>Eliminates physical safety risks</td>
</tr>
<tr>
<td>Makes better use of materials to prevent landfill</td>
</tr>
<tr>
<td>Protects valuable materials from theft</td>
</tr>
<tr>
<td>Prevents diffusion of dust</td>
</tr>
<tr>
<td>Optimizes transportations</td>
</tr>
<tr>
<td>Eliminates disturbance/noise</td>
</tr>
<tr>
<td>Relieves labor workers from manual work</td>
</tr>
<tr>
<td>Facilitates workspace accessibility</td>
</tr>
<tr>
<td>Design considers the product lifecycle</td>
</tr>
<tr>
<td>Reduces occupied space (footprint) of objects</td>
</tr>
<tr>
<td>Machines/tools are flexible for different situations</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Low priority</th>
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Findings of the current urban mining segment shows that:

- Firms operating in the segment today highly prioritizes and are willing to pay for solutions that addresses issues related to safety, cost control, environmental and social care.
- The segment are in comparison to a low degree willing to pay for solutions addressing limited space, lifecycle consideration, and machine/tools flexibility.

In the future 2030, these market priorities are suggested to be different due to a number of changes. These are indicated to have an impact on the construction industry and the urban mining market segment, according to the study. Identified changes and future scenarios are concluded in the table below (table 2).
Table 2. Summarized changes and future scenario elements. It is based on the extrapolation of various trends and present need priorities.

<table>
<thead>
<tr>
<th>Nature of change</th>
<th>Future scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology 1: Smarter management of internal resources</td>
<td>Innovation management and workplace optimization enables higher creative output and better use of internal resources</td>
</tr>
<tr>
<td>Technology 2: 3D technology</td>
<td>Collaboration with 3D tools across firms in the supply and value chain. Low cost in design and more advanced manufacturing of products.</td>
</tr>
<tr>
<td>Technology 3: Adoption of ICT in processes</td>
<td>Worksite consists of a network and infrastructure for communication and information. Enables close collaboration among clients, firms and community. Work allocation shifting to a long-term service provision.</td>
</tr>
<tr>
<td>Technology 4: Advanced robotics and machines</td>
<td>Human and machines works alongside to complement each other, enabling higher productivity and speed. Humans provide support for emotional intelligence and ability to solve unknown problems in this relationship. Machines undertake hazardous, repetitive and high-risk tasks.</td>
</tr>
<tr>
<td>Technology 5: New/smart construction materials</td>
<td>Materials are stronger, durable, energy efficient, self-maintaining, allowing a longer lifespan of buildings and infrastructure. Materials used in construction are more sustainable.</td>
</tr>
<tr>
<td>Urbanization</td>
<td>Urban population has grown significantly bigger, and cities grow denser. World population keeps growing.</td>
</tr>
<tr>
<td>Stricter regulations and legislations</td>
<td>Urban mining practices are forced to comply with societal &quot;rules&quot; and regulations regarding noise levels, preventing physical risks and keeping emissions to a minimum etc., on similar conditions as citizens.</td>
</tr>
<tr>
<td>Globalization</td>
<td>Use and implementation of ICT have contributed to a globalized market opening up for collaboration and competition.</td>
</tr>
</tbody>
</table>

The changes and future scenarios suggest on higher and lower priority in some specific segment issues and needs.
The future urban mining segment puts higher priority and have an increased concern in solutions addressing safety, social care, and lifecycle consideration.

The findings are further finalized and concluded in an overview of relative importance (priority), related segment concerns or issues, and identified needs that characterizes both current and future urban mining segment (table 3).

Table 3. The need priorities of the present and the future are concluded and related to the identified industry/segment concerns or issues.

<table>
<thead>
<tr>
<th>Present segment 2015</th>
<th></th>
<th>Need</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High priority</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>•</td>
<td>Prevent spread of hazardous waste</td>
</tr>
<tr>
<td>Environment</td>
<td>•</td>
<td>Eliminates physical safety risks</td>
</tr>
<tr>
<td>Social care</td>
<td>•</td>
<td>Makes better use of materials to prevent landfill</td>
</tr>
<tr>
<td>Cost control</td>
<td>•</td>
<td>Protects valuable materials from theft</td>
</tr>
<tr>
<td></td>
<td>•</td>
<td>Prevent diffusion of dust</td>
</tr>
<tr>
<td><strong>Low priority</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space</td>
<td>•</td>
<td>Facilitates workspace accessibility</td>
</tr>
<tr>
<td>Lifecycle consideration</td>
<td>•</td>
<td>Design considers the product lifecycle</td>
</tr>
<tr>
<td>Machines/tools flexibility</td>
<td>•</td>
<td>Reduces occupied space of objects</td>
</tr>
<tr>
<td></td>
<td>•</td>
<td>Machines/tools are flexible for different situations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Future segment 2030</th>
<th></th>
<th>Need</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Higher priority</strong></td>
<td></td>
<td></td>
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<td>•</td>
<td></td>
</tr>
<tr>
<td><strong>Lower priority</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contingency</td>
<td>•</td>
<td>Protects valuable materials from theft</td>
</tr>
<tr>
<td></td>
<td>•</td>
<td>Relieves labor workers from manual work</td>
</tr>
</tbody>
</table>
Conclusion and Implementation

The identified current and future scenarios of the segment enables actors and stakeholders concerned with the construction industry and urban mining segment to identify and explore the consequences of different activities or decisions. Furthermore, having the possibility of a planned change, i.e. a proactive approach rather than a reactive. It enables solution providers to innovate in unexplored areas with less risk, and with the possibility to benefit from first-mover advantages.

- The study highlights an increasing priority in the safety for humans, the environment, a lifecycle approach in design, and collaboration across supply/value-chains in urban mining practices.

- Ensuring safety to humans, preventing noise, landfill of waste, dust and emission remains the top prioritized needs that urban mining practices must comply with today and to a higher extent in the future.

- Incorporating a lifecycle approach and collaboration across supply/value-chains will be a competitive factor for firms operating in the future urban mining market segment. However, this is not prioritized in today’s market segment in relative importance.

Moreover, going into the presented future scenarios may require firms to do dramatic changes in the organization. It would mean changes in the management process and organizational strategies. This could be vital for firms in fully representing and addressing the needs related to safety, social and environmental care in their practices, and in justifying their importance to the society. These are driving factors that are of increasing importance in the urban mining segment. Firms having these concerns and issues already incorporated in their values and mission are suggested by the findings to have a head start. They are especially suitable to go into the urban mining segment, and in staying there in the future.
Abstract

**Context:** Current unsustainable practices have resulted in the depletion of natural resources and a prevailing material scarcity. Urban Mining has emerged in this context and suggests the “mining” of cities or other sources in urban areas to retrieve valuable resources. It raises the topic of how urban mining as a market segment of the construction industry is like today and in the future.

**Objective:** The thesis sets out to study what firms in the urban mining market segment desires in terms of needs and priorities. Furthermore, what could be prioritized in the future (2030), what future scenarios could be expected and what implications these can have on organizations within the segment and on the construction industry.

**Method:** A foresight methodology was applied as a framework for the research design. Interview with representatives from 10 firms, including observations of their operations, resulted in a number of mutual needs shared across the urban mining segment. These were prioritized in relative importance based on a questionnaire of 67 respondents representing 44 different firms in Sweden. A combination of these studies and a review of technology trends further enabled the extrapolation of future scenarios.

**Results:** The findings shows that firms within the urban mining market segment prioritizes and emphasizes needs related concerns in optimization, cost control, safety, environmental and social care today. Needs related to safety, environmental and social care are indicated to remain top prioritized as a result of the future market circumstances. A holistic and lifecycle approach in urban mining practices was deemed of low priority today but was indicated to grow significantly in relative importance in the future.

**Conclusion:** Technology, urbanization and globalization indicates stricter and more competitive market circumstances in the future. Especially related to safety, lifecycle consideration, environmental, and social care. The research suggests that firms concerned and those operating within the urban mining segment may need to undergo transformational changes in their organization to meet what the market segment expects in the future. Moreover, the findings opens up the possibility for actors and stakeholders concerned with the construction industry to proactively go into a desired future by knowing how the future market could unfold.

Keywords: Urban mining; C&D; Emerging technology; Trends; Management; Product & service development; Needfinding, Customer needs; Sustainability
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M. Sc. in Industrial Management and Engineering
2015-06-15
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1 Introduction

Natural resources are nowadays getting depleted due to traditional and unsustainable ways of gathering raw materials. KPMG (2012) reports that 96% of global firms expect significant or moderate impact on business performance from raw material scarcity. The continuous need for materials have resulted in substantial accumulations of natural resources in urban environments and in the forms of buildings, infrastructure, products and landfills etc. (Brunner & Rechberger, 2004; UNEP, 2010; Baccini & Brunner, 2012). This brings up the perspective of “mines” that can be found in urban environments, which is in contrast to our traditional view of mines found in nature. Resources found in urban environments are not permanently employed in its structure and can be extracted for reuse and recycling, hence “Urban Mining” (Krook & Baas, 2013; Cossu et al, 2012).

According to Cossu et al. (2012) the urban mining concept has been brought up in many forms and definitions in various reports, websites and conferences. Krook & Baas (2013) argues that the urban mining term have been used as a “fancier” term to describe other concepts that are already in use, such as resource management, cradle-to-cradle and integrated waste management. In this report a more narrow understanding of urban mining is applied, where “urban” refers to the area inside city borders and “mining” as the extraction of resource from reservoirs situated in these areas (Krook & Baas, 2013). These reservoirs could for instance be construction & demolition (C&D) materials, municipal solid waste, electronic waste, rubber products, or whatever material located in urban environments and that is valuable to process. The European Commission reports that C&D waste alone accounts for 25-30 % of all waste generated in the EU countries\(^1\). Many firms within the construction industry are involved in the supply chain or process that could be considered urban mining. For instance, machine rental and C&D contractors that supply services for taking down buildings, or recycling firms that make better use of waste materials from these buildings.

With the accumulation of materials in cities and the increasing urbanization in mind; potential future scenarios for the construction industry (year 2030) could be that mining mother earth is no longer allowed, regulations requires reuse and recycling, and land might be the most scarce resource. The future is uncertain and there are plenty of studies that attempt to address the future potential scenarios of the construction industry closely related to the topic of urban mining. Harty et al. (2007) reviews many future studies and concluded that the methodological approaches used in these studies did not generate any significantly different advice or recommendations for the industry than those from non-future oriented construction industry research. Identifying present and future potential market and industry issues, or implications deriving from trends\(^2\) are common within the literature (Harty et al., 2007; Woolfson et al., 2012; Hwang & Yeo, 2011; Panahi et al., 2014; Woolthuis, 2010; Yuan et al., 2011). However, no research related to urban mining market segmentation and of future

\(^1\) Reported in European Commission’s DG Environment information site about C&D waste, which was last updated 27/03/2015.

\(^2\) A trend is according to Oxford Dictionary ”a general direction in which something is developing or changing”.

1
customer characteristics was identified. A call for journal articles by Krook (2010) in the *Journal of Cleaner Production* (Elsevier) have also requested research within the topic of identifying new markets in urban mining activities – which opens up for research in the presented topic.

### 1.1 Scope

Multiple industries and sectors are involved in urban mining. The research topic and question of the thesis is limited to mainly study the construction industry’s involvement in urban mining (figure 1-1). C&D, as pointed out earlier, represents a significant part of urban mining and embodies many other “downstream” sub-fields such as municipal solid waste and electronic waste.

The thesis sets out to study how the future urban mining market segment could turn out in 2030. Trends can be useful important information in understanding and in extrapolating\(^4\) that future. However, trends come in a big range of different types. Osterwalder & Pigneur (2010) presents four types of trends relevant in studying future scenarios: *technology*, *regulatory*, *societal & cultural*, and *socioeconomic* (demographic) trends.

Technology trends are the primary type of trends that is studied in the thesis. The other type of trends are defined to fall outside the boundaries of the scope but is discussed. This means that the thesis “only” covers one path, while leaving other parts out for future work. Technology is suggested by historical events to be central in how society or new markets develops. It can also bring regulatory, societal & cultural and demographic changes as a consequence (Makridakis, 1995; Menon 2010). Technology trends are therefore considered as among the more important out of the different types of trends to study in understanding a market segment.

The thesis delimits to mainly study the customer needs and their prioritization of needs to contribute and in understanding the future urban mining market segment. Customers’ needs are long-lived – for instance, the need of having a portable storage of digital data has been consistent for decades but the technical solutions have been different (from floppy disks to cloud storage today) (Patnaik & Becker, 1999). However, prioritizations of need or wants may vary as people and organizations are constantly shaped by external factors such as the influence of society, media and technology etc.

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\(^3\) A customer is regarded as a person with an interest, influence or concern in the choice of a product or service. For instance a manager, purchaser or an end-user of a product.

\(^4\) *Extrapolate* - Extend the application of (a method or conclusion) to an unknown situation by assuming that existing trends will continue or similar methods will be applicable (according to *Oxford Dictionaries, viewed 2015-06-13*)
Figure 1-1. Urban mining is studied as segment of the construction industry. Urban mining is closely related to the material/product/service supply, C&D, and waste management businesses. The figure is used to primarily illustrate the studied urban mining concept. The scale-ratio has no meaning in the figure.

1.2 Research question

Technology advances will open up for new opportunities and new markets. Customers might have different priorities, needs and values etc. A research topic that arises from this is how the urban mining market segment within the construction industry could be like in the future.

A market segment is commonly characterized by a group of some kind, for instance customers that have common needs and priorities. Following this, the thesis attempts to identify and map the future urban mining market segment of the construction industry by answering – *what would characterize customers within the future urban mining market segment 2030 in terms of needs and priorities?* The thesis therefore sets out to identify the future desires of customers of the urban mining market segment.

The research question can be broken down in a set of sub-questions. Answering the following set of questions solves the defined research question.

1. What needs are shared across firms within the urban mining market segment today and in the future?
2. Which of the identified needs are among the most prioritized today and in the future (2030)?

5 There are mostly firms or organizations that operates within the urban mining segment of the construction industry but is referred as customers in the thesis.
1.3 Purpose

It is argued that the successful management of change is crucial to any firm to succeed in the present highly competitive and continuously evolving business environment (Todnem By, 2005). The goal with the thesis is to provide support for these kind of changes. The purpose is to furthermore contribute in mapping the future urban mining market segment of the construction industry.

The findings that are presented can have strategic implications for actors and stakeholders that supply the construction industry with products and services. The findings can also aid in designing and implementing strategies toward targeting customers in the segment, as well as in marketing, and decision-making. It can furthermore be used as input in the development of new products and services in order to capitalize the market. Furthermore, provide recommendations on how actors and stakeholders concerned with the construction industry could prepare for future scenarios that are identified.
2 Theory

2.1 Stakeholder analysis

Stakeholder management is a well-documented field within management studies and is considered a critical component to the successful delivery of any project, programme or activity (Atkin & Skitmore, 2008; OGC, 2011). Brugha & Varvasovszky (2000) states that one can develop an understanding of how decisions are taken in a particular context by collecting and analyzing data about a stakeholder\(^6\). The aim of doing this could be to evaluate and to understand stakeholders for different purposes. For instance in mapping market segments, understanding decision-making motives, and what factors that determines a customer’s desirability of a product.

Stakeholder needs, personal traits, position, interest, influence, values and interrelations are examples of characteristics that can be interesting in a stakeholder analysis (Brugha & Varvasovszky, 2000). A stakeholder analysis is hence a reasonable starting point since this paper intends to investigate the characteristics of a customer within a future market segment. The challenge however is not only to understand the present market segment, but the future urban mining market segment. But first of, why are stakeholder/customer needs relevant for the research topic and for market segmentation?

2.2 Customer needs and Needfinding

Customer needs are useful information in developing products or services, as well as in business and marketing-related activities (Patnaik & Becker, 1999; Gaskin et al. 2010). Patnaik & Becker (1999) argues that most developers of products or services intuitively understand that customer needs are important. They can do so by addressing their customer’s problems that the clearly understand. Patnaik & Becker however states that understanding a need rather than an isolated problem is more useful as it can be leveraged across an entire business activity – “... providing value beyond the development of any single product” (Patnaik & Becker, 1999, p. 38).

Going back to the previous example for the need of having a portable storage of digital data. Punch cards, magnetic tape, and floppy disks are different types of solutions that have all existed for the purpose of fulfilling the same need, i.e. the need of having a portable storage of digital data. This example proves an important point. Needs are long-lived while solutions are temporary depending on current technological possibilities. Since people’s needs last longer than solutions, companies should focus on finding better ways to serve those needs rather than holding onto specific and existing solutions (Patnaik & Becker, 1999). A firm that exists only for a specific type of solution might hence be a dying firm. It is therefore strategically important for a firm to understand what customer needs that constitutes the market or segment that they operate in. The customer needs can help firms to plan their short and long-term

\(^6\) Business Dictionary defines a stakeholder as “a person, group or organization that has interest or concern in an organization.” (http://www.businessdictionary.com/ viewed: 2015-01-18)
product development. Furthermore, provide a roadmap that they can work towards (Patnaik & Becker, 1999).

Patnaik & Becker (1999) highlights that needs can be difficult to detect. They may be obvious after the fact they are revealed, but not before. There are numerous famous examples of this. Henry Ford, for instance, said ‘If I had asked my customers what they wanted, they would have said a faster horse.’ In fact, what the customers really needed was the possibility to transport from location A to B in the shortest possible time. The problem of how needs can be collected arises from this example. Asking a customer directly will not always reveal a need. Another problem is that all needs a customer may have are not equally important to him/her. A methodology called Needfinding addresses these issues (Patnaik & Becker, 1999).

However, customer’s priorities of needs might change over time due to technological, cultural, and societal factors etc. This raises the problem of addressing needs and the prioritization of needs over time, since need priorities might be different comparing from today and in the future. Foresight or forecasting could possibly address this issue.

2.3 Foresight concept

Foresight is described as an activity aimed at supporting strategic future oriented action, and it is further described as a process of analyzing the present in order to predict a potential future scenario or scenarios (Schwarz, 2008, Amsteus, 2008). Theoretical and empirical research have shown that managerial foresight can have positive relation to firm performance, which in a more general sense suggests foresight as a scientifically acceptable concept (Amsteus, 2011).

Methods related to future studies, foresight, forecasting or planning are therefore reasonable to consider in mapping future scenario of any kinds. Foresight is therefore considered a relevant approach in understanding customer characteristics of a future market segment.

There are number of terms applied in research related to predicting the future, what is needed in the future, and predicting future events that are not yet observed etc. According to Horton (1999) and Major et al. (2010) there is no widely accepted definition of foresight. This has resulted in the term often being misunderstood. Amsteus (2008) reviewed past usages of foresight and definitions, and argues that there is a plethora of definitions and usage of the foresight concept. This may foster a complexity that is easy to get lost in, according to Amsteus (2008). Since there are plenty of different usages and definitions, as well as tools and methods, used in foresight it could be wise to first state the requirements and the expected type of input and output data. From there, select a definition and method that is suitable for the research.

Research within psychology, for instance, suggests that human’s daily thought is directed towards potential future events, and that humans can based on past experiences simulate future possible events (Suddendorf & Corballis, 2007; Addis et al, 2007). Foresight in management emphasizes analyzing the present in order to project the future, which is a similar concept (Amsteus, 2008).
A general standpoint and approach in the multidisciplinary field of foresight is that data should be rooted in the past and present in order for the results of future scenarios to be of credibility. This could set the requirement for the research and furthermore the type of data that can be expected in solving the research problem.

2.3.1 Foresight approaches
The literature present many different approaches or methodologies for foresight. Three frequently used methods in future studies and in the field of management is the Delphi technique, Scenario technique, and quantitative forecasting (primarily as quantitative business forecasting) (Schwarz, 2008).

The Delphi technique relies on experts that deal with future problems and the goal is to achieve a consensus between varying opinions (Schwarz, 2008).

The Scenario technique is mainly a qualitative method that differs from the Delphi technique by relying on the management of an organization instead of experts. The aim is to build future scenarios based on trends and key uncertainties to be combined in pictures of the future (Schoemaker, 1992).

Quantitative forecasting relies on the technique of extrapolating data and trends, with the assumption that the past is a prologue to the future and that the upcoming future will not change dramatically from past patterns (Ewing, 1979; Ackoff, 1981).

Future User is another method developed by Innovation Leadership Board LLC, originally from Stanford University. Carleton et al. (2013, p. 103) describes Future User as a method that “... creates a future profile of a user within a targeted demographic by comparing similar groups over time”. The Future User methodology is argued to enable the study of future user needs without extrapolating biases from today’s users (Carleton et al., 2013). It relies on using current evidence and historical facts to develop a target user or group that is grounded in reality (Carleton et al., 2013). It is further explained to facilitate the comparison of similarities and differences of two segments over time, which in our case would be the current and the future urban mining segment.

The foresight methodology can set the framework for the research design in order to answer the research question. Furthermore, guide what kinds of data is required, and what order of procedure the research can follow in order to study a future stakeholder. Also in for instance understanding how trends can be related needs, need priorities and changes in the segment. Needs, priorities, and trends can for instance be used as input data to study the future need priorities of the urban mining segment. Trends would be useful in the sense that it can suggest how the future could turn out.

2.4 Trends
Environment and external factors such as industry forces, macro-economic forces, market forces and trends, all have an influence on what a customer or firm prioritizes in terms of needs. Whether it is clothing fashion, societal factors such as laws, rules, norms, culture, or technology development – all can have an influence on a customer’s preferences. The thesis
delimits to solely investigate trends in order to understand what needs firms prioritizes in the future urban mining market segment, as stated in the scope.

Both past and present trends are variables that can be studied to understand why firms’ prioritizes in terms of needs as they do today and in how they might in the future. Osterwalder & Pigneur’s (2010) breakdown and categorization of trends can be used to further understand the concept of trend. Osterwalder & Pigneur (2010) presents four types of trends relevant to foresight: technology, regulatory, societal & cultural, and socioeconomic trends.

**Technology** does not have direct relation to what a customer needs (Patnaik & Becker, 1999). It does however have a strong relation to how well customer needs can be fulfilled. Patnaik & Becker (1999) gives the example of Apple’s MessagePad, 1997, that despite featuring cutting-edge technology still sold poorly and ultimately was removed from the product line. Technology trends are relevant to the study in the sense that it could enable solutions for better satisfying customer’s needs. Thus, have the possibility to represent important opportunities or disruptive threats in a market (Osterwalder & Pigneur, 2010). This can further affect what is prioritized in terms needs.

**Regulatory** factors are commonly known to affect economies, firms and the market of products and services. Customer demand can be influenced by regulatory trends (Osterwalder & Pigneur, 2010). Firms, for instance, are forced to conform their operations accordingly to laws and regulations. Consequently, it could force a firm in what it prioritizes to deliver to a market (even against their will and wants), and in order to maintain a legal business.

**Societal & cultural** trends relate to societal and cultural values in a society. These can potentially explain why people or firms behave or will behave the way they do. Shifts in societal or cultural values can have impacts on a market (Osterwalder & Pigneur, 2010). Some societal trends can for instance be caused by disruptive events like the World Trade Center terrorist incident “9/11”. This event raised a discussion revolving construction design as for safety and proactive measures. Events such as these can potentially affect what customers or organizations prioritize in terms of needs, which make societal & cultural trends relevant to study if one desires to map a future market segment.

**Socioeconomic** trends (includes demographic trends) are related to factors such as income and wealth distribution among a population in a market. Spending patterns, and amount of disposable incomes are other examples that can have an impact on a market (Osterwalder & Pigneur, 2010). For instance, urbanization and the proportion of people living in urban areas opposed to rural areas can have a significant impact on urban mining. Disruptive customer demands can emerge as a result of socioeconomic or demographic shifts.

The scope of the thesis limits to primarily study technology trends, as stated in the scope. A question that rises from this choice is how technology can affect a market segment or customer group. According to Menon (2010) technology can have significant effects on society and furthermore bring changes to a market. (Makridakis, 1995; Menon 2010). The agricultural and industrial revolution are two examples of how technology brought forth changes to the society, for instance in how people lived, worked, and consumed products (Menon, 2010). The industrial revolution had for instance more people moving to the cities to
find a job (Menon, 2010). Having a full-time job in cities and a salary changed ways of how people consumed products. Instead of farming your own food, it was now more convenient to buy it directly. Cities also introduced a new lifestyle. The expansion of the mass manufacturing industry, abusive child labor, the increased smog levels etc. eventually resulted in new legislations. All of these are well-known highlights in history and how technology can bring consequences. These examples highlights technology as central in the development of the society, social and cultural structures, and in legislations. Therefore makes technology an interesting factor to study in order to understand market circumstances. It is suggested that technology can have an influence on a market’s demand and supply, which further affects what is prioritized in terms of needs. It can be argued that a highly prioritized need is likely to be of high demand on the market (people want to pay for it).

Trends can be useful in foresight and in supporting strategic future oriented actions, as previously argued. It can give a sense in which direction a market is going towards. A foresight based on customer needs along with trends can give indications on potential need and priorities within a future market segment. However, a future scenario alone – that states ‘what’ could be expected – might not be a strong enough argument to encourage actions or provide industry insights. Applying a context of theory in ‘how’ the identified future scenario can aid firms within the addressed industry to stay competitive, adds an additional dimension to the thesis.

2.5 Change Management

Increasing globalization, rapid pace of technological innovation, and shifting social and demographic trends – drives changes in the business environment of firms, industries and nations alike. This is a common takeoff for many research topics in management. Change is triggered by internal or external factors, comes in different shapes, forms and sizes (Todnem By, 2005). For organizations to survive and succeed in an increasing competitive and continuously evolving business environment – it is crucial to be successful in the management of change according to Todnem By (2005). Moran & Brightman (2001, p. 111) defined change management as

“...the process of continually renewing an organization’s direction, structure, and capabilities to serve the ever-changing needs of external and internal customers”

Todnem By (2005) states in a critical review of change management literature that “change is an ever-present element that affects all organisations” (p. 378), both at an operational and strategic level. It is therefore “... no doubt regarding the importance to any organisation of its ability to identify were it needs to be in the future, and how to manage the changes required getting there” (p. 369). This implies the significance of foresight, which is implied as a fundamental part of the change management process.

Changes can be further characterized by how they come about or how they are approached (Todnem By, 2005). Planned, emergent, contingency and choice are presented as four different types of changes depending on how it comes about (table 2-1).
Table 2-1. Changes can be characterized by how they come about or how they are approached.

<table>
<thead>
<tr>
<th>Type of change</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned</td>
<td>Different states are understood in advance, in order to move (change) from an unsatisfactory state to an identified state. Change is approached proactively.</td>
</tr>
<tr>
<td>Emergent</td>
<td>Changes ‘suddenly’ come about due to unpredictable changes in circumstances and conditions. Change is approached reactively.</td>
</tr>
<tr>
<td>Contingency</td>
<td>Changes are approached as situational and dependent on organizational structure and performance for “optimum fit”.</td>
</tr>
<tr>
<td>Choice</td>
<td>Relates to changes that are not driven by external variables but by internal interests, e.g. organization consciously decides not to change their internal practices to fit in with external variables.</td>
</tr>
</tbody>
</table>

Changes can also be characterized by scale. Todnem By (2005) presents four types of change identified by scale: *fine-tuning, incremental adjustment, modular transformation*, and *corporate transformation* (table 2-2).

Table 2-2. Changes can be characterized by scale depending on the extent of impact on an organization.

<table>
<thead>
<tr>
<th>Change type characterized by scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine-tuning</td>
<td>Changes foster individual and group commitment to clarify established roles, and to promote confidence in beliefs and norms in departments, e.g. alignment adjustments to the organization’s mission.</td>
</tr>
<tr>
<td>Incremental adjustment</td>
<td>Distinct yet non-radical modifications to existing management processes and organizational strategies.</td>
</tr>
<tr>
<td>Modular transformation</td>
<td>Major shifts of one or several departments, divisions or parts of an organization. The changes can be of radical nature.</td>
</tr>
<tr>
<td>Corporate transformation</td>
<td>Corporate-wide and radical alterations in the business strategy. Examples of this are reorganization, altered power and status, reformed organizational purpose and core values.</td>
</tr>
</tbody>
</table>
The implication of a future scenario and the changes it brings to a market segment or industry can be studied from a change management perspective. A future scenario is likely to be different from a current scenario, which means that there is a change in-between the present and future scenario.
3 Methodology

The thesis sets out to understand need priorities of a future market segment in order to facilitate a change or understand motives of actors and stakeholders, which is related to stakeholder analysis in its core. Stakeholder analysis sets the theoretical foundation of the thesis, wherein foresight is the main concept in achieving this since. How the thesis sets out to do this is to be further elaborated.

3.1 Foresight

Tools or methods related to futures studies, foresight, forecasting or planning is reasonable to consider in identifying future scenarios of any kinds. The Delphi method, Scenario technique, quantitative forecasting and Future User are few methodologies in foresight that can be used for this purpose. Overall, the key concept of foresight in the presented methods are similar to one another. These methods are more or less presented as general frameworks that can be adopted in research for different purposes, and the use of either of them can be expected to give similar results. They all fulfill the defined requirement in taking consideration of the past and present to predict the future. The Future User however, suits the research problem quite well since it builds upon concepts like stakeholder analysis, and Needfinding. The other presented methods are more generally applicable compared to the Future User methodology and therefore requires adjustments.

Quantitative forecasting was excluded since it is based on quantitative techniques that statistically assume that the environment of the organization will not change significantly from its current pattern (Ewing, 1979; Ackoff, 1981). There is a possibility of disruptive changes in market characteristics along with the current emerging circumstances of urban mining, which is why quantitative forecasting was excluded. The Delphi and Scenario technique were also excluded since the methods presumes that a focus group of people from the construction industry (in this case) needs to be arranged and allowing them to do the foresight analysis. These methods hence depend on subjective opinions of experts, which could impair the results due to bias (a researcher’s point-of-view rather than practitioners or industry experts).

3.1.1 Future User foresight methodology

The choice of method ended up on Future User since it suits the research problem in hand as it already is, while the other presented methodologies such as the Delphi method and Scenario technique are more generally applicable to various purposes and therefore requires adjustments.

The methodology itself is formed as a general framework suitable for many purposes related to future users/groups of different kinds and therefore only consists of guiding questions. Hence, the methodology needs to be somewhat adapted to suit the research question at hand.

Basically, the “subject of study” as it exists today is described, thereafter the past is studied to understand how the subject have changed over time, afterwards the target subject of the future is described, and lastly the present and future subject is compared. The analysis will
ultimately provide insights in how the “two” subjects of study changes over time (Carleton et al., 2013). In our case it would mean insights in how the market segment changes over time towards the future, and the possibility to study what implications it can have on the industry.

The Future User methodology was hence applied as framework for the research design and in defining four steps based on the guidelines provided by the methodology (Carleton et al., 2013). It therefore sets a high-level framework for the order of procedure, data collection and analysis.

1. Needs and need priorities describing the primary segment today are collected.
2. Past industry issues and trends are reviewed and analyzed to study how today’s market segment (needs and need priorities) was shaped.
3. The future market segment in the target year (2030) is extrapolated based on present industry issues and trends.
4. The future and present segment are compared and contrasted in order to identify similarities and differences.

The relation between needs priorities and trends is not apparent and given in beforehand. That is why the second step of backtracking into the past is necessary in order to find correlations in how the past shapes what is known in the present. Only then can it be possible to study how the future based on trends influences the need priorities.

Each step is further elaborated in details of how the research was done in upcoming subsections.
3.2 Primary data: Needfinding

Needfinding as a methodology contains a number of methods that directly addresses the defined research problem in investigating what characterizes the urban mining segment in terms of needs and priorities, and therefore makes a reasonable approach to proceed with.

Summarizing the needfinding process: interviews and observations were conducted with stakeholders operating within urban mining to collect data for eliciting customer needs. The needs will furthermore be prioritized in terms of relative importance, which adds another dimension to the results. Altogether, the needs and priorities were identified through interviews and observations. The data are complemented with surveys to prioritize the needs in terms of relative importance. The data could thereafter be used as input data in the foresight method to set the baseline for analyzing the past as well as the present. The choices of specific methods are further described in upcoming subsections.

3.2.1 Sampling: data sources

The source of data can have a negative impact on the validity, reliability and relevancy to the research. Biased or not valid data might reduce the overall quality of the thesis. Literature that
presents scientific approaches are preferred sources to reduce the risk of data being biased towards specific interests, and sustain the quality of the thesis (Ghauri & Grønhaug, 2010). Only few exceptions was done when using other kind of literature. However, it was made sure that none of these were used in the core parts of the thesis.

Eliciting needs from global firms or using literature that has global characteristics were preferred since urban mining is a global phenomenon. Data was collected from multiple sources on local, domestic or regional level instead when this was not possible. The collected data were therefore more likely to be generalized. All sampling are judgement based, which means that the researcher’s judgement was used in getting a sample that is representative to the population (Ghauri & Grønhaug, 2010). Hence, defining urban mining and those representing it was done prior to the sampling in order to prevent a wrong judgement to affect the results.

Employees within firms and firm-related activities were considered the main data sources for the research. These could for instance be executives, project managers or labor workers within the construction industry and related to urban mining. Job position was not considered when choosing the data source since all people in a firm are assumed to be a direct or indirect influencer to the choice, preference or procurement of a product or service. Firms whose operations or context that can be related to the product lifecycle in urban mining and were considered subjects for observations. Some example of these are firms involved in the supply or end-of-life phase of materials in urban mining. This means that a wide range of different firms are potential data sources. An effort to include different firms within different lifecycle phases have been done in order to keep the scope wide and to cover as many aspects of the urban mining segment as possible, which could result in general needs that are shared across the whole market segment.

Firms operating in urban mining were also sampled to quantitatively measure the relative importance of the different needs, wherein representatives in firms were considered possible subjects for representing a firm. The selection of respondents for the survey sampling was randomly chosen.

3.2.2 Qualitative methods: Collecting data for eliciting customer needs
Identifying customer needs is primarily a qualitative task, according to Griffin & Hauser (1993). Patnaik & Becker (1999) suggests three commonly used methods for this purpose: interviews, focus groups and observation.

Observations can be complemented with interviews in the needfinding process. Observations complements interviews in understanding the context better and support in asking critical questions, for instance related to “why a person acted in a certain way and what he or she felt during the observed situation” – which could result in getting crucial data (Patnaik & Becker, 1999, p. 42).

The interviews were structured with open-ended questions rather than close-ended. “The goal is to elicit an honest expression of needs, not to convince a customer of what he or she needs” (Ulrich & Eppinger, 2012, p. 79). Patnaik & Becker (1999) further argues that methods like
surveys does not help much in identifying needs that people cannot readily articulate. They do however work well in quantifying customers’ preferences or priorities among existing options. The researcher may not know customer needs in beforehand either, which makes open-ended questions the preferred choice. That is also why surveys were not considered when collecting the needs.

3.2.2.1 Interview with customers
Unstructured interviews were conducted with customers and the data was recorded as notes and recordings. The interviewer gave open-ended (lead) questions to record the responses and in order to later understand “why”. Open-ended formulated questions are preferred in order to not involve the interviewer’s influence in the data (Ghauri & Grønhaug, 2010). Examples of asked questions were “what are your daily challenges?” “what do you like/dislike …”, and ”how do you envision your work in the future?”. The goal was to allow the respondent to give “new” and unforeseen information from a scientific point-of-view, since closed-ended questions tend to cease the interview from being an explorative process of an unknown field (Krag Jacobsen, 1993).

3.2.2.2 Observation of firm operations
Field observations were conducted in order to collect data that ultimately revealed needs not consciously known by the customer themselves or the researcher in beforehand. Observations can complement the interviews by accessing data about what people actually do and instead of what they might claim they do (Ghauri & Grønhaug, 2010). Field notes and photos were generated from the observations. How the observation were conducted and how it could affect the validity and reliability of the data is important to consider and in ensuring the quality of the results.

The observer was a part of the situation, event or the performed operations by being guided and informed by a person from a firm. The collected data will hence be closely related to what the firms allowed the observer (the researcher) to observe, most probably what the guide believed what was interesting for the observer to see. It could therefore impair the data since it might not have given a general view of the firm’s operations related to urban mining. The number of conducted interviews and observation will hence be a factor that influences reliability and validity, as well generalizability.

The people who being observed knew that they were observed. They may however not know the purpose of the observation. Phillips (1996) found that the behavior of a labor force was influenced when studied by an observer classified as anti-working class, which could result in the data being invalid. The observed not knowing the purpose of the observation was an advantage to the study since this factor could hence be eliminated.

A neutral perspective was established by letting the firms set the agenda of the visits and the observer not being familiar to the site or the performed operations. The observations were therefore “open” and the risk of bias impairing the data was reduced by not having something specific “to look for”. However, an observation cannot be completely unstructured due to observer’s interest, goal or bias. The Empathy Map (attached to Appendix A) developed by visual thinking company XPLANE was therefore applied in order to structure the
observations to help obtaining relevant data that was later used in eliciting the customer needs (Osterwalder & Pigneur, 2010). According to Osterwalder & Pigneur (2010, p. 131) the tool helps you to – “go beyond a customer’s demographic characteristics and develop a better understanding of environment, behavior, concerns, and aspirations.” It will help to structure the observation and to focus on what the customer sees, hears, really thinks and feels, says and does, and their pains and gains (Osterwalder & Pigneur, 2010). It will also distract the observer from its own interest, goal or bias.

3.2.2.3 Interpreting raw data in terms of Needs

Field notes, pictures, video clips and transcribed recordings all comes as raw primary data. Needs were elicited from these by multiple collaborators in order to exhaust the data and increasing the chance of revealing results that another might have missed out due to bias.

The needs were interpreted by studying the raw data gathered from customers. The customer needs were further expressed as written statements in terms of desired product features or functions (what), and not in terms of solutions (how). This is important since customer needs should not be confused with “wants” or specific solutions. Words such as “must” and “should” is avoided as well since they imply a level of importance for the need (Ulrich & Eppinger, 2012).

In an interview with a labor worker, the respondent stated, ‘You might believe that some waste is recyclable but it is apparently just trash’ – ‘everything that glimmers is not gold’.

A list of more than 100 customer needs are commonly expected from a needfinding activity such as this, which can be complex to deal with (Ulrich & Eppinger, 2012). The needs were hence sorted in a hierarchical structure of primary needs (also known as strategic needs) and are further elaborated with detailed secondary needs. This is a common practice presented by Griffin & Hauser (1993) in order to facilitate clarity, resolution, and ease of viewing in follow-up activities such as in product & service development.

3.2.3 Quantitative method: Customer’s prioritization of needs

When a list of needs have been collected the next step involved measuring the relative importance of the different customer needs. This measurement is important to the study since it pinpoints what needs are important to focus on. A firm can for instance purposefully design and develop a product to achieve higher customer satisfaction and more competitive advantages if they know where to allocate their resources and which customer needs to prioritize if trade-offs must be done (Griffin & Hauser, 1993).

A survey was conducted to quantitatively measure the relative importance of the collected needs. Various methods have been developed for ranking and rating customer needs. The methodology for this have been widely discussed and studied by Griffin & Hauser (1993). Methods such as pair-wise comparison, conjoint analysis and the widely used 5- (or 7- and 9-) point direct rating scale was studied by Griffin & Hauser (1993). Pair-wise comparison may
theoretically have a higher validity in terms of measuring relative importance but due to its repetitive nature it may lead to inconsistencies in the respondent’s judgement. Griffin & Hauser (1993) evaluated the different approaches and found that none of these were significantly better than another in terms of correlation between a random sample and a panel sample.

A 5-point direct rating scale was used in the survey due to its simplicity in survey design and usability. The survey respondents were asked to rate each primary need, for instance ‘Prevents diffusion of dust’, on a 5-point direct rating scale. The rating scale is explained in a straightforward manner to reduce the risk of misinterpretation. There is a risk that very few respondents will give the needs a low rating with the 5-point rating scale, since the purpose with the needfinding process was to find needs that are shared across firms within urban mining. This means that most needs should be highly preferred and rated otherwise something went wrong in the needfinding process. It therefore somewhat confirms the validity of the needs.

The 5-point direct rating scale also brings the risk of all needs getting a top rating due to the mindset “why not?” There is also the risk of respondents interpreting the survey as a “wish-list”. The survey description and the different options are elaborated to prevent this from happening. For instance, the 3-point rating states that it “Would be nice to have but is not necessary”, while 5-point rating states “Is critical. I would not consider a product without it”. It could reduce the risk of the respondent picking a 5-rating unless he/she really considers the need as “critical” for his/her firm. The survey is attached in appendices (Appendix B & C).

Chan et al. (1999) argues that using a scale based on linguistic terms such as “Undesirable” and “Is highly desirable” are always subjective to the reader and thus imprecise. The survey will therefore use a more detailed explanation for the different options, e.g. to not only state “Undesirable” but also include a further explanation. It would reduce the span of subjective interpretation and the scale being imprecise due to being defined by linguistic terms. A scale of 5 has shown to be sufficient to determine the customer need prioritizations according to Griffin & Hauser (1993).

The different survey options were elaborated and defined with explanations, accordingly to what is suggested by (Ulrich & Eppinger, 2012).

1. **Undesirable.** I would not consider a product/service solution with this function.
2. **Not important,** but I would not mind having it.
3. **Would be nice to have** but is not necessary.
4. **Is highly desirable,** but I would consider a product/service solution without it.
5. **Is critical.** I would not consider a product without it.

The primary customer needs were further be clustered into two categories; low and high priority based on the respondents ratings. The 1-3 ratings of each need are weighted as 5-3-1 negative priority points, while the highest scored needs of 3-5 ratings are weighted as 1-3-5 positive priority points. This ensures that the results had a reasonable priority weighting when
assessed. The negative and positive priority points were in the end summed, which enabled a ranking among the needs.

3.3 Secondary data: Key trends

Another important data required in the chosen method is the mapping of both past and present key trends. These are necessary in order understand why the need priorities are as they are today and can be in the future. Secondary data from published sources were used in identifying technologies and trends for foresight. Academic sources such as journal articles and scientifically structured literature were chosen for this purpose. The information are checked to comply with appropriate years, if it addresses correct level (national or regional etc.), and its overall authenticity before used as data input in the thesis, as suggested by Ghauri & Grønhaug, (2010).

There are comprehensive literature and studies aimed to map potential future scenarios and trends. These sources were prioritized when mapping relevant trends for the presented methodology procedure. The data collection was done through an explorative approach guided by the identified needs and prioritizations. The primary data collected from the needfinding process did also reveal trends within urban mining. Trends are further categorized as – technology, regulatory, societal & cultural, and socioeconomic (demographic) trends (Osterwalder & Pigneur, 2010). However, only technology trends were studied. The other types of trends were subject for discussion.

The collected customer needs and priorities are central in understanding the past and present, as well as in the projection of the future. They will therefore control and direct the literature review the upcoming stages.

3.3.1 Technology trends – Gartner’s hype cycles

Gartner Hype Cycle is a research methodology aimed to give analysis of how technologies or applications will evolve over time. The purpose is to provide a source of insight for firms or researchers about the risk and promise of emerging technologies within industry contexts. Steinert & Leifer (2010) describes Gartner’s hype cycle as one of the most prominent and influential consultant models for advising large firms on their technology strategy. It is used by many practitioners and by researchers to justify R&D or a certain technology for investment decision (Steinert & Leifer, 2010; Kim et al., 2012). Gartner reviews emerging technology trends through comprehensive scientific efforts. Knowing that Gartner’s Hype Cycle model is widely and generally used for information analysis and forecasting, makes it a reliable source when studying emerging technologies and trends.

To understand how technology influences firms within urban mining, it is first necessary to understand how past technology changes have influenced the need priorities as we know today. We do not know how or whether technology influences the need priorities within urban mining. Hence, first understanding how past technology trends shaped the result at hand is necessary in order to further foresight how technology today may influence the future.

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7 Gartner Inc. is a leading global technology research and consulting firm, and has 6600 associates. It was founded 1979.
Gartner’s hype cycles have collected technology trends throughout the history, which makes it a convenient source.

3.4 Analysis: Projecting the future based on data of the past and present

Having data consisting of industry issues and trends for the past and the present makes it possible to foresee a future scenario. The goal is to analyze if the need priorities will be different in the future. If that is the case – what will then be prioritized in terms of needs 2030? This was done by qualitatively analyzing the results and by observing it to conceptualize and theorize. An interplay between the theory and results is necessary in order to make sense of the data.

Firstly, the future customer in the target year (2030) is extrapolated based on present industry issues and emerging trends. A central assumption in this is the feasibility of extrapolating trends to identify future elements.

Secondly, the future and present customer are compared and contrasted with each other to identify similarities and differences. The purpose is to highlight what actually could be similar or different concerning the current and the potential future scenario, which might not be apparent.

3.5 Research ethics

The presented methodology involves a comprehensive data collection involving many participants, representing both individuals and organizations. There is always a risk that research might cause harm of some kind to participants that are involved (Ghauri & Grønhaug, 2010). The thesis reliability and validity can also be affected by the researcher’s ethics and moral principles (Ghauri & Grønhaug, 2010). A number of actions were done to prevent these issues.

Anonymity is assured to be preserved during the study, as well as after it is done, by clearly stating to the participants that they will remain anonymous before agreeing to participate. The author has also undertaken the responsibility in preventing any unauthorized access to the collected raw data. Coercion is prevented in all the cases whenever data is requested from a participant by making clear that it is completely optional to participate. The research methodology was further adapted to not force the participants into actions that could be detrimental to their self-interest. Special equipment, such as a recorder or camera, is not used without the participant’s consent. The participants were always told the purpose of the research before asked to participate in an interview or survey.

The author further maintains research ethics and moral principles by only committing to activities described in the methodology and presenting no other results than what the actual research have shown.
4 Result

4.1 Customer needs of the urban mining segment

Twelve different firms involved in urban mining, ranging from suppliers, C&D contractors to waste management and recycling firms, were subjects to the study. Eight out of the ten firms are located in Sweden, and most of them operate internationally. 65 mutual customer needs were identified throughout the needfinding process. The results indicate that firms, as customers within the urban mining segment, share and have multiple of the elicited needs in common (table 4-1).

The empirical data collected from interviews and observations are clustered in categories, summarized and concluded in the following subsections. This data was used to elicit multiple needs.

4.1.1 Risks, disturbance and nuisance

‘Most often, it could be that you feel a very strong scent or something chemically that nobody recognizes. This forces us to go away for a while before we know what it is’. Manual handling of waste commonly involves human and environmental exposure to hazardous waste like asbestos and mercury, either directly or indirectly. C&D or waste management activities usually require labor workers to be present and many times in direct contact with the materials that are handled. Repetitive and strenuous work is common within urban mining today. Construction workers in the picture below (figure 4-2) are seen wearing face masks, reflective clothing and helmets to protect themselves from the hazardous substances, nuisance, and the dangers of a normally trafficked and confined working space.

The construction industry is generally known for its high rate of accidents, health issues and environmental impact. It was stated that ‘demolishing buildings with nearby houses around is hard’ and ‘a lot of dust is released into the air when demolishing’. Generated dust can cause permanent internal injuries to humans. These statements imply the environmental and health issues that C&D projects causes. It was observed that the spread of dust particles could be prevented to some extent by the use of water hoses. Using water to spray on the buildings is a common practice in C&D today to prevent dust from spreading.
Eliminates disturbance/noise.  
Protects the surrounding environment from disturbance.  
Prevents high and constant noise.  
Prevents nuisance from odor.

Prevents diffusion of dust.  
Prevents dust to generate.  
Prevents human/environmental exposure to dust.

Prevents spread of hazardous waste.  
Prevents human and environmental exposure to hazardous waste.  
Protects humans and environment from poisonous gases and impurities.  
Separates waste containing mercury.  
Prevents water to be contaminated (leachate).

Facilitates workspace accessibility.  
Machines and equipment can operate in confined spaces.  
Limited space does not inhibit operations.  
Machines move quickly to desired positions.

Optimizes transportations.  
Maximizes load capacity.  
Informs the weight of current load.  
Minimizes transportation in the waste management process.  
Cargo space is (always) utilized.  
Reduces repeated transportation of materials.  
Materials are not transported unnecessary distances.

Machines/tools are flexible for different situations.  
High targets are reachable.  
Adjustment/change of tools are quick to perform.  
Machine equipment are precise.  
Objects are not damaged during operations.  
Functions on sites with no access to electricity and water.

Relieves labor workers from manual work.  
Assists in identifying type of waste.  
Assists in sorting waste correctly.  
Identifies the value of materials.  
Objects are easily disassembled.  
Materials are easily moved.  
Prevents waste from ending up on ground.  
Materials can be efficiently removed from the ground.

Reduces occupied space (footprint) of objects.  
Eliminates intermediate storages.  
Optimizes storing of materials with different shapes.  
Reduces the occupied space of materials.  
Reduces the footprint of machines/equipment.  
Materials can be processed into desired sizes on site.

Makes better use of materials to prevent landfiling.  
Reuses or recycles waste on-site/locally.  
Prevents reusable/recyclable waste to end up in landfills.  
Eliminates by-products from operations.  
Makes use of plastic waste.  
Makes use of insulation materials.  
Makes use of bottom ashes from combustion processes.  
Makes use of end of life tires.  
Handles solid sludge and slag.  
Collects or utilizes energy-rich organic waste.

Eliminates physical safety risks.  
Protects surrounding environment from physical damage.  
Handling materials can be done with no direct human physical presence.  
Allows a safe workplace.  
Eliminates interfering risks from water and power sources.

Design considers the product lifecycle.  
Components are easily assembled/disassembled.  
Components are universal fittable.  
Components are easily handled and moved.  
Precludes disassembly before assembly.  
Attachments are attachable and detachable without welding.  
Different material compounds can be easily separated from an object.

Protects valuable materials from theft.

| Table 4-1. Hierarchal list of primary and secondary customer needs shared across firms within the urban mining market segment | Reduce occupied space (footprint) of objects. Eliminates intermediate storages. Optimizes storing of materials with different shapes. Reduces the occupied space of materials. Reduces the footprint of machines/equipment. Materials can be processed into desired sizes on site. Makes better use of materials to prevent landfiling. Reuses or recycles waste on-site/locally. Prevents reusable/recyclable waste to end up in landfills. Eliminates by-products from operations. Makes use of plastic waste. Makes use of insulation materials. Makes use of bottom ashes from combustion processes. Makes use of end of life tires. Handles solid sludge and slag. Collects or utilizes energy-rich organic waste. Eliminates physical safety risks. Protects surrounding environment from physical damage. Handling materials can be done with no direct human physical presence. Allows a safe workplace. Eliminates interfering risks from water and power sources. Design considers the product lifecycle. Components are easily assembled/disassembled. Components are universal fittable. Components are easily handled and moved. Precludes disassembly before assembly. Attachments are attachable and detachable without welding. Different material compounds can be easily separated from an object. Protects valuable materials from theft. |
Noise regulations vary depending on the place of where the C&D is taking place. Dense cities or urban environments have stricter regulations of constant and maximum noise levels depending on the time of the day. ‘Dislikes that it is never calm and quiet’ was stated which further highlights the significance of noise disturbance. C&D within dense cities requires stricter control and safety measures in general since more factors needs to be taken under consideration. The circumstances within dense cities are extreme if compared to locations distant from city centrals, for instance in dust emission, regulated noise levels, nearby surroundings etc.

4.1.2 Logistics
Transportation of materials is another issue found significantly reflecting on costs and environmental impacts. The C&D and recycling sector is commonly dealing with high volume of materials that is transported on a regularly. The data highlights logistics as a major cost driver. Planning and optimizing material flows, space and intermediate storages is significant as it represents a major part of the cost structure of many firms within urban mining. In multiple cases, firms prioritized minimizing costs in their business approach rather than providing extraordinary value, since that was the only way they could profit. The reason could be that urban mining today represents managing a high volume of materials of relatively low value.
Another side of the issue is utilizing machines and equipment within confined spaces, such as during the deconstruction of a building. A labor worker on a demolition site stated ‘In general it is better with small machines or equipment to be able to work in confined workspaces’. Materials, people, and machines usually have to share the same workspace, which could mean higher safety risks, impair logistics, and increased costs.

4.1.3 Flexibility in equipment

Every task, project or site is unique. A building is rarely the same as another building if the surrounding is a relevant aspect, which it usually is and especially in urban mining.

Basic and general tools such as hammers, light power-tools, and excavators that can be used for a wide-range of different jobs are commonly used. A big space of creativity for improvised solutions and “work-arounds” is enabled by the use of tools such as these. The use of universal equipment has the benefit of flexibility and allows adaption to different jobs and projects. This however usually involves lead times for adjustments and continuous change of tools in a similar manner to that of a manufacturing firm that readjusts their processes for the production of a different product, which is both time consuming and hence costly.

Work-arounds such as piling materials on the ground in order to boost the reachable height of an excavator have been observed. Machine operator need to change their tools multiple times throughout a project to perform various tasks. Construction workers break into walls and cherry-picks materials during a deconstruction job with the use of sledgehammers, simple tools and wheelbarrows, since they cannot fit an efficient machine within the confined spaces. Specialized machines and non-universal tools that cannot be use for multiple purposes and are costly, not only monetary but in the sense that it limits the capability and range of what kinds of jobs a firm can undertake.
Flexibility with low readjustment times is a desired product characteristic in an industry characterized by unique projects and equipment as primary assets for firms.

4.1.4 Manual labor work
Handling materials both by hand or machine is a consistent activity throughout multiple urban mining material streams. Waste management processes usually involve disassembly, cherry-picking or separating materials that are desired for reuse or recycling, and what is not. The main observed method doing this is manually, either by the aid of construction equipment such as an excavators, or completely by hand with/without handheld tools.

‘There is a challenge in knowing what type of materials you’re dealing with. Stuff you've never seen ends up here – you might believe that some waste is recyclable but it is apparently just thrash. Everything that glimmers is not gold’. This suggests the importance of individuals’ experience-based judgment skills as every job, building or site is unique. Safe and precise automated solutions can hence be complex to develop.

Labor workers in C&D sites or in waste management related operations signify know-how. Identifying, assessing value, sorting, and handling materials in an efficient and safe manner is mostly based on experience. Hence, adaptability to worksite circumstances and finding work-arounds is a highly regarded ability among employees for many firms within urban mining today.

4.1.5 Reuse and Recycling within C&D
C&D generates waste such as concrete, glass, plastic and insulation materials. Materials like – ‘plastics and old insulation cannot be recycled’ – and usually end up in the landfill. Due to the issue of lack of space on C&D sites, the waste is usually either crushed on site, thereby trucked away to the closest landfill, or a recycling and waste management facility. Some materials such as crushed concrete and window glass are common in modern buildings, and can be reused as infill in construction projects to save costs on transportations. Reusing waste materials locally on site or nearby sites is however not always possible.
Cost and time are regarded as important factors in many C&D projects since these are usually the main variables in making profit. The reason why contractors within C&D do not put much effort into reuse or recycling most waste is simply due to the lack of benefits. It would in many of the studied cases firms actually save them costs by landfilling or outsourcing the end-of-life activities of the waste. If cost savings can be done without taking further responsibility of the waste (for reusing or recycling etc.) and if it is completely legal, then it is likely to be the preferred choice. Finding better and innovative uses of waste is a challenge that was raised. ‘Better local collaboration’ and ‘the waste that we can't use anymore is landfilled’ was stated which indicates that there is a need and desire for better use of waste but have been dismissed due to the cost of today’s capabilities.

4.1.6 Design for lifecycle

Most products usually contain different materials and needs to be disassembled during its end of life phase for reuse or recycling to be possible. Recycling and waste management firms can during their daily operations see how technology and design of products changes over the years. As products go towards higher complexity in its technology and design they have recently become harder to disassemble as well, according to the interviews. For instance, glue and other adhesives, were pointed out to have become more common in the manufacturing of modern products. Reusing or recycling products were not incited if the cost exceeded potential gains. The results have highlighted that profit in most cases were prioritized over environmental care (legally).

Many of those interviewed proposed that a greater focus on a product’s lifecycle should be put initially in the design development process. Design decisions can determine a product’s lifecycle considerably in terms of for instance recyclability, reusability and environmental impact.

A service technician stated ‘these parts takes long time to weld and to make it fit the machines’, ‘everything is so big and unwieldy to work with. That is why it is so time consuming’. It suggests that a product’s lifecycle and user’s needs is not always considered in the design or manufacturing phase. Tradeoffs such as cost optimization and choice of production process may prioritize reducing a firm’s manufacturing costs rather than the products complete lifecycle. This might cause costly down-stream issues that the environment or somebody else suffers from.

4.1.7 Material theft

C&D sites and waste management facilities are often exposed to the public, and are rarely protected from unauthorized intrusion by other than by fences or cameras. C&D and waste management practices usually involve dealing with high volume of materials and that are temporarily stored on sites. Valuable machines, tools and processed materials are usually exposed to the public on the sites, which makes the risk of thievery or sabotage inevitable.
Thievery or sabotage usually happens before or after the working hours. The use of cameras or guards are common countermeasures. Creative work-arounds have been observed to prevent thievery. For instance covering piles of copper with other materials or with the heavy buckets of excavators, or wheel loaders. Equipment and machines are parked in a way to inhibit access to the fuel tanks with diesel. These work-around highlights the need of cost-efficient solutions to prevent theft of valuable materials.

4.2 Customer need prioritization

Knowing the customer needs of a market segment is not always sufficient, since the range could be wide and consist of multiple needs. The different needs are rarely equally important to the customer as well.

Pursuing to meet all the needs may not be possible from an optimal, economical or firm capability point-of-view. In order to strategically proceed with, for instance, the development of a product or service development it could be wise to know which needs are most desired by the customers and hence which to prioritize.

A survey was conducted to statistically assess which of the elicited needs are the most desired by firms operating within the urban mining market segment. The sample population for the survey was defined as firms within the construction industry that are involved in activities related to urban mining in Sweden, which was estimated to around 41,676 firms by 2014 statistics from SCB\(^8\). All employees within the firms were considered representatives and influencers in their firm’s choices of products & services, hence potential candidates for the survey.

The respondents were asked to rate each of the elicited primary needs on a scale of 5, based on how important it is for them. 67 participants out of 297 (22.5%) answered the survey. Altogether, 67 employees within 44 different firms operating within the urban mining segment responded to the survey. The results have a confidence level of 95% and a confidence interval of ±15%. According to statistics, it means we can be 95% certain that the true percentage of the population is within the confidence interval (±15%) of the survey results. It further means that it is possible to generalize based on these results, i.e. to state that these results are generally applicable to the whole urban mining market segment in Sweden. The average respondent is 47 years old and holds a managerial position.

\(^8\) SCB – Statistika Centralbyrå, Statistics Sweden. A national statistics administrative authority in Sweden
Table 4-5. Respondents rated each of the needs based on how important they are for their respective firms. 67 participants within 44 different firms responded to the survey.

<table>
<thead>
<tr>
<th>Needs</th>
<th>1. Undesirable. I would not consider a product/service solution with this function.</th>
<th>2. Not important, but I would not mind having it.</th>
<th>3. Would be nice to have but is not necessary.</th>
<th>4. Is highly desirable, but I would consider a product/service solution without it.</th>
<th>5. Is critical. I would not consider a product/service solution without it</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eliminates disturbance/noise</td>
<td>0%</td>
<td>3,00%</td>
<td>14,90%</td>
<td>52,20%</td>
</tr>
<tr>
<td>2</td>
<td>Prevents diffusion of dust</td>
<td>0%</td>
<td>1,50%</td>
<td>11,90%</td>
<td>49,30%</td>
</tr>
<tr>
<td>3</td>
<td>Prevents spread of hazardous waste</td>
<td>0%</td>
<td>0%</td>
<td>4,50%</td>
<td>6,00%</td>
</tr>
<tr>
<td>4</td>
<td>Facilitates workspace accessibility</td>
<td>0%</td>
<td>6%</td>
<td>26,90%</td>
<td>49,30%</td>
</tr>
<tr>
<td>5</td>
<td>Optimizes transportsitions</td>
<td>1,50%</td>
<td>0%</td>
<td>13,40%</td>
<td>58,20%</td>
</tr>
<tr>
<td>6</td>
<td>Machines/tools are flexible for different situations</td>
<td>0%</td>
<td>7,50%</td>
<td>35,80%</td>
<td>38,80%</td>
</tr>
<tr>
<td>7</td>
<td>Relieves labor workers from manual work</td>
<td>0%</td>
<td>1,50%</td>
<td>23,90%</td>
<td>58,20%</td>
</tr>
<tr>
<td>8</td>
<td>Reduces occupied space (footprint) of objects</td>
<td>0%</td>
<td>9%</td>
<td>28,40%</td>
<td>49,30%</td>
</tr>
<tr>
<td>9</td>
<td>Makes better use of materials to prevent landfill</td>
<td>1,50%</td>
<td>0%</td>
<td>4,50%</td>
<td>44,80%</td>
</tr>
<tr>
<td>10</td>
<td>Eliminates physical safety risks</td>
<td>0%</td>
<td>3%</td>
<td>10,40%</td>
<td>25,40%</td>
</tr>
<tr>
<td>11</td>
<td>Design considers the product lifecycle</td>
<td>0%</td>
<td>6%</td>
<td>32,80%</td>
<td>46,30%</td>
</tr>
<tr>
<td>12</td>
<td>Protects valuable materials from theft</td>
<td>0%</td>
<td>3%</td>
<td>11,90%</td>
<td>41,80%</td>
</tr>
</tbody>
</table>

The results shows that all the identified needs are more or less important in the urban mining segment today, which strengthens the needfinding results to start with. However, not all the needs are equally important. For instance, the need ‘Prevent spread of hazardous waste’ is distinctly rated as among the most important needs, while ‘Design considers the product lifecycle’ was considered relatively less important if weighted and compared.

The different survey options are weighted and the survey respondents’ rating of each need was summed to determine which of the needs are regarded as the most important, which can be seen in the table below (table 4-6).
Table 4-6. A ranking of customer needs was established based on survey results. The needs are listed from top to bottom based on how important the needs are according to firms operating in the urban mining segment. Left column consists of listing numbers assigned to facilitate traceability. Weighted sum is the assessed point for each need based on the survey results.

<table>
<thead>
<tr>
<th>Nr.</th>
<th>High priority</th>
<th>Weighted sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eliminates disturbance/noise</td>
<td>199</td>
</tr>
<tr>
<td>2</td>
<td>Prevents diffusion of dust</td>
<td>221</td>
</tr>
<tr>
<td>4</td>
<td>Facilitates workspace accessibility</td>
<td>147</td>
</tr>
<tr>
<td>7</td>
<td>Relieves labor workers from manual work</td>
<td>169</td>
</tr>
<tr>
<td>9</td>
<td>Makes better use of materials to prevent landfill</td>
<td>250</td>
</tr>
<tr>
<td>10</td>
<td>Eliminates physical safety risks</td>
<td>250</td>
</tr>
<tr>
<td>3</td>
<td>Prevents spread of hazardous waste</td>
<td>312</td>
</tr>
<tr>
<td>12</td>
<td>Protects valuable materials from theft</td>
<td>223</td>
</tr>
<tr>
<td>5</td>
<td>Optimizes transportations</td>
<td>202</td>
</tr>
<tr>
<td>11</td>
<td>Design considers the product lifecycle</td>
<td>131</td>
</tr>
<tr>
<td>8</td>
<td>Reduces occupied space (footprint) of objects</td>
<td>126</td>
</tr>
<tr>
<td>6</td>
<td>Machines/tools are flexible for different situations</td>
<td>123</td>
</tr>
</tbody>
</table>

The survey results statically states that ‘Prevents spread of hazardous waste’, ‘Eliminates Physical safety risks’, and ‘Makes better use of materials to prevent landfill’ are the main prioritized needs by firms within the urban mining segment today. ‘Design considers the product lifecycle’, ‘Reduces occupied space (footprint) of objects’, and ‘Machine/tools are flexible for different situations’ are among the least prioritized needs.

Next step involves investigating past key trends that shaped today’s need priorities. Understanding the pattern of how the need priorities are shaped today enables the extrapolation of present (future) trends to determine future need priorities.

4.3 Technology trends

Trends are central in foresight with its ability to give a sense or a general direction in which development is going towards. Understanding how past technology trends have shaped the present is necessary in order to be able to foresight based on today’s trends. A pattern of how technology trends relates to how priorities are shaped can be understood by doing so. Secondary sources of literature was used to map these trends.

4.3.1 Past technology trends

Abudayyeh et al. (2004) presented a comprehensive review of construction research trends based on journal articles from the American Society of Civil Engineer’s Journal of Construction Engineering and Management. The review analyzed construction research trends of 879 published technical papers between 1985-2002, representing countries and continents worldwide. Abudayyeh et al. (2004) found that the primary research industry issues relates to scheduling, productivity, constructability, simulation, cost control, planning, safety, and computer systems over the years 1985-2002. As for the period 1997-2002, the top five areas were simulation, scheduling, productivity, performance and optimization – which is
a more relevant period for the thesis if we look back into the past around 15 years from now to understand how it shaped today. These gives a clear overview of what kind of construction industry issues that were addressed at that time. Academic research often reflects the society and the market. It is therefore likely that the addressed research issues presented by Abudayyeh et al. (2004) can or is influenced by stakeholders within the construction industry.

Harty et al.’s (2007) review of construction industry future studies is also aligned with Abudayyeh’s findings. Harty et al. reviewed technology trends of this time in a more detailed sense. Emerging technologies such as offsite construction, ICT-implementation, nanotechnology, robotics, and virtual design are few examples of technology trends in 1997-2002 (Harty et al., 2007). The technology trends are concluded and categorized in the table below concluding the literature review (table 4-7).

Table 4-7. The table concludes the results of a review of past industry issues, emerging technologies and trends 1997-2002. The “main addressed industry issues” presented by Abudayyeh et al. (2004) horizontally groups the technologies and trends.

<table>
<thead>
<tr>
<th>Main issue</th>
<th>Technology</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity Optimization</td>
<td>Virtual design &amp; 3D, CAD, virtual reality</td>
<td>Increased use of 3D technology</td>
</tr>
<tr>
<td>Scheduling</td>
<td>Prefabrication, preassembly, standardization of mass customization, offsite, industrialization</td>
<td>Increased standardization and offsite construction</td>
</tr>
<tr>
<td>Performance</td>
<td>Internet remote working, smart buildings, ICT-enabled communication, digitalization</td>
<td>Increased use of common ICT and information-sharing platforms</td>
</tr>
<tr>
<td></td>
<td>Further mechanization, safety-driven automation, robotics, sensing, AI</td>
<td>Increased automation and use of robotics</td>
</tr>
<tr>
<td></td>
<td>Nanotechnology, biotechnology, sustainable materials</td>
<td>New/smart construction materials</td>
</tr>
</tbody>
</table>

The main addressed issues: productivity, optimization, performance, scheduling and simulation within the period 1997 to 2002 reflects the technology and trends at that time. The literature suggests that there is a direct relationship between the addressed industry issues, development of specific technologies, and future expectations or trends. The issues prioritized by research and the industry drives the development of a specific emerging technology, which will therefore give rise to an industry trend. Emerging technologies like for instance virtual design, CAD and virtual reality created expectations for an increased use of 3D technology in the construction industry (Harty et al., 2007). The other emerging technologies constituted and supported other technology trends in a similar way.

New approaches of construction that emerged at that time followed a similar pattern with a correlation to the main issues prioritized by research and the industry. Instances of more construction work performed offsite rather than the conventional onsite was seen at that time.

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9 ICT - Information and Communications technology
Prefabrication, preassembly and mass customization of building components suggested that the construction industry was going through industrialization. This gave rise to the trend of increased standardization and offsite construction within the industry (Harty et al., 2007).

ICT-technologies like remote working, digitalization and communication emerged within the construction industry along with the increased industry concerns in productivity, optimization and scheduling (Abudayyeh et al. 2004; Harty et al., 2007). ICT contributed to the globalization and revolutionized many industries. The increased mainstream adoption of common ICT and information-sharing platform eventually brought it to the construction industry.

Technologies such as further mechanization, robotics and AI in construction also emerged in the construction industry along with the growth of ICT. The development in these was closely interrelated with productivity, performance and optimization issues or concerns of existing construction practices (Harty et al., 2007).

The chase for increased productivity and performance within the construction industry did not only drive emerging technologies related to ICT, robotics and automation. More sustainable and more environment-friendly materials started to gain attention. Research findings in Nano- and biotechnology demonstrated radical new material properties, such as self-maintaining and cleaning materials, which created a trend for new and smarter construction materials (Harty et al., 2007).

4.3.2 “Present” technology trends

A number of main urban mining issues can be concluded from the needfinding data and need priorities presented in the results (table 4-6). These suggests safety, social, environment, optimization, and cost control as among highest prioritized and addressed issues or concerns of the urban mining segment.

There are many types of different technology trends. Various information sources and especially the literature and Internet alone contain a complex amount of technology trends. Gartner addresses this issues and reviews technology trends. Furthermore publishes hype cycles for emerging technologies annually, which is directly useful for the thesis (Fenn & LeHong, 2011; Rivera & Meulen, 2013; 2014).
The Gartner hype cycles delimits to primarily analyze technologies that are going through a set of defined stages – from technology trigger (technology breakthrough) to the plateau of productivity (where mainstream adoption starts to take off) (Fenn & LeHong, 2011). All other technologies fall outside the boundaries of the published hype cycle reviews, which make a good sample of multiple emerging technologies that can be used in identifying technology trends. However, not all of these are relevant for urban mining as studied in this thesis. The emerging technologies that Gartner presents are not solely for the construction industry and some technologies therefore fall outside the boundaries of the subject. Hence, a selection of the remaining technology trends were done guided by the five prioritized issues that were previously identified. By doing so, it was possible to converge and assure that the selected technology trends are relevant and are likely to be prioritized within urban mining. Trends are identified by sampling emerging technologies, which can give a sense of in what direction the general development is going towards, i.e. a technology trend. The result is further concluded and presented in the table below (table 4-9).
Table 4-9. The table contains concluded results of a review of present industry issues and emerging technologies 2011-2014. The ‘main issues’ horizontally groups the emerging technologies and trends.

<table>
<thead>
<tr>
<th>Main issue</th>
<th>Technology</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimization</td>
<td>Gamification, Idea management, Smart workspace</td>
<td>Smarter management of internal resources</td>
</tr>
<tr>
<td></td>
<td>3D scanners, Volumetric &amp; holographic displays, enterprise 3D printing, Virtual reality, Image recognition, Virtual world</td>
<td>Increased use of 3D technology</td>
</tr>
<tr>
<td>Social</td>
<td>Internet of things, Augmented reality, Big data, Cloud computing, Context-enriched services, Mesh networks: sensor, Hosted virtual desktops, Location-aware applications, Predictive analytics</td>
<td>Increased use of ICT for managing network, communication, and data.</td>
</tr>
<tr>
<td>Cost Control</td>
<td>Smart robots, Mobile robots, Virtual assistants, Gesture recognition/control, Autonomous vehicles, Machine-to-machine communication services, Speech recognition, Computer-brain interface, Human augmentation, Bio acoustic sensing</td>
<td>Increased use of advanced robotics and machines</td>
</tr>
<tr>
<td>Safety</td>
<td>Nanotechnology, Biotechnology, Ultra-lightweight (super strong) materials, Sustainable materials</td>
<td>New/smart construction materials</td>
</tr>
</tbody>
</table>

4.3.2.1 Smarter management of internal resources

New approaches and the adoption of technologies such as gamification, idea management, smart work, and smart workspace represents the trend for better or smarter management of internal resources (Fenn & LeHong, 2011). The benefits can be seen in higher productivity for firms, increased innovation output, and bringing out untapped potential of internal resources (especially employees).

A growth in vendors providing support to innovation management, ideation modules, and collaboration platforms to firms can be seen in parallel with success stories for idea management. These have consequently driven the interest in innovation and the confidence in engaging employees and others in innovation processes in firms (Fenn & LeHong, 2011).

Gamification is an emerging technology or approach that could bring out more of the employees’ potential. “Gamification” is described as the use of game mechanics in non-entertainment environment to drive engagement or to change user behaviors (Fenn & LeHong, 2011; Rivera & Meulen, 2014). The idea is to incorporate game mechanics in different challenges. For instance in innovation, business or planning challenges in order to encourage desirable behaviors while creating joy and entertainment. Humans tend to enjoy games and have a natural tendency to engage in something they find entertaining (Fenn & LeHong, 2011; Rivera & Meulen, 2014)
Smart workspace is another approach arising from the growth of ICT and the trend for better or smarter management of internal resources. Feller, a director of Cisco Systems stated that – big companies have a cultural bias toward “Let's get our people into a shared space which is secure” implying that firms tend to force and lock their employees in their offices (Crosland, 2013). Along with an increasing mobile workforce – this could mean that employees needs to spend “1-2” hours getting to and from work, getting stuck in traffic every day, while their vehicles emits greenhouse gases. Feller further encourages to challenge this traditional view of workplace (Crosland, 2013). Finding new ways of organizing the work, workplace, or even eliminating parts of how we see a workplace could mean more productive firms and healthier working environment. Cisco and Google are among the early adopters for these technologies that represents this trend. Google, for instance, has gained a great amount of reputation for their emphasis on a good workplace in order to keep their employees creative, happy, healthy and productive.

These approaches or technologies could affect the current practices in urban mining and how the C&D sites or work may look in the future. The purpose could be to optimize the use of internal resources and creating higher social value for employees and stakeholders.

4.3.2.2 Increased use of 3D technology and virtual design

The increased use of 3D technology can be seen in many industries as new areas of applications are continuously explored. NCC\(^{10}\) is an early adopter that has successfully implemented virtual design and construction technology called Building Information Model (BIM). A C&D project that NCC directed was awarded ‘the best construction of the year 2015’ in Sweden by Byggindustrin\(^{11}\), which was according to the jury a result of the innovative use of BIM (Bennewitz, 2015). BIM was used for many purposes during the design and construction phase. For instance, to facilitate collaboration among client, contractors, visualization, simulation, design and CAD integration. The project managed budget savings and finishing before the set finish time as a result of the innovative use of BIM (Bennewitz, 2015).

Other areas of applications for 3D technologies within the construction industry have also emerged. One of them is the 3D printing of buildings. 3D printing is an emerging technology that is reaching mainstream use and is constantly applied to new areas (Fenn & LeHong, 2011).

3D scanners, volumetric & holographic displays, 3D printing, virtual reality and virtual world are examples of emerging technology that can represent and support the trend for increased use of 3D technology in urban mining and the construction industry. These can have implications on the optimization of processes in for instance planning, design and simulation activities, which is closely related to cost control. The social factor of collaboration and better involvement of contractors, the community, as well as users and customers is of growing interest in urban mining.

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\(^{10}\) NCC is one of the leading construction firms in northern Europe

\(^{11}\) Byggindustrin is a leading industry magazine for the construction sector in Sweden.
4.3.2.3 Increased use of ICT for managing network, communication, and data
ICT have since its origin and today a growing influence on many aspects of work related to network, communication and data. Advances in processing, embedded sensors and wireless connectivity brings the digital technology to objects and places in the physical world (Fenn and LeHong, 2011; Rivera & Meulen, 2014). ICT-technologies progress in the domain of network, communication, and data can enable optimization and changes in current practices related to urban mining. Cost control, safety and social care are other aspects that emerging technologies within this area could contribute to.

Location-aware applications, mesh-network: sensors, augmented reality, and communication tools are examples of emerging technologies that supports and represents the trend for increased use of ICT for managing network, communication and data (Fenn and LeHong, 2011; Rivera & Meulen, 2014). The physical world is getting more connected with these technologies along with the increased use of Internet of Things (devices and physical assets connected to the Internet) and augmented reality. Cloud computing and hosted virtual desktops are network technologies that opens up additional workplace “dimensions” that can be exploited.

Emerging technologies such as big data, and predictive analyze enables processing and the management of “extreme” amounts of data. Facebook and Google are known adopters of big data through collecting and analyzing extreme amounts of data provided by users from using their services. Big data assumes that all kind of data can be managed and analyzed for different purposes with the use of powerful computers. This is somewhat in contrast to existing practices of only being able to manage and analyze few selected data to analyze. Big data deals with increased velocity of data in order make predictive and near-real-time analysis of large datasets possible (Fenn and LeHong, 2011; Rivera & Meulen, 2014).

4.3.2.4 Increased use of advanced robotics and machines
The perception of machines and computers replacing humans now belongs to a past conception. The evolving relationship between humans and machines can be seen with the adoption of multiple emerging technologies today (Rivera & Meulen, 2013). Rivera & Meulen (2013) states that the relationship between human and machine is being redefined through the technologies in this area. Hence, the “gap” between human and machine is narrowing down. Machines are becoming better at understanding humans and the environment – by for instance recognizing the emotion in a person’s voice – and vice-versa – humans are becoming better at understanding machines through Internet of Things (network of physical objects) for instance. Both machines and humans are getting smarter by working together rather than alone (Rivera & Meulen, 2013; 2014). The trend ‘increased use of advanced robotics and machines’ represents potential advancements in the construction industry related to the issues of optimization, cost control, safety and social value.

Rivera & Meuler (2013; 2014) presents six potential areas of technology that constitutes this trend and that can have significant impact on industries, and possibly the construction industry. They are based on observations of how early adopters applies the technologies.
Augmenting humans with technology enables increased human capabilities and performance in physical, emotional and cognitive areas. One of the main benefits with this could be to create a more capable workforce, hence to improve productivity. Bio acoustic sensing, computer-brain interfaces, and human augmentation are a few examples of technologies in this area.

Machines replacing humans have clear opportunities in for instance replacing humans in dangerous work, repetitive tasks, and taking care of simple yet expensive tasks to perform. Autonomous machines or vehicles are some of the technologies in this area.

Humans and machines working alongside each other can be a better choice than having either humans or machines alone. IBM has developed a robot that performs background research for doctors, and much similar to a human research assistant that helps doctors to stay up-to-date with research when giving diagnoses or treatments. By having humans and machines working alongside each other enables the best of both sides – i.e. the machines’ speed and productivity, as well as humans’ emotional intelligence and ability to handle the unknown. The technologies: autonomous vehicles, mobile robots, natural-language question and answering, and virtual assistants support this part of the trend.

Machines are getting better at understanding humans and the environment with technologies such as bioacoustics sensing, 3D scanners, computer-brain interface, natural-language question and answering, gesture control, health monitoring, and speech recognition. These benefit the machines in understanding human context and emotions. Furthermore, it opens up possibilities in the range of use of machines.

Humans are also getting better in understanding machines, which is in contrast to the previous. Humans will need to trust and feel safe around smart and automated machines if they are to be used in helping or replacing human tasks. Robots sensing social cues from visual and auditory sensors, communicating with human-like facial expressions, as well as Internet of Things will provide visibility and understanding in how machines are operating. Machine-to-machine communication, mesh network: sensors, and Internet of Things are some of the technologies supporting this.

Machines and humans are becoming smarter with the surge in big data, predictive analytics, complex event processing, natural language question and answering, and cognitive computing approaches. These technologies provide decision support to not only humans but also machines. It supports the automation, artificial intelligence and awareness of machines. These have shown to be driving technologies for both humans and machines in moving into a digital future.

4.3.2.5 New/smart construction materials

The development of new or smart construction materials is consistent. Nano- and biotechnology – despite going far back in the history – still shows radical and yet unknown potential.

The development of nanotechnology-based materials for the construction industry is ranging from conceptual ideas to commercially available products, according to Hanus & Harris’
A review of current research in the field. Recent results in the field of nanotechnology have shown significant promises in addressing the challenges that the construction industry faces today in terms of safety, sustainability, and strength properties in materials (Hanus & Harris, 2013). Nanotechnology along with biotechnology have introduced radical new functionalities to existing materials. Other than improvements in strength of materials – self-cleaning and self-maintaining properties in materials have also been introduced. Air-purifying paints, and optically transparent insulation are other examples (Hanus & Harris, 2013). Research suggests a trend of new and smarter material in future construction. Safety and environmental benefits are among the main identified construction and urban mining drivers for this trend.
5 Discussion

The major findings consist of a prioritization of 12 identified primary needs that are generally shared across firms within the urban mining segment (table 4-6). The primary needs can also be seen as strategic guidelines that can be useful in firm-related activities like in the development of new products or services, marketing, and in establishing new business areas (Gaskin et al., 2010). They can be further used in the development of products or services for the urban mining segment, to plan short and long term development, as well as allowing design managers to determine which problems they should prioritize to solve first (Patnaik & Becker, 1999).

The 12 primary needs consist of a number of secondary needs that cover a wide range of issues – from safety, optimization, cost control, to social and environmental care. All the urban mining needs have not been fully elicited and identified. There are probably many needs of the urban mining segment other than the ones presented in the results. This means that the thesis can only represent the urban mining segment in the specific needs that are identified.

The high number of needs can be hard to handle and complex to work with. It might not be apparent to firms in which need or needs they should focus on fulfilling, furthermore what tradeoffs to do if one must be chosen over another. Adding to this, not all of the identified needs are equally important to the firms operating in the urban mining segment. Just one or a few of the needs might be able to be addressed due to limited resources or capabilities. Hence, the survey was conducted with representatives from firms operating in the segment in order to prioritize the primary needs. These were further ranked based on relative importance to facilitate the use and implementation of the needs.

The need priorities are to some extent affected by selection bias in the sampling. The survey was sent to random stakeholders in different positions within firms. A majority of the survey respondents held a managerial or higher position. Therefore, the survey result does not completely represent firms within the urban mining segment since it does not include all the “ranks” that constitutes a firm. The people holding a managerial or a higher position usually have higher influence in decision-making in an organization and therefore probably have more power in the choice of products or services they procure. From that sense, the need priorities could represent what firms within the urban mining segment would actually prioritize to pay for. The results could hence be even more representative to the segment if seen from this perspective. ‘Lower-ranked’ respondents usually have lower power in decision-making hence less influence in the firm’s choice of products.

Altogether, 44 different firms within the urban mining segment in Sweden responded to the survey. The result primarily represents Sweden. The need priorities would most likely be different if firms in other countries would be sampled in the survey. Most of the respondents also belonged to a medium or larger sized firm than smaller local firms (based on number of employees and the size of area they operate in). Therefore, not all firms within the urban mining market segment are represented, which could be a validity threat. However, it can be
argued that larger firms represent the industry in a greater extent since they operate on a more regional and domestic level or even globally. In that sense, the sampling representing larger firms could actually favor the results at hand.

From a statistic point-of-view the results have a confidence level and interval of 95% respective ±15%, meaning that we can be 95% certain that the obtained results are generally applicable to the urban mining segment, and could vary with ±15. The results might not be statistically strong enough in determining which of the needs are exactly the most or least prioritized ones among the others. It is however possible to determine the needs that are among the highest and lowest prioritized.

The study heavily relies on the concept of trends being possible data in understanding a general direction in which change and development is going towards. The use of trends in business, foresight and strategic purposes are common in literature, as argued in the theory section, and therefore considered reliable for in identifying future scenarios (Osterwalder & Pigneur, 2010). Trends deriving from emerging technologies were analyzed for this purpose. A selection of technology trends was done using the driving factors (main issues) of urban mining elicited from the need priorities. For instance, safety was highlighted as an important factor or topic deriving from the need finding and the relative importance of the needs. It is for instance clear if an emerging technology can have implication on safety, and a sample of emerging technologies relevant to urban mining was selected in this manner. It cannot be guaranteed that all emerging technologies were reviewed, which should not be a problem either. Because what is important is identifying the technology trends that is rising from the massive amount of the emerging technologies. A sample of emerging technology is sufficient in identifying and representing a technology trend.

There are trends that are not covered by the study due to the challenge of incorporating them all, however, just studying a few selected it is possible to understand the bigger picture, which is similar to how a sample in statistics can represent a whole population or a country. Hence, a sample of trends was extrapolated to generate scenario fractions or “elements” of the future segment, which was further analyzed. This opens up a discussion more related to the methodology (subsection 5.4) whether foresight is a reliable methodology in solving the research problem or not.

In the end, a list of needs, priorities and technology trends characterizing the urban mining segment was collected. This sets the foundation for the analysis of future scenarios, and more specifically – what needs that are probable to be prioritized in the future urban mining market segment in 2030.

5.1 Future scenarios deriving from trends

The results indicate that firms in the construction industry and urban mining segment are going towards a smarter and innovative management of internal resources, with a higher focus on bringing out the full potential of human resources. The driving factor behind this is optimization of the business, e.g. making the best or effective use of resources, as well as the growing importance of the social factor and care for the well-being of employees. In the
future, firms make better use of their human capital by emphasizing the well-being of their employees and by optimizing the context in which they are operating in. It is done through smarter work approaches, and ways that induce both encouragement and motivation. The management of ideas and innovation-related activities are more productive and efficient in bringing together all the creativity within the firm, partners, clients and the community alike. The workplace within a firm or on a project site is carefully designed to optimize the performed work, time and logistics revolving the employee. Work tasks are designed to boost productivity through enjoyment and mental motivation.

The increased use of 3D technology is suggested by the results as a “natural” direction for the urban mining segment to go more towards, as it shows significant potential for cost control and optimization of current practices. It also have implications on safety with a more transparent project procedure, and in collaborative management, which makes it easier to proactively reduce risks. The technology development in ICT is closely intertwined with 3D technology. Advances in this area have reached many industries as well as the construction industry. 3D technology and ICT systems have given rise to powerful collaborative tools, where partners, clients and community can take a proactive role in many parts of the projects and especially in the planning and design phase of the projects. An increased globalization in the construction industry can be seen, as these tools supports efficient collaboration and making physical constraints like distances less relevant. Uses for 3D printers have expanded along with the related technologies and design software tools, enabling low-cost and more advanced manufacturing capabilities. Fenn & LeHong (2011) argues that cost of 3D printers will drop significantly. Prices for 3D printers and 3D printing manufacturing are likely to be lower due to the economy of scale with the increasing product shipments, which further decreases prices due to increased and competitive pressure becoming a growing factor.

A growing community makes available resources and knowledge immense. Firms within the urban mining are hence less dependent on their own internal resources. Urban mining in whole concerns the society and many stakeholders. The social factor in incorporating partners, clients and the community in order to make use of all possible resources is therefore vital for firms to stay competitive in the urban mining segment.

ICT for managing communication and data is established in the construction industry. Extreme management and processing of worksite and project data enables real time analysis for optimizing processes and in controlling factors such as noise, pollution level, vibration and other safety matters. Equipment and human status are continuously analyzed to prevent risks, to predict needs for maintenance, and in optimizing the workflow etc. The work site during C&D is organized with the use of communication tools and predictive data analysis, which is no longer dependent on physical limitations in presence or distance. The collaboration tools, information, and data tools emerging from the advances in ICT have brought a shift towards a more holistic and lifecycle based approach. Bringing together design, construction and smarter management of the work site (Harty et al., 2007). Firms within the urban mining segment have therefore expanded their competencies into ICT and in areas across the supply-chain. Once again, the optimization of processes, cost-control, and the social aspect are driving factors in why firms within the urban mining segment engages with ICT technologies.
ICT and 3D technology has together brought a shift towards a more lifecycle-based approach by bringing together material management, design, construction and other activities within the industry. Construction and contractors now works in closer collaboration as a unit, going from a short-term construction work allocation to long-term service provision.

Advanced machines and robotics is working alongside humans on a project site as partners. Machines complements humans in aspects like speed and productivity that humans might lack, while human complements machine in emotional intelligence and the ability to handle the unknown. The industry’s overall health and safety record has improved with autonomous machines or robotics undertaking tasks in hazardous areas and where risks are deemed high for humans. This is among the first place where robotics is implemented as to the prioritized safety factor of urban mining. However, autonomous machines or robotics cannot perform every task on a project site. Instead humans work in close collaboration with the machines in a role similar to a supervisor’s, able to communicate with machines directly with human feats. Machines are also able to communicate and coordinate work with other machines with increased productivity by being consistent and not constrained by human factors, such as regulated working hours or labor regulations. All in all, the increased use of advanced machines and robotics drives the optimization of construction processes, in the cost control, and for the overall safety in urban mining.

By analyzing the findings it can be assumed that shifts in technology have produced new manufacturing capabilities, enabling wide adoption of new materials and ways of producing them. Environmental aspect in urban mining is partly addressed through “clean” materials, energy efficient, and manufacturing processes that consider the material’s life cycle. Materials are self-maintaining to stay durable and can monitor themselves in a similar manner to how Internet of Things is applied, which prolongs the lifespan of buildings and infrastructure. Materials used in construction are hence considered more sustainable. The findings along with the trends suggest a number of changes in the future. Future segment changes highlighted by the finding are also concluded in the table below (table 5-1).

<table>
<thead>
<tr>
<th>Nature of change</th>
<th>Future scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology 1:</td>
<td>Innovation management and workplace optimization enables higher creative output and better use of internal resources</td>
</tr>
<tr>
<td>Smarter management of internal resources</td>
<td></td>
</tr>
<tr>
<td>Technology 2:</td>
<td>Collaboration with 3D tools across firms in the supply and value chain. Low cost in design and more advanced manufacturing of products.</td>
</tr>
<tr>
<td>3D technology</td>
<td></td>
</tr>
<tr>
<td>Technology 3:</td>
<td>Worksite consists of a network and infrastructure for communication and information. Enables close collaboration among clients, firms and community. Work allocation shifting to a long-term service provision.</td>
</tr>
<tr>
<td>Adoption of ICT in processes</td>
<td></td>
</tr>
</tbody>
</table>

Table 5-1. Summarized changes and future scenario elements. It is based on the extrapolation of various trends and present need priorities.
Technology 4: Advanced robotics and machines
Human and machines works alongside to complement each other, enabling higher productivity and speed. Humans provide support for emotional intelligence and ability to solve unknown problems in this relationship. Machines undertake hazardous, repetitive and high-risk tasks.

Technology 5: New/smart construction materials
Materials are stronger, durable, energy efficient, self-maintaining, allowing a longer lifespan of buildings and infrastructure. Materials used in construction are more sustainable.

Urbanization
Urban population has grown significantly bigger, and cities grow denser. World population keeps growing.

Stricter regulations and legislations
Urban mining practices are forced to comply with societal "rules" and regulations regarding noise levels, preventing physical risks and keeping emissions to a minimum etc., on similar conditions as citizens.

Globalization
Use and implementation of ICT have contributed to a globalized market opening up for collaboration and competition.

The future scenario presented in this section is primarily technology-oriented. Regulatory, societal & cultural, and socioeconomic trends are also closely intertwined with technology trends, and important to consider when studying a future scenarios (Osterwalder & Pigneur, 2010). Although the thesis does not specifically addresses these type trends in its scope, it is still necessary to discuss them since they can affect the overall results.

The needfinding and review of trends implies on increased legislation and regulation that is likely to affect the construction industry in the future. Going through the history and the findings, it can be seen that safety, environmental and social care are important aspects that the industry are concerned with. The construction industry is commonly known for its high-rate of accidents and health issues. The construction industry represents a significant proportion of the environmental impact through, for instance, the production of building materials like concrete, and its high volume material turnover, which requires loads of transportation. According to United Nations, the proportion of the world population living in cities will grow from 54% (2014) to 66% by 2050 (UN, 2014). Considering the continuously growing world population, exceeding 7 billion people as we speak, these circumstances can have significant implications on society and the construction industry. The societal needs are likely to drive sustainability (incorporating a balance between economic, environmental and social aspects) within the construction industry. Stricter regulations and legislations are probable to drive better management of materials and resources, less disruption to the community, and ensuring safety to employees as well as citizens. More C&D is expected to take place in dense city environments, which means that urban mining practices must to some extent – with low exceptions – comply with societal rules on conditions similar to what citizen follows in their daily lives. It could for instance be maintaining a low noise level,
ensuring no physical risks to the surrounding environment, no hazardous activities, and not causing diffusion of dust or other health impairing emission.

An increased globalization can be expected from the growth in ICT. ICT enables better communication, information, network and information management, which furthermore blurs the physical boundaries by connecting the world. Construction performance and activities of the construction industry can incorporate global partners to higher extent, which opens up new markets as well as increased competition. ICT further contributes to a common standard. An expansion of the national construction sector into a more global arena can therefore be expected (Harty et al., 2007). The trends for stricter regulations, increased urbanization, and globalization are among the more apparent and perhaps significant trends highlighted in the analysis besides the reviewed technology trends.

5.2 Urban mining future needs and priorities

The needs are assumed to be consistent and similar today and in the close future (2030). This assumption is based on Patnaik & Becker’s (1999) theory of needs being consistent and long-lived. The type of solutions may change over time as new technology emerge but is often addressing the same set of customer or user needs. However, need priorities or “wants” can change over time since people or organizations are constantly exposed to various factors, both from internal and external sources. By analyzing the changes and future scenarios (table 5-1) it is possible to find connections and ‘hints’ on what could be prioritized in the future market segment. They represent potential market circumstances and furthermore impacts on the society. These can therefore have influence in what stakeholders considers important and is prioritized in terms of needs.

By studying how past trends and industry concerns shaped today’s need priorities it was possible find a correlation between them. The correlation between needs priorities and trends was identified to be related to the concerns and issues addressed by the industry or the market segment. Going from the past to the present: (1) The past issues suggested and incited a direction of development, (2) which ultimately shaped the past trends. (3) The trends thereafter suggested scenarios that reflects the present, (4) which shaped the context in where the need priorities was identified.

Figure 5-2. The foresight methodology allows one to understand the correlation between the input data and how the desired information, in this case need priorities, is correlated to other factors when going from different time states.

| Industry concerns/issues | Trends | Future scenarios | Indications on priorities |

By iterating this process from what is known today enables us to find future need priorities. Extrapolating on trends and present need priorities gives us future scenarios (table 5-1). The future scenarios suggests concerned issues within the urban mining segment, which can
further be reflected on the current need priorities, which gives indications on future need priorities.

If we take off from the future scenario – let us say we are in the future scenario right now – then it would mean that the technology, socioeconomic, and regulatory changes mentioned in table 5-1 would be existing circumstances. In that future market these technology and changes would more or less be baseline requirements for firms within the urban mining in order to stay competitive. Thus, firms within the urban mining segment would prioritize to reform their organization to meet or follow these external circumstances.

For instance, in a market with firms and competitors employing technologies for smarter management of internal resources, which directly addresses the issue of optimization in urban mining, – it could mean that the need for ‘optimizing transportations’ is directly addressed with the use of smart workplaces. It can therefore be presumed that this need would be of higher priority in the scenario.

As for the 3D technology change it can be expected that the technology allow better collaboration across the supply and value chain, and in delivering better product and service solutions. Partners, clients and community can take proactive roles in many parts of the urban mining process and especially in the design phase. This change is likely to drive the importance of the need for ‘design to consider the product lifecycle’. The expansion in ICT communication, network and data has likewise opened up for a close collaboration along the supply chain, as well as globally. Changes related to the ICT advancements can be expected to impact many construction or urban mining practices through further digitalization, data management, analysis and more due to its wide nature. ICT have due to its wide implementation range the potential to enhance most process and therefore the possibility to influence many of the prioritized needs in the future. ICT can be implemented to better meet needs like ‘protecting valuable materials from theft’, ‘optimizing transportations’, ‘preventing diffusion of dust and disturbance’, ‘better facilitation of workspace accessibility’ and enabling a ‘better lifecycle perspective in design’ for instance.

The use of autonomous machines or robotics in hazardous, repetitive and high-risk tasks have clear benefits in addressing the needs related to safety, like ‘eliminating physical safety risks’, ‘preventing spread and exposure to hazardous waste’ and in ‘relieving labor workers from manual work’. In the future urban mining it is not unlikely that some practices or operations utilize autonomous machines or robotics, and considered state-of-the-art in the future. This could drive firms in the segment to prioritize the needs that is primarily addressed by these changes. Autonomous machines and robotics have clear advantages in urban mining in the sense that they are not affected by health constraints that humans do.

Urban mining in the future sets stricter sustainability conditions. Dense and growing cities are subjects for urban mining. The use of new materials with more sustainable properties and longer lifespan may be necessary to be prioritized in order to meet the sustainability conditions of the future market segment. Furthermore, to meet needs such as ‘preventing spread of hazardous waste’, ‘making better use of waste materials’ and in reducing C&D
“side-effects” related to the needs for ‘preventing diffusion of dust’ and ‘eliminating disturbance or noise’ by prolonging the lifespan of buildings and infrastructure.

The urban population is expected to grow significantly bigger, and cities are getting denser as suggested by United Nation’s study of the future urbanization (UN, 2014). The urbanization, and stricter regulations and legislations as consequences can have many implications on the urban mining market segment. Firms operating in this market have to prioritize ‘preventing the spread of hazardous waste’, ‘eliminating physical safety risks’, ‘and making better use of materials to prevent land’ in order to protect citizens and not causing direct harm to the surroundings in urban environments. As cities are getting denser firms may prioritize products and solutions addressing the need of ‘reducing occupied space (footprint) of objects’. In order to be proactive in meeting the previously mentioned needs – firms may need to consider having a lifecycle approach in many of their urban mining activities.

Lastly, the further globalization of the construction industry and urban mining segment will probably create a more competitive market. Firms may need to leverage their capabilities by incorporating partners, multiple products and services, the community and other parts of the supply chain to maximize the creation of customer value. This will be important for firms within urban mining in order to gain an upper hand in a more competitive and globalized market environment. Prioritizing a holistic, and ‘design that considers the lifecycle of products or services’ could be necessary for firms within the segment to stay vital and competitive.

The changes that the future scenarios proposes, as suggested and argued, are all likely to affect what firms within the future urban mining segment prioritizes in terms needs. Expected similarities of the present state (today) and potential future states (2030) in terms of need priorities and relative importance, are analyzed in order to contrast the changes from today and the future.

5.3 Comparison of present and future need priorities

The future need priorities are qualitatively assessed to determine shifts in relative importance based on the previous analysis. The validity and reliability of this analysis cannot be completely guaranteed due to the nature of foresight, and future scenarios “just” being “potential” scenarios. However, the results and analysis can be used as indications in determining if a need could “potentially” be higher or less prioritized compared to the present need priorities. For instance, which of the needs are suggested to stay, increase or decrease in relative importance based on the changes and future scenarios. The analysis can at least back up this level of interpretation, which can be informative enough to get a sense in what direction the urban mining market segment is heading towards. A new ranking among the future need priorities cannot be reliably defined due to the set scope, limitations, and weaknesses in research design.
Table 5-3. The future’s need priorities are qualitatively assessed and extrapolated based on the present trends and priorities. Similarities categorize needs that suggest low change in relative important when comparing present and future scenarios. Differences presents need that shows significant changes in relative importance. Positive or negative signs indicate increase or decrease in relative importance.

<table>
<thead>
<tr>
<th>Similarities (low changes in relative importance)</th>
<th>Differences (significant changes in relative importance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Makes better use of materials to prevent landfill</td>
<td>• Eliminates physical safety risks (+)</td>
</tr>
<tr>
<td>• Prevents diffusion of dust</td>
<td>• Protects valuable materials from theft (-)</td>
</tr>
<tr>
<td>• Prevents spread of hazardous waste</td>
<td>• Design considers the product lifecycle (+)</td>
</tr>
<tr>
<td>• Optimizes transportations</td>
<td>• Relieves labor workers from manual work (-)</td>
</tr>
<tr>
<td>• Eliminates disturbance/noise</td>
<td></td>
</tr>
<tr>
<td>• Reduces occupied space (footprint) of objects</td>
<td></td>
</tr>
<tr>
<td>• Facilitates workspace accessibility</td>
<td></td>
</tr>
<tr>
<td>• Machines/tools are flexible for different situations</td>
<td></td>
</tr>
</tbody>
</table>

Many of the future need priorities remain similar to present need priorities in relative importance, with or without slight indication on changes. The environmental related needs like for instance ‘Makes better use of materials to prevent landfill’, ‘Prevents diffusion of dust’, and ‘Prevents spread of hazardous waste’ still remains among the highest prioritized needs according to the analysis. The analysis of changes and future scenarios, especially the effects of urbanization – heavily suggests that these will still remain among the top prioritized needs. The technology-related changes addresses many of the needs but the future scenarios do not clearly and reliably indicates changes in many of the needs. However, the emphasis on safety and a lifecycle-approach in urban mining – which directly addresses ‘Eliminates physical safety risks’ and ‘Design considers the product lifecycle’ – was clearly suggested by the future scenarios in being much more prioritized in the future.

The results and analysis suggests ‘Design considers the product lifecycle’ is going from among the lowest prioritized needs to much higher priority, and relative importance. ‘Protecting valuable materials from theft’ and ‘Relieving labor workers from manual work’ were indicated to be of less priority and relative importance. The reason to this could be the environmental, social and safety related needs being highly emphasized by many of the changes, especially related to urbanization and stricter regulations. For instance meeting the regulated noise level, dust or emission levels, and safety aspects are compulsory in order for urban mining to even be considered. ‘Preventing material theft’ or ‘Relieving labor workers from manual work’ – that can be related to contingency in industry issue – becomes secondary in this context and therefore less prioritized. Labor workers doing manual work is usually not the problem itself according to the results. It is rather the safety, health, and social issues revolving the work that is of concern. Having humans undertaking hazardous tasks is usually not an issue if safety and health can be assured.

All the findings related to how the need are related to the urban mining segment issues, and their priorities, are concluded in the table below (table 5-4).
Table 5-4. The need priorities of the present and the future are concluded and related to the identified industry/segment concerns or issues.

<table>
<thead>
<tr>
<th>Present segment 2015</th>
<th>Main identified issues</th>
<th>Need</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High priority</strong></td>
<td>Safety</td>
<td>• Prevent spread of hazardous waste</td>
</tr>
<tr>
<td></td>
<td>Environment</td>
<td>• Eliminates physical safety risks</td>
</tr>
<tr>
<td></td>
<td>Social care</td>
<td>• Makes better use of materials to prevent landfill</td>
</tr>
<tr>
<td></td>
<td>Cost control</td>
<td>• Protects valuable materials from theft</td>
</tr>
<tr>
<td></td>
<td><strong>Low priority</strong></td>
<td>• Prevent diffusion of dust</td>
</tr>
<tr>
<td></td>
<td>Space</td>
<td>• Facilitates workspace accessibility</td>
</tr>
<tr>
<td></td>
<td>Lifecycle consideration</td>
<td>• Design considers the product lifecycle</td>
</tr>
<tr>
<td></td>
<td>Machines/tools flexibility</td>
<td>• Reduces occupied space of objects</td>
</tr>
<tr>
<td></td>
<td><strong>Future segment 2030</strong></td>
<td>• Machines/tools are flexible for different situations</td>
</tr>
<tr>
<td><strong>Higher priority</strong></td>
<td>Safety</td>
<td>• Eliminates physical safety risks</td>
</tr>
<tr>
<td></td>
<td>Social care</td>
<td>• Design considers the product lifecycle</td>
</tr>
<tr>
<td></td>
<td>Lifecycle consideration</td>
<td>• Protects valuable materials from theft</td>
</tr>
<tr>
<td><strong>Lower priority</strong></td>
<td>Contingency</td>
<td>• Relieves labor workers from manual work</td>
</tr>
</tbody>
</table>

5.4 Foresight methodology – benefits and limitations

There is currently an ongoing discussion about foresight in future studies, its applicability, benefits and limitations in assessing future scenarios of industries (Harty et al., 2007). Harty et al.’s (2007) critical review of construction future studies highlights three key points related to the concept of foresight and the implications future studies can have.

The first is to what extent the methodology have to consider potential futures of much wider issues. There are both foreseen and unforeseen variables that can affect the future scenarios and the challenge is taking all of them in consideration, which might be impossible. This could be seen as a weakness of the foresight concept in general. Macro-economic factors, societal concerns and dynamics of other industries are just a few additional variables that could unpredictably intersect with the construction industry. Furthermore, make a complex system that could affect the validity and reliability of the results. Another issue is what is considered outside and inside the boundaries of the construction industry, which is a point of debate in literature already (Pearce 2003 through Harty et al., 2007). It can thereby indirectly affects urban mining as defined in the thesis. In any case, a model of what is considered the construction industry and segments must be defined (which is done), and it is within these boundaries that the findings origins from (figure 1-1). The complex system of foreseen and
unforeseen factors must be consciously scoped, delimited and taken out of the equation in the theoretical framework and research design in order to ensure the validity and reliability of the research.

This thesis presents eight types of changes and urban mining segment future scenarios, which can be seen as single fractions or elements of the future. Therefore, not all factors that might influence the future have been studied within the scope of the thesis. The study primarily focuses on emerging technology representing technology trends and with the assumption that a sample of trends can represent a bigger picture. The findings and the future scenarios therefore only represent the aspects of what are studied, which is primarily technology changes. It means that the identified future scenarios might not be reliable. This is a general problem with foresight since it is often impossible to consider all influencing factors. However, the issue can be seen as a puzzle that represent the future market segment. Using this metaphor, it would mean that we have only set a fraction of the puzzle, which represents the technology part. This means that the future is still unknown since we cannot see the full picture of the puzzle. Even though, we have a better understanding of what the picture of the puzzle could be like. Taking a guess of what the full picture represents would be easier since we have some parts put in place already. Therefore, the findings can support a decision-making process by eliminating some of the unknown factors that are now known.

Another general weakness of the methodology is that the study is based on the “present” as known during the time the research took place. What is defined as present changes as time passes, which means that the reliability of the results are getting lower over time (gets harder to guess the full picture based on the findings). As time passes there is a likelihood that some kind of actions might disrupt the future scenarios defined in this thesis. It could for instance be something as a new set of stakeholders, or a firm that have put in actions to counteract the future scenario that is to them not desirable. Unforeseen incidents is hard or impossible to assess in a future study due to its unforeseeable nature. Harty et al. (2007) presents the two World Wars as examples of unanticipated occurrence that have led to wholesale change. Even more far-fetched examples like cataclysmic events, for instance an asteroid impact, might render the future scenarios no longer valid in an instant. These highlight the weakness of the foresight methodology in being able to take unforeseen factors and variables in considerations.

A recommendation is therefore: the findings can reliably support a strategic decision today and the near future, but is less reliable to do so as time passes.

The second is the discussion of what exactly are “good” and “bad” futures. Firms’ need priorities are influenced by both internal and external factors. A firm may want to prioritize what they desire accordingly to their values and mission but cannot. External factors, such as regulations and legislations could override these internal factors. State laws can more or less dictate a market and thus what firms must prioritize. Else, it might risk being sentenced and punished. This raises the ethical question of for whom the future scenarios are good or bad for. Even though the thesis is directed to support the construction industry, the urban mining market segment and society, it could by indirect means favor just the society or a state only. The implications of the findings presume and encourage firms to be the ones to undergo the changes in order to meet what the market or society demands, which can be costly, risky and
without guaranteed payback. Having this in mind, the findings presented in this thesis should be approached as recommendations and used with a critical judgment, which is encouraged when making use of any academic and scientific literature in general.

It is also assumed that technological advances are positive processes, and the increased use of technology would contribute to better working practices within urban mining. This is not always the case. For instance, history have shown that manufacturing progression have resulted in a massive group of labor workers losing their job. Once again, the question for those whom the changes are good or bad for is raised. There might be resistance or in refusing a technology or process by those whom it is bad for, ultimately a future scenario can be prevented.

The third involves the challenge in accounting all the implications on a wide variety of actors and stakeholders. The thesis delimits to only study the needs of customers, i.e. firms that operate within the urban mining market segment and the recommendations will be primarily conveyed to firms that provides product and service solutions to these. This may benefit specific firms or sectors and on the expense of others. Therefore, it is necessary to take a step back and look on the more general picture, e.g. what implications the findings can have on the construction industry and the society as whole.

5.5 Implications on construction industry

The motivation for conducting future studies in construction is to understand how firms and other actors might respond to a range of potential changes in the future (Harty et al., 2007). The purpose of this study is to incite changes by enabling preparedness through the identified future scenarios, which could be likened to agility (agile) (Harty et al., 2007).

The thesis presents a set of prioritized needs as a future market scenario. These allow for instance product and service providers to the urban mining segment to initiate changes from a present state to a desired state in a planned manner. The main benefit of initiating changes with a planned approach is the possibility of acting proactively. It is argued that the trigger for change is often unpredictable hence tends to be reactive, discontinuous, ad hoc and often prompted by a situation of organizational crisis (Todnem By, 2005). At that time, it could be too late or costly to undergo the change. These kind of changes would probably have been a more successful change if done earlier by preventing the crisis in the first hand. Acting reactively may also influence the process negatively due to time pressure and being forced to reallocate resources on a short notice. The foresight findings can therefore be useful in eliminating unpredictable factors and allowing firms being proactive rather than reactive.

The future scenario and the findings related to it are not what is important. Having a model for understanding how the market operates, rather than the answer – allows stakeholders within the industry today to inform decision they make about their activities (Harty et al., 2007). The future scenario makes it possible to shape the connection between the present and the future. Perhaps most importantly – it gives indications on how the market operates. Thus, enabling actors or stakeholders to alter, mitigate or influence the change process, hence the future, which goes back to the idea of “having the future in your hand” (Harty et al., 2007).
Furthermore, aid in defining strategies for bringing a desired positive future or avoiding a less preferable one.

Needs related to safety and integrating a lifecycle-approach was highlighted to be higher and more prioritized in the future. On the other hand, ‘protecting valuable material from theft’ and ‘relieving labor worker from manual work’ was suggested to be less prioritized in the future urban mining segment. Firms may need to undergo incremental adjustments or modular transformations of their organizations in order implement changes towards the type of future scenarios that are suggested here. This could mean modifications in existing management processes and strategies to incorporate safety to a higher extent in operations (Todnem By, 2005). Major shifts of departments or organizational divisions may as well be required in order to integrate a supply/value chain lifecycle approach across firm. In conclusion, firms can be expected to go through changes in their management processes, organizational strategies, and radical shifts in departments or divisions to meet what is expected in the future urban mining market segment of 2030.

5.6 Future work

The thesis delimits to mainly study the needs and priorities of firms operating in the urban mining market segment, today and the future. The purpose is to contribute in mapping the urban mining segment within the construction industry, and more work in defining the segment is welcomed. Trends are important data in doing this. Technology trends were primarily studied in order to extrapolate future scenarios. There are many other types of trends besides technology – for instance, regulatory, societal & cultural, and socioeconomic trends. These can be further reviewed and explored to identify more urban mining future scenarios, which can give a more reliable future view of the urban mining segment. Future research addressing other types of trends can be built upon the presented results and data, and complement the research in defining the urban mining market.

A few points of criticism were directed towards the use of foresight methodology in research. The thesis highlights the issue of preventing foreseen and unforeseen variables from affecting the validity and reliability of future studies. This is an old issue in future study literature that still remains a big issue. Future research in foresight methodology could look into the process of defining research design models and implementation to aid researcher and practitioners in eliminating unknown and unforeseen variables in future studies.
6 Conclusion

The continuous development and expansion of cities and urban environments represents a significant turnover of materials. Opportunities of urban mining have emerged along with the depletion of natural resources and prevailing material scarcity. Advances in technology, increasing urbanization and globalization suggest changes in the future market circumstances and in how firms operate in the future urban mining segment.

12 general and primary needs shared across firms within the urban mining segment were identified along with the priorities and relative importance of these. These characterizes issues related to safety, optimization, cost control, social and environment—which have shown to be critical aspects and what highlights a general direction in where the market segment is heading towards in the future. They represent both threats and opportunities for stakeholders and actors in the construction industry.

The following needs are suggested to be among the highest prioritized needs in today’s urban mining market segment.

- Prevent spread of hazardous waste
- Eliminates physical safety risks
- Makes better use of materials to prevent landfill
- Protects valuable materials from theft
- Prevent diffusion of dust

The following needs are suggested by the findings to be significantly higher in relative importance in the future urban mining market segment.

- Eliminates physical safety risks
- Design considers the product lifecycle

So how can stakeholders in the construction industry and firms providing products and services to the urban mining segment prepare for the future scenarios presented in the study?

Overall, the study highlights an increasing importance and priority in the safety for humans, the environment, a life-cycle approach in design, and collaboration across supply/value-chains in urban mining practices. Ensuring safety to humans, preventing noise, landfill, dust and emission remain the top prioritized needs that urban mining practices must comply with today and to a higher extent in the future. Incorporating a life-cycle approach and collaboration across supply/value-chains will be a competitive factor for firms operating in the future urban mining market segment. However, this is not prioritized in today’s market segment in relative importance.

Moreover, going into the presented future scenarios may require firms to do dramatic changes in the organization. It would mean changes in the management process and organizational strategies. Firms may therefore be required to go into the very depth of their core values and
mission, according to the analysis. This could be vital for firms in fully representing and addressing the needs related to safety, social and environmental care in their practices, and in justifying their importance to the society. These are driving factors that are of increasing importance in the urban mining segment.

Applying a life-cycle approach and collaboration across the supply/value-chain is something that has been suggested in many construction future studies. Major shifts in departments or divisions may be required for firms to successfully go into this change. Existing organizational structures cannot be expected to fully support this change, which may also be the reason to why it has been shown to be such a challenging task. Stakeholders and actors concerned with the urban mining market segment are therefore encouraged to challenge the status quo in order to meet what is expected in future. The market today is according to the prioritized needs not ready to fully engage in this area. It might therefore not be wise to dive head first in this area with irreversible investments since technology is rapidly advancing addressing this area, making it uncertain.

It can be suggested that firms in the near future should start looking into emerging 3D and ICT technologies to in the future establish a holistic and lifecycle approach in their operations through collaboration across the supply and value chain. Firms with capabilities in ICT may have a head start in this area. Knowledge and competencies obtained in the field of ICT can be seen as a long-term investment as it opens up for opportunities, with autonomous machines and robotics within the close vicinity. ICT technologies have a wide range of applicability in solutions and in addressing most of the identified needs.

With the future scenarios at hand it can support firms in successfully managing a change into a desired state, whether it is by going towards the defined future scenario itself or if an alternate future is desired. The identified future scenarios enable actors and stakeholders to identify and explore the consequences of different activities or decisions. The possibility of having a planned change enables a proactive approach rather than a reactive. It could encourage actors to innovate in unexplored areas with less risk, and with the possibility to benefit from first-mover advantages. The identified future need priorities can also strategically guide the product development process of firms providing solutions to the urban mining segment. The research is based on what is defined as the “present” which is at the time study was done. Thus, the findings can reliably support a strategic decision today and the near future, but is less reliable to do so as time passes since

Neither of the needs, priorities, and trends are completely limited to the construction industry alone. In fact, they are a result of changes across industries and other unknown variables playing its part. Hence, actors in urban mining may other than what is suggested need to look outside their own product range and incorporate other products and services in their future offerings. Even outside the borders of what defines the construction industry today.
Reference


Carleton, T., Cockayne, W., & Tahvanainen, A. (2013). Playbook for strategic foresight and innovation. A hands-on guide for modeling, designing, and leading your company’s next radical innovation.


Appendix

A. XPLANE’s Empathy Map for observation
B. Need prioritization survey (English)

User/Customer need prioritizations – C&D industry (urban mining segment)

For each of the following product preferences/functions, please indicate on a scale of 1 to 5 how important these are to you. Please use the following scale:

6. **Undesirable.** I would not consider a product/service solution with this function.
7. **Not important,** but I would not mind having it.
8. **Would be nice to have** but is not necessary.
9. **Is highly desirable,** but I would consider a product/service solution without it.
10. **Is critical.** I would not consider a product without it

1—2—3—4—5

**Eliminates disturbance/noise**
- Protects the surrounding environment from disturbance
- Prevents high and constant noise
- Prevents nuisance from odor

1—2—3—4—5

**Prevents diffusion of dust**
- Prevents dust to generate
- Prevents human/environmental exposure to dust

1—2—3—4—5

**Prevents spread of hazardous waste**
- Prevents human and environmental exposure to hazardous waste
- Protects humans and environment from poisonous gases and impurities
- Separates waste containing mercury
- Prevents water to be contaminated (leachate)

1—2—3—4—5

**Facilitates workspace accessibility**
- Machines and equipment can operate in confined spaces
- Limited space does not inhibit operations
- Machines moves quickly to desired positions

1—2—3—4—5

**Optimizes transportations**
- Maximizes load capacity
- Informs the weight of current load
- Minimizes transportation in the waste management process
- Cargo space is (always) utilized
- Materials are not transported unnecessary distances

1—2—3—4—5

**Machines/tools are flexible for different situations**
- Targets are reachable
- Adjustment/change of tools are quick to perform
- Machines/equipment are precise
- Equipment are not damaged during operations
- Functions on sites with no access to electricity and water
<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th><strong>Relieves labor workers from manual work</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Assists in identifying type of materials</td>
<td></td>
</tr>
<tr>
<td>Assists in sorting materials correctly</td>
<td></td>
</tr>
<tr>
<td>Identifies the value of materials</td>
<td></td>
</tr>
<tr>
<td>Objects are easily disassembled</td>
<td></td>
</tr>
<tr>
<td>Materials are easily moved</td>
<td></td>
</tr>
<tr>
<td>Prevents waste to end up on ground</td>
<td></td>
</tr>
<tr>
<td>Materials can be efficiently removed from the ground</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th><strong>Reduces occupied space (footprint) of objects</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Eliminates intermediate storages</td>
<td></td>
</tr>
<tr>
<td>Optimizes storing of materials with different shapes</td>
<td></td>
</tr>
<tr>
<td>Reduces the occupied space of materials</td>
<td></td>
</tr>
<tr>
<td>Reduces the footprint of machines/equipment</td>
<td></td>
</tr>
<tr>
<td>Materials can be processed into desired sizes on site</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th><strong>Makes better use of materials to prevent landflling</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reuses or recycles waste on-site/locally</td>
<td></td>
</tr>
<tr>
<td>Prevents reusable/recyclable waste to end up in landfills</td>
<td></td>
</tr>
<tr>
<td>Eliminates by-products from operations</td>
<td></td>
</tr>
<tr>
<td>Makes use of plastic waste</td>
<td></td>
</tr>
<tr>
<td>Makes use of insulation materials</td>
<td></td>
</tr>
<tr>
<td>Makes use of bottom ashes from combustion processes</td>
<td></td>
</tr>
<tr>
<td>Makes use of end of life tires</td>
<td></td>
</tr>
<tr>
<td>Handles solid sludge and slag</td>
<td></td>
</tr>
<tr>
<td>Collects or utilize energy-rich organic waste</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th><strong>Eliminates physical safety risks</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protects surrounding environment from physical damage</td>
<td></td>
</tr>
<tr>
<td>Handling materials can be done with no direct human physical presence</td>
<td></td>
</tr>
<tr>
<td>Allows a safe workplace</td>
<td></td>
</tr>
<tr>
<td>Eliminates interfering risks from water and power sources</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th><strong>Design considers the product lifecycle</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Components are easily assembled and disassembled</td>
<td></td>
</tr>
<tr>
<td>Components are universal fittable</td>
<td></td>
</tr>
<tr>
<td>Components are easily handled and moved</td>
<td></td>
</tr>
<tr>
<td>Precludes disassembly before assembly</td>
<td></td>
</tr>
<tr>
<td>Attachments are attachable and detachable without welding</td>
<td></td>
</tr>
<tr>
<td>Objects can be separated into different material types</td>
<td></td>
</tr>
</tbody>
</table>

| 1—2—3—4—5 | **Protects valuable objects/materials from theft** |

Any comments or additional points you would like to add?
C. Need prioritization survey (Swedish)

Prioritering av kundbehov – Bygg- och riv-industrin (segmentet för urban mining)

För följande behov/funktioner, vänligen ange på en skala 1 till 5 enligt hur viktiga dessa är för dig. Vänligen använd följande skala:

1. **Oönskad.** Jag skulle inte vilja ha en produkt eller tjänst med denna funktion.
2. **Inte viktig,** men jag skulle inte ha något emot att ha det.
3. **Vore bra att ha** men är inte nödvändigt.
4. **Är mycket önskvärt,** men jag kan överväga en produkt eller tjänst utan det.
5. **Är oerhört viktigt.** Jag skulle inte vilja ha en produkt eller tjänst utan det.

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th>Ovåsen/störningar förhindras</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Omgivningen skyddas från ovåsen och störningar</td>
</tr>
<tr>
<td></td>
<td>Hög och konstant ovåsen förhindras</td>
</tr>
<tr>
<td></td>
<td>Förhindrar obehag från illalukt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th>Spridning av damm förhindras</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Förhindrar att damm uppstår</td>
</tr>
<tr>
<td></td>
<td>Människor och miljö skyddas mot exponering av damm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th>Spridning av farligt avfall förhindras</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Människor och miljö skyddas mot farligt avfall</td>
</tr>
<tr>
<td></td>
<td>Människor och miljö skyddas mot giftiga gaser och föroringar</td>
</tr>
<tr>
<td></td>
<td>Avfall innehållandes kvicksilver separeras</td>
</tr>
<tr>
<td></td>
<td>Vatten skyddas från att förorenas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th>Framkomligheten på arbetsplatser underlättas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maskiner och verktyg kan användas i små utrymmen</td>
</tr>
<tr>
<td></td>
<td>Arbete hämmas inte av begränsat utrymme</td>
</tr>
<tr>
<td></td>
<td>Maskiner förflyttas snabbt till önskade platser</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th>Transporter optimeras</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lastkapacitet maximeras</td>
</tr>
<tr>
<td></td>
<td>Lastens vikt informeras</td>
</tr>
<tr>
<td></td>
<td>Transporter i avfallhanteringsprocessen minimeras</td>
</tr>
<tr>
<td></td>
<td>Lastutrymmet utnyttjas alltid</td>
</tr>
<tr>
<td></td>
<td>Material transporteras inte över onödiga sträckor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1—2—3—4—5</th>
<th>Maskiner/verktyg är flexibla för olika situationer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Föremål är åtkomliga</td>
</tr>
<tr>
<td></td>
<td>Anpassningar/justeringar av verktyg är snabba att genomföra</td>
</tr>
<tr>
<td></td>
<td>Maskinverktygen är precisa</td>
</tr>
<tr>
<td></td>
<td>Verktygen skadas inte vid användning</td>
</tr>
<tr>
<td></td>
<td>Kan användas på platser som inte har tillgång till el och vatten</td>
</tr>
</tbody>
</table>
Mängden manuellt arbete minskas
Identifiering av material/avfall underlättas
Sortering av material/avfall underlättas
Värden på material kan identifieras
Föremål kan enkelt demonteras
Material kan enkelt förflyttras
Förhindrar att avfall hamnar på marken
Undanröjning av material på marken sker effektivt

Tar bättre tillvara på begränsat utrymme
Mellanlagringar elimineras
Föremål i olika former lagras effektivt
Den ockuperade ytan av material minskas
Den ockuperade ytan av maskiner/verktyg minskas
Material/avfall kan bearbetas till önskad storlek på plats

Avfall tas tillvara för att förhindra deponering
Återanvändare eller återvinnare avfall lokalt
Restprodukter elimineras
Tar vara på plastavfall
Tar vara på isoleringsmaterial-avfall
Tar vara på bottenaska från förbränningsprocesser
Tar vara på uttjänta däck
Rötslam och slagg hanteras
Energirik organiskt avfall samlas och tillgodogörs

Fysiska säkerhetsrisker elimineras
Omgivning skyddas från fysisk åverkan
Hantering av material kan utföras utan direkt fysisk närvaro
En säker arbetsplats möjliggörs
Risker som orsakas från vatten och kraftkällor elimineras

Designas ur ett produktlivsperspektiv
Komponenter är enkla att montera och demontera
Komponenter är universellt passbara
Komponenter är enkla att hantera och förflytta
Demontering före montering utesluts
Moduler är fästbara och löstagbara utan svesning
Föremål kan separeras i olika materialtyper

Värdefulla föremål/material skyddas från stöld

Har du några kommentarer eller ytterligare punkter att tillägga?