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Waste Management in Norway

A study of possible application of "ISO 37120
Sustainable Development in Communities -
Indicators for city services and quality of life"

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Problem Description

The objective and purpose of this study is to explore *"ISO 37120:2014 Sustainable Development in Communities – Indicators for city services and quality of life"*, with focus on solid waste, in order to evaluate the standard's contribution as a waste management tool at a local level, as part of a sustainable development of communities.

Main content:

- Introduction to the topic
- Presentation of relevant literature regarding waste management, sustainable development, circular economy and performance indicators
- Overview of current goals, strategies and trends at the national level
- Outline of ISO 37120 and other standards if relevant
- Collecting qualitative data on local performance regarding waste management
- Apply and explore performance indicators on solid waste in ISO 37120 with regard to qualitative data
- Evaluation of ISO 37120 as a tool regarding waste management, and if possible give recommendations and suggestions

Preface

This study is the final product of the MSc in Industrial Ecology at the Norwegian University of Science and Technology (NTNU) in Trondheim. It is written at and supervised by the Department of Industrial Economics and Technology Management during the spring of 2016.

My two years at Industrial Ecology is soon to be history, and this thesis is the final result. It is partly based on- and a continuation of the project thesis from autumn 2015 *Analysis of Sustainability Assessment Frameworks for Development of Cities and Communities*. Thus, some parts of the thesis are based on what was conducted in the project, but with modifications.

The journey started five years ago at the bachelor's program in Social Anthropology at NTNU, were my final essay dealt with the consumer society and its impact on nature. Hence, it is delightful to me to close the circle by writing this thesis on waste management in light of the transition towards a circular economy and a sustainable development of cities and communities. For a long time I have been interested in these topics, and through increasing focus on them, for instance by the Norwegian Waste Management and Recycling Association (NWMRA), I got inspired to do this study that you are holding in your hands.

I would like to thank several people who have contributed. Thanks to Håkon Bratland at NWMRA for his guidance and feedback with regard to the questionnaire, for sending it forward, and for giving me more insight to the waste management industry. Trine Tveter at Norwegian Standardization shared information and material on ISO 37120 that were very useful; thank you. I would also like to thank Annik M. Fet and NTNU Sustainability for giving me insight to one of their pilot projects on sustainable cities and local communities during the autumn of 2015, as well as sharing literature about the standard. I must also say thank you to all those who responded to my requests, the questionnaire and the interviews. John Eilif Hermansen, Associate Professor at IØT, NTNU, has been my supervisor and I would like to thank him for his constructive guidance and feedback, his engagement and interest in the study.

Lastly, thanks to my fellow students at IndEcol for sharing experiences, tips and tricks, for motivation and inspiration throughout the semester. You are all great!

Abstract

As a contribution in reaching the UN SDGs and towards a circular economy *"ISO 37120:2014 Sustainable Development in Communities – Indicators for city services and quality of life"* has been explored to assess its possibility of being applied as a tool at a local level in Norway. The focus has been on management of solid waste, which is one of the topics in the standard. A triangulation of methods has been used when addressing the research issue, mainly consisting of qualitative strategies.

The study indicates that in terms available data at KOSTRA, it is practically possible to apply the solid waste indicators in ISO 37120 at a local level in Norway. When quantifying the indicators, the municipalities Oslo, Bergen, Drammen and Asker were used as examples and illustrations. As the waste management systems in Norway is considered to be satisfying, by a sample of local authorities and local waste management agencies, the solid waste section in the standard alone will not contribute extensively with new insight and knowledge. This result is based on a qualitative questionnaire, as well as interviews. On the other hand, it is assumed that applying the standard will be more beneficial and convenient if all topics are implemented and considered, with the aim of being compared with communities outside Norway - as it is an international standard. Thus, the standard could still be useful and beneficial to apply, especially if all topics is considered and not only the solid waste section. With regard to the transition into a circular economy and reaching the UN SDGs, there are suggested solid waste performance indicators, as in light of these initiatives the standard is slightly incomplete.

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Acronyms and Abbreviations

CE	Circular Economy
EC	European Commission
EEA	EU's European Environment Agency
IE	Industrial Ecology
IKS	Inter-municipal agency (interkommunalt selskap)
ISO	International Organization for Standardization
KLD	the Norwegian Ministry of Climate and Environment
KMD	the Norwegian Ministry of Local Government and Modernisation
KOSTRA	Norwegian Municipality to Central Government-Accounting System (Kommune-Stat-Rapportering)
LA	Local Authority
LCA	Life Cycle Assessment
MSW	Municipal Solid Waste
NEA	Norwegian Environment Agency
NWMRA	Norwegian Waste Management and Recycling Association (Avfall Norge)
SDG	UN Sustainable Development Goals
SN	Norwegian Standardisation (Standard Norge)
SSB	Statistics Norway
WMA	Waste management agency

Waste Management Agencies

BIR	Inter-municipal WMA in Bergen area, Hordaland District (Bergen Interkommunale Renovasjonsselskap)
IVAR	Inter-municipal management agency in Stavanger area, Rogaland (Interkommunalt vann, avløp og renovasjon)
RfD	Inter-municipal WMA in Drammen area, Buskerud (Renovasjonsselskapet for Drammensregionen)
TRK	Inter-municipal WMA for Time, Rennesøy and Kvitsøy, Rogaland

1. Introduction

Solid waste management is a crucial topic regarding sustainable urban development of cities and communities (UN General Assembly, 2015, EC, 2015a). It is an important part and component of a city's services, activities and performance over time. ISO has developed a standard on sustainable development of city services and quality of life that covers 17 topics, which includes over 100 indicators to measure and quantify performance (ISO/TC 268/WG 2, 2015). One of these topics is solid waste. In order to manage and improve the solid waste city service, it has to be measured and quantified, analysed and assessed, by having performance indicators. Could the ISO framework and these international indicators on solid waste contribute and be useful in a Norwegian context?

The global trend of urbanization is transforming our world and planet (IPCC WG3, 2014; WHO, 2015). How cities and urban settlements are developing, is an important aspect considering climate change and sustainability. Mitigation strategies and climate action plans at a local level are implemented several places, and various tools and frameworks on how to make cities and communities more sustainable are under development. Due to rapid urbanization globally, waste management is one of the challenges a city or community must handle. Additionally, large industrialization combined with population growth and high consumption rates will make the amount of solid waste increase even more (Ghisellini et al., 2015). Thus, proper waste management solutions are needed.

1.1 Background

In December 2015 EU launched an action plan for development of a circular economy (EC, 2015a). This plan, *Closing the loop - An EU action plan for the Circular Economy*, deals with the transition into a circular economy were resource efficiency and reduction in negative environmental impact, in combination with economic growth and increased employment rates, are of concern. In addition, this action plan is a contribution in reaching the UN SDGs (KLD, 2016). In the Norwegian Environment and Climate agency's strategy document on EU's issues of priority in 2016 (KLD, 2016), changes in the regional waste directive are one of the areas of focus. Four changes to the waste directives are suggested (KLD, 2016). The commission is suggesting that 65 % of the municipal solid waste (MSW) and 75 % of packaging material should be recycled within 2030. There should be a 10 % gradual reduction

of MSW transported to open dump, and disposal of sorted waste shall not be accepted. Otherwise, there are no changes in what type of waste that should be of focus and priority. Currently, the waste categories of priority are plastics (such as marine plastic waste), food waste, critical raw materials, materials from construction industry and bio-products. These changes will affect Norway, as the regional regulations set guidelines for national policies and plans.

According to the Norwegian Environment Agency (NEA) the amount of solid waste in Norway increases as a result of economic growth and higher consumption rates (NEA, 2015b). The amount of waste is increasing more than the GDP (Gross Domestic Product), were the main contribution is from industrial waste. However, during the last decade, the amount of industrial waste has decreased while waste generated by households has increased. In 2013, 22 per cent of the total amount of waste generated in Norway came from private households (see Figure 1). New data were available 25.05.2016, which confirms that the total amount of waste still increases, and that the amount never been as high since Statistics Norway started waste accounting (SSB, 2016a). However, there were no changes with regard to private households and domestic waste.

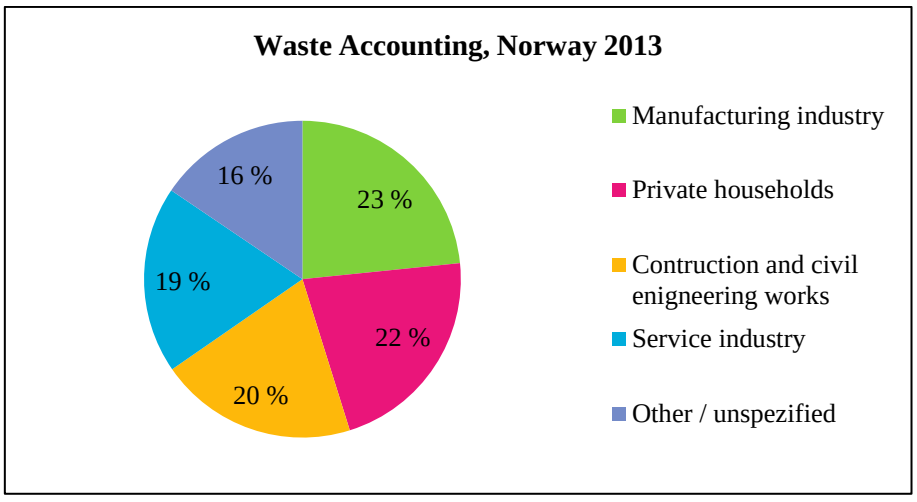

Figure 1: Waste accounting for Norway in 2013 based on data at Statistics Norway (SSB, 2015a)

In September 2015 the UN announced and completed the Sustainable Development Goals (SDG), which replaced the Millennium Development Goals (MDG) from year 2000 (Galatsidas, 2015, UN Department of Economic and Social Affairs, 2015, UN General

Assembly, 2015). The SDGs are the shared agenda and working plan towards a more sustainable world, socially, economically and environmentally. It consists of 17 global goals and 169 targets that all countries are obliged to take into consideration. In a Norwegian context goal 11 are evaluated to be of special concern (Grønningsæter and Stave, 2015), which focus on how to get sustainable cities and communities. Norway does also need to comply with the SDGs and this will in all likelihood influence the various districts and municipalities of Norway, in addition to companies and enterprises. It will also lead to changes in the national goals, initiatives and strategies (UD, 2015).

One of the Norwegian national goals regarding solid waste is that the amount should not increase more than the economic growth. This means that waste generation should decouple from economic growth and increase less rapidly (NEA, 2015b, NEA, 2015c). Proper waste management systems will reduce negative environmental impact and emissions of GHGs, such as methane from disposal of organic waste to an open dump and hazardous waste consisting of chemicals, dangerous substances or heavy metals. At the same time, waste is a resource that can be reused, such as plastics and cardboard.

Topics such as climate change, negative environmental impact, consumption and waste generation, and resource scarcity, are interconnected. The environment has been put at risk due to the social metabolism and transition into industrial societies (Ghisellini et al., 2015, Fischer-Kowalski et al., 2014). Our negative impact on the natural environment and climate has increased significantly since the 1990s (KLD, 2016, Houghton, 2015, IPCC WG3, 2014b). Therefore, a closed loop system, where recycling and reuse are of focus, is crucial and important in order to develop sustainable societies. Proper adaptation and mitigation strategies are to be developed, as increased population will lead to increased amount of consumption, as well as waste. Without proper waste management systems and strategies, including measuring and reporting of performance, both the environment and the human health will be put at risk. To reach the development goals at a global and national level, actions at a local level are crucial as well. Thus, tools to guide the local communities and cities in the right direction will be very useful.

1.2 Topic, Research Questions and Research Issue

In light of current political debates and initiatives on sustainable development of cities and communities as well as on climate change issues, proper strategies to handle the challenges are necessary. One part of such strategies could be performance indicators to measure progress, as well as benchmarking tools to compare results. *"ISO 37120:2014 Sustainable Development in Communities – Indicators for city services and quality of life"* is a standard that could be helpful as a tool regarding these aspects, which will be referred to as ISO 37120 in the study. The standard will be applied and analysed with focus on solid waste (clause 16), with regard to a Norwegian context.

Waste management is a large and complex topic, thus it is necessary to make some limitations and exclusions. The study does not include or consider one specific case with in-depth empirical data. Instead, the focus is on the bigger picture and tendencies with regard to MSW, and mainly domestic waste.

Research questions:

- To what extent could ISO 37120 be useful as a tool in the waste management system and strategies at a local level in Norwegian municipalities?
- Could the solid waste indicators be useful as a tool in the process of making more sustainable and environmental friendly places, as part of reaching the SDGs and towards a circular economy?
- Could ISO 37120 be useful and utilized by Norwegian municipalities as a tool regarding solid waste management and associated environmental challenges, to improve environmental sustainability performance?

Research issue:

ISO 37120 and indicators on solid waste will be analysed and explored, in order to assess its possibility of being applied as a management tool to improve waste management systems and environmental sustainability performance at a local level in a Norwegian context.

1.3 Structure of Thesis

First, methods and the methodological framework of the study are presented. This is illustrated with a research model that shows the various stages and elements that the study consists of. The chapter do also include a literature review, a presentation of the research design and how data material has been collected, as well as a short evaluation of the methodology. Secondly, to express the basic logic of the approach, relevant theoretical resources are emphasized. This includes clarification of terms and definitions, an elaboration on ISO 37120 and clause 16 on solid waste, presentation of relevant laws and regulations, goals and strategies, as well as a description of the environmental impacts and effects of solid waste, and its relation to the human society. Thirdly, a short outline of the empirical data utilized in the analysis is presented. Then, in the fourth part ISO 37120 is analysed and explored. It is separated between a questionnaire analysis and a quantification of the solid waste indicators. Fifthly, the results of the analysis are shortly presented. Thereafter, sixthly, the results are discussed by being connected to the theoretical resources, background and context of the study. Finally, there will be a given some recommendations, followed by a short conclusion and suggestions for further work.

2. Method

To address the research issue, a literature search and review has been conducted, a questionnaire developed and the ISO 37120 indicators on solid waste has been quantified. A methodological framework of the study has been constructed and will be presented below, which aims at visualize the research process. Subsequently, it will be explained how the literature search was conducted, as well as elaborated on what data material, research strategy and research design is chosen. Finally, it will be reflected on the methods that are applied.

2.1 Research Model

In order to illustrate how the study has been conducted, Figure 2 is constructed. The research model below is inspired by one developed by Duane Davis' in *Business Research for Decision Making* (1998). The model is modified and shows five phases and various processes and stages within them. There are three types of arrows which illustrates what kind of connection it is between the processes. The relations are direct, indirect or hypothetical, as illustrated.

The observation phase makes the fundament for the other phases. Interesting and specific facts about the reality were observed, which is directly related to the context of the study. This makes the basis for Chapter 1.1 Background as well as the research issue. Some of these elements are elaborated on in Chapter 3 Theoretical Resources. The concept phase in the model consists of relevant theory and resources, which are included as strategies to address the research issue. This is related to, as well as a result of, the context. As the arrows show, the concepts are also connected to the research issue. The construct consists of an analysis, which is directly related to and a continuation of the concept phase. As an outcome of the construct and the other phases, there is the concluding part. The results are presented, as well as discussed and evaluated, which is connected to the observations and research issue. Recommendations and the concluding paragraph follow from this. As the 'Hypothetical Relations' box shows, all steps are somehow interconnected.

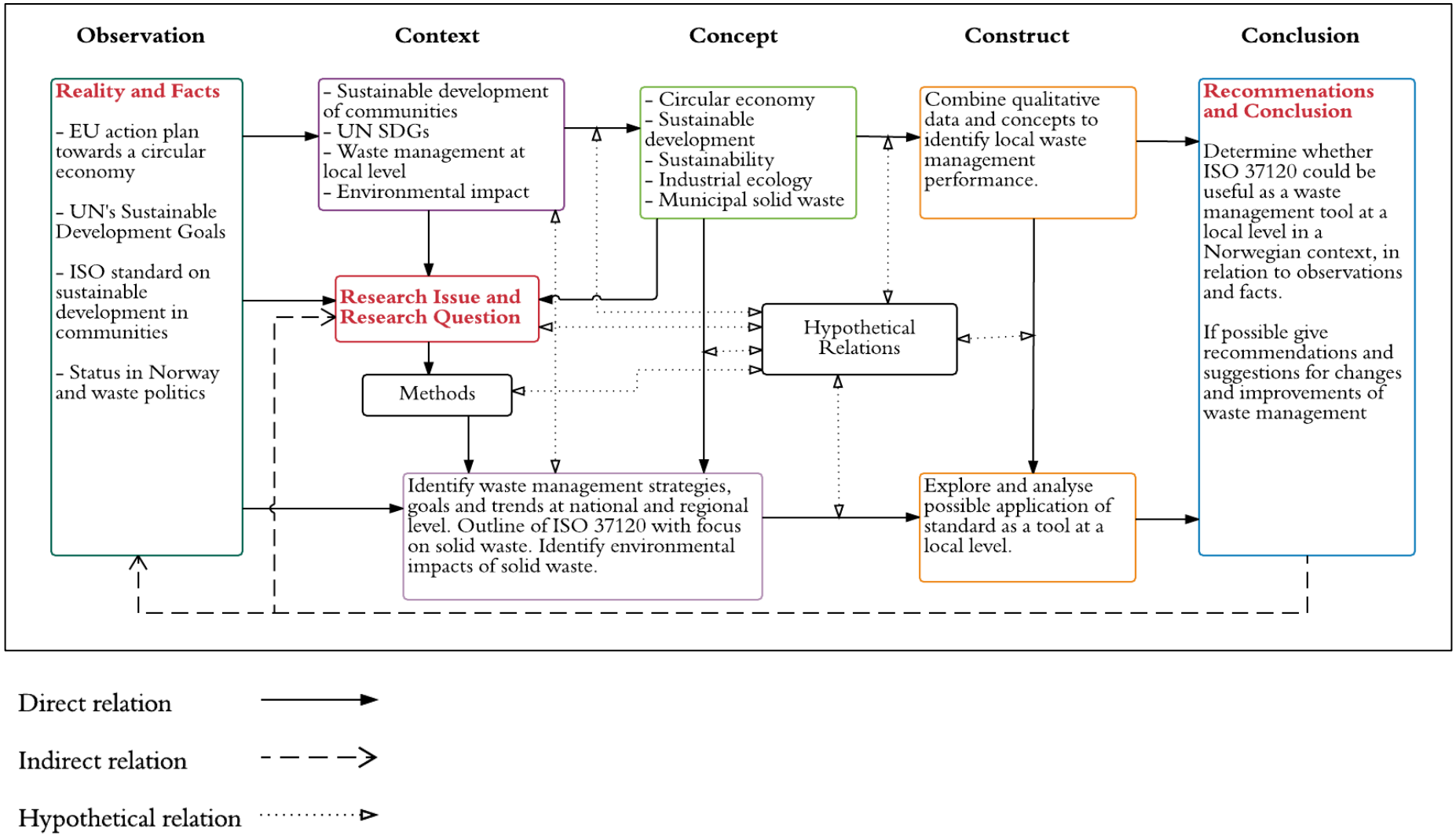

Figure 2: Research Model based on and inspired by Davis (1998).

2.2 Literature Search and Review

Reviewing and searching for existing literature with regard to research topic is a good way to get an overview of what has already been conducted on the area (Bryman, 2008). One will be able to identify what research methods and research strategies have been utilized previously, as well as map out important concepts and theories. How the literature search and review were performed will be explained below.

Definite searches on Oria and Scopus were performed in order to find relevant literature on topics such as waste management and circular economy. Searching for literature, several keywords and truncations were utilized, as shown in Table 1. Results were sorted by 'most relevant' and 'most popular', which is a useful function to find acknowledged and credible articles. As research means to search, and search once again, searches for literature has been performed regularly. When searching for literature, the same keywords were utilized at the two databases to see if different results showed up. Oria and Scopus were chosen as databases as these have been recommended by professors and fellow students. The databases are reliable sources for information, as there are mostly scientific papers that has been reviewed before publication. Table 1 shows how and when the searches were performed, as well as what keywords, truncations and sorting were utilized.

When sorting out what articles and literature were relevant, the title, year of publication and popularity (number of citations) were observed. As research within the topics is continuously changing and developing, number of citations was not the best way of sorting the results. Thus, the most relevant articles have been found by sorting based on relevance, which means that new articles within the topic were found. After importing a number of articles that might be relevant into the reference program and software EndNote, all abstracts were read. Additionally it was looked at the keywords to evaluate what articles should be read more in detail. By sorting out and eliminating some literature, the introduction and conclusion to the remaining articles were read. Table 1 does also show what searches and keyword that did not result in any relevant sources, in addition to relevant literature which will be presented shortly.

Table 1: Overview of the literature search process at Oria and Scopus, including keywords, sorting and relevant findings.

Date	Database / search tool	Keywords	Sorting	Findings
25.01.16	Oria	"waste management" AND "performance indicators"	Relevance	Zaman and Lehmann (2013) [Science Direct]
				Sanjeevi and Shahabudeen (2015) [SAGE]
				Wilson et al. (2015) [Science Direct]
				Huang et al. (2011) [Science Direct]
				Chavez et al. (2011)
				Mendes et al. (2013) [Science Direct]
				Font Vivanco et al. (2012) [Science Direct]
			Popularity	None
		"waste management" AND "performance indicators" AND "Norway"	Relevance, Popularity	Nothing relevant
		"waste management" AND "performance indicators" AND "municipal*"	Relevance	The same results as above (Zaman & Lehmann, Sanjeevi, Wilson etc.)
27.01.16	Scopus	"waste management" AND "performance indicators"	Date, relevance + cited by	Rigamonti et al. (2016)
				Manfredi and Goralczyk (2013)
		"solid waste management" AND "performance indicators"		Nothing relevant
09.03.16	Oria	"Municipal solid waste" AND "management" AND "reporting" OR "audit*"	Relevance + Popularity	Nothing relevant
		"Municipal solid waste" AND "management" AND "reporting"		Nothing relevant
	Scopus	"Municipal solid waste" AND "management" AND "reporting" OR "audit*"		Nothing relevant
19.04.16	Scopus	“circular economy” AND “sustainability	Date Relevance	Sauvé et al. (2016) Ghisellini et al. (2015) Murray et al. (2015)
		“circular economy” AND “sustainable development”	Date Relevance	Nothing relevant
	Oria	“solid waste” AND “environment” AND “impact	Relevance Popularity	Harrison et al. (2007)

The articles and literature in Table 1 were evaluated to be relevant for the study. However, none of the articles considered a Norwegian or Scandinavian context. Most of the literature has a high focus on China, among others due to high industrialization, changes in consumption patterns, rapid urbanization and high increase in municipal solid waste (MSW). Because of this, some articles were excluded. Additionally, some articles and literature were eliminated as the focus was on construction waste and not domestic MSW.

Literature review shows that there are several articles about performance indicators with regard to waste management (Zaman and Lehmann, 2013, Sanjeevi and Shahabudeen, 2015, Wilson et al., 2015, Huang et al., 2011, Mendes et al., 2013, Font Vivanco et al., 2012, Rigamonti et al., 2016). However, none of them mention ISO 37120, which might be because the standard not only considers solid waste but other topics and city services as well. Many are suggesting one or two indicators for specific contexts. Mostly there are cases from Asia (China, Taiwan, Japan e.g.), but also countries in other parts of the world such as Portugal and Mexico. These are places characterized by changes and transformations due to population growth, changes in consumer habits and patterns, density and industrial development. There are relatively new articles on the topic with various local cases, contexts and empirical data.

Life cycle perspective is an important focus in most of the articles and research, were LCA or MFA also has been applied (Rigamonti et al., 2016, Font Vivanco et al., 2012). These methodologies are also crucial in Christensen's *Solid Waste and Technology Management* (2011), which is a relevant book with regard to the study.

Other literature

In addition to articles and published scientific papers, curriculum from previous courses is used, such as the book by Christensen (2011), as well as *Industrial Ecology and Sustainable Engineering* by Graedel and Allenby (2010) and *Global Warming. The complete briefing* by Houghton (2015). Part of the literature was found during the preliminary project, which this study is a continuation of. These articles and searches (more precisely on sustainable development of communities) are not shown in Table 1.

Regarding ISO 37120 specifically, there are not any literature available on the databases. Thus, literature and documents on this standard were obtained from Norwegian

Standardisation (SN) and contacts at NTNU Sustainability. For instance, a research project at NTNU from summer 2015, *Analyse av standarder og indikatorer for bærekraftige, resiliente og smarte samfunn, anvendt for Trondheim Bylab*, has been useful (Hov, 2015).

As topics such as circular economy and sustainable development are of current interest by policy makers, literature and sources has also been derived from EU's webpages, Norwegian Waste Management and Recycling Association (NWMRA) and publications by the Norwegian Environment Agency and the Norwegian Ministry of Climate and Environment.

2.3 Research Design and Data Material

There are two distinctive research strategies within social research that can be selected when gathering data material and information. It is the qualitative strategy that is based on empirical data and the quantitative strategy, which describes the reality in numbers and values (Ringdal, 2007, Bryman, 2008). These strategies can also be combined, and then it is called a mixed methods research strategy, which is chosen for this study. However, mainly a qualitative research strategy is applied and a case design. A questionnaire has been developed and interviews have been performed to get primary data. Already existing official data material, secondary data, has also been collected and analysed, in order to quantify the performance indicators on solid waste in ISO 37120.

According to Ringdal (2007) and Bryman (2008), a single case study or comparative case study can for instance examine and explore families, companies, local communities or countries. In this research several local communities and waste management agencies in Norway are part of the study, to explore if ISO 37120 could be useful as a tool. Thus, the research design is a variation of a comparative case study. As it consists of a qualitative questionnaire, interviews and collection of public data, it can be classified and identified as a triangulation (Ringdal, 2007). There is a combination of quantitative and qualitative data, but as the quantification means at illustrate how the standard can be applied, the research strategy is mainly qualitative. In what follows, how and why the questionnaire was constructed will be presented, as well as who responded to it. Then, the quantification process of solid waste indicators in ISO 37120 will be explained and what data material collected from Statistics Norway that were utilized. But first, it will be expanded on the interviews and personal communication that was important when conducting the study.

2.3.1 Interviews and personal communication

When conducting a qualitative study, techniques and research methods to collect data could be interviews and conversations by telephone or visit (Ringdal, 2007). For this study, contact was established with the municipalities Asker, Drammen, Bergen and Oslo, by sending emails to the administration. This resulted in contact with persons with various positions within local waste management. Semi structured interviews (Bryman, 2008) by telephone were performed with three of these informants, representing the municipalities Drammen, Asker and Bergen. The interviews were based on questionnaire results and quantification of indicators, for further elaboration. Gjerdrum kommune and Oslo kommune were also contacted for an interview, but did not respond. Additionally, the Norwegian Environment Agency was contacted, as well as Trondheim kommune and Bærum kommune. None of these responded.

Contact was established with the Norwegian Waste Management and Recycling Association (NWMRA, Avfall Norge) who is "*coordinating and maintaining municipal interests and inter-municipal cooperation in the waste management sector*" (Elvestuen, 2016). They are doing research, mapping the waste sector operations, promoting and developing waste management policies and function as a resource for private companies and public services with industry-specific knowledge. For this study, NWMRA was helpful with developing the questionnaire and sharing it with contacts in the waste management industry. Additionally, the email correspondence and interview was useful in order to get an overview of the waste sector and current political actions and trends.

Through email correspondence and interview, contact were established with Norwegian Standardisation (SN, Standard Norge) as well. Norwegian Standardisation is member of the International Organization for Standardisation (ISO) and is responsible of standardisation processes in Norway within various scientific areas, such as waste management (Tveter, 2016a). They are developing and publishing Norsk Standard (NS). Contact with Norwegian Standardisation was beneficial to get more information on ISO 37120 that were utilized in the questionnaire.

Through personal communication with Statistics Norway (SSB) issues regarding the information- and reporting system KOSTRA (Kommune-Stat-Rapportering) were explained. Statistics Norway is responsible of collecting and analysing data on various areas within the

society, such as local waste management. All authorities at the municipal level are obliged to report specific data through KOSTRA (see Chapter 3.3.2). As a reporting and information system, the local authorities reports data to the government, such as data with regard to waste management activities.

2.3.2 Questionnaire

According to Ringdal (2007), surveys are the most common research strategy within the social sciences and are a systematic method to collect data from a sample of companies and organizations. A survey was developed as a self-completion questionnaire to be filled out digitally. In order to get subjective responses and results, developing a questionnaire were evaluated to be a suitable and relevant way of mapping waste management strategies at local level. It was necessary to collect information and data from different municipalities and agencies, to get a representative sample of informants and results. All respondents answered the same questions (see Appendix A. Questionnaire and Summary of Responses). The questionnaire was developed using Google Forms and were divided into two sections with 17 questions in total. One section contained questions with regard to local waste management strategies and the second about international standards, and mainly ISO 37120.

The respondents were chosen strategically and not as a random sample. As the local authorities are responsible by law of management of municipal waste (see Chapter 3.3.2), it was reasonable to send the questionnaire to them. Additionally, several local waste management agencies responded as well, who has the assigned and practical responsibility. In general, all respondents are somehow connected to local waste management, either strategically or practically. Thus, both agencies and authorities are chosen as respondents in order to get more width to the sample. The questionnaire was first sent to the local authority administration in seven different municipalities, were two did not respond (Trondheim and Bærum kommune). Some of the local authority administrations sent the request and questionnaire forward to the local waste management agency. The questionnaire were also sent forward through Håkon Bratland, Scientific Advisor in the NWMRA, who sent it to ten different waste management agencies, to either senior managers or department managers. Some of the managers forwarded it further to the local authorities.

2.3.3 Quantification of indicators

As a way of exploring ISO 37120 the performance indicators within solid waste are quantified. The purpose is to illustrate how the standard can be applied, and determine whether it can be applied properly based on existing, available data. In order to quantify the indicators, data material has been derived from Statistics Norway and KOSTRA. Audited data for the period 2012 to 2014 were utilized, as well as unaudited data by 09.04.2016 for year 2015. These data made the basis for the quantification. Four municipalities were selected for quantification, which were Oslo, Bergen, Drammen and Asker (see Chapter 4.3). A four year time span was chosen in order to observe the performance over time.

In ISO 37120 it is described and defined how to calculate the indicators, and what parameters and data material to use. All quantification parameters utilized can be seen in Appendix D. The quantification process was as follows:

1. Literature search: Checking Hov's report (2015) and how the quantification of indicators for Trondheim were performed and what data material were applied
2. Structuring the solid waste indicators and the parameters utilized for calculation
3. Required data, in terms of the descriptions and parameters, were collected using SSB / KOSTRA. Data were collected for year 2012 until 2015 (e.g. total population, average household size, total amount of solid waste) for four different communities / municipalities in Norway (see Appendix D. Quantification Parameters)
4. Using parameters and calculating results in terms of indicator descriptions as formulated in ISO 37120 (see Table 12 in Chapter 5.2.1)
5. Analysing results by comparing them and making illustrative graphs and tables

2.4 Evaluation and Reflection of Methods

The triangulation is evaluated to be a good way of addressing the research issue. Primary data has been gathered through a questionnaire and interviews, as well as already existing data has been applied. As the standard consists of indicators it was inevitable to quantify them, as a way of determine possible application. The questionnaire gives subjective responses on questions about local waste management strategies in a standardized way, as all respondents answered the same questions. The aim of developing a questionnaire was to map out whether it would be interesting and useful to the communities to apply the standard as a tool. In order to have various degrees of proximity and presence, interviews by telephone and visits were performed as well (Ringdal, 2007). The latter would also give more in depth responses and give the respondents the opportunity to express and communicate aspects and perspective that

were not possible through the questionnaire. Even though the triangulation is considered to be an appropriate method, there are some weaknesses. It will be reflected more on each method in the following sections.

In order to keep the precision in terms, responses, institutions and positions, some tables and figures related to the qualitative research will be in Norwegian. The informants were all Norwegian and the study addresses a Norwegian context. Hence, it is presumed that the study mainly will be read by Norwegians. In other tables and figures the information will be translated into English, if it is evaluated to be beneficial and appropriate. Some will also be in both languages. In the Appendices as well, the language is a combination of the two, but mainly Norwegian.

2.4.1 Interview and personal contact

The interviews performed were mostly technical and not sociological. This means that the intention and aim with performing them, was to collect informative data about specific issues. Three interviews were carried out over the telephone and two through face-to-face meetings. Overall, this research method is evaluated to be a beneficial way of collecting data, due to its flexibility and semi-structured nature. It enables conversations and in-depth interview.

Due to long response time, contact by email is evaluated to not be the most efficient way of getting information and communicate with relevant persons. Several emails have been sent (to local authorities, to the Norwegian Environment Agency and NWMRA) with long response time or without any response at all. Additionally, general requests to local authorities indicate that it is beneficial and more efficient to identify the one who should respond.

2.4.2 Questionnaire

The questionnaire was developed in a way to make it easy for the respondents to answer. This means that there was minimal ‘open answers’, but instead already formulated response categories. Each question did also have a response category called ‘other’, which made it possible to the respondent to write their own answer or make a comment if none of the categories were suitable. Additionally some questions were having the Likert scale in a horizontal format. By making the questionnaire this way, it was presumed that there would be more respondents, as it would take less time to respond to it. Also, the respondents did not

need to formulate many sentences themselves. Other positive effects of a questionnaire are that all respondents get the same questions, which enable stable conditions. Additionally, as it were to be filled out digitally the respondents were flexible when filling it out. The respondents were only able to skip a few questions, but most of them were mandatory.

However, it was expressed by several local waste management agencies that it probably would be most beneficial and useful if the local authorities responded. At the same time some local authorities evaluated it the opposite way and forwarded the request and questionnaire to the local waste management agency. It is presumed that this is the reason why Trondheim and Bærum did not respond, due to confusions about who should. This indicates that it would have been beneficial if it was specified who should respond to the questionnaire, in order to avoid confusions.

General weaknesses with a questionnaire, according to Bryman (2008), are for the respondent being prompt and probe. It is not possible to help the respondents when answering the questions, neither to ask the respondents to elaborate an answer. Thus, interviews were performed as well.

2.4.3 Quantification and application of standard and indicators

When applying clause 16 in ISO 37120 and using the indicators and descriptions on calculations, the main challenge where the distinctions and variations in definitions. In the KOSTRA system municipal waste is synonymous with waste generated by households. The definition developed by ISO does also include waste from institutions. Thus, data and numbers derived from KOSTRA do not include and are not based on the same information which is demanded and asked for by ISO 37120. This means that the quantification shows information based on household waste, were car wreck is included as well. Thus, the quantification results would be different if other data where utilized.

Additionally, information with regard to two parameters was not available at KOSTRA. There was also some confusion regarding what KOSTRA data to apply, as it is a quite comprehensive system with 87 performance indicators on solid waste only (SSB, 2015d). It is separated between waste delivered and disposed to material recycling, composting, biogas, incineration, waste disposal site and other treatment (waste that is disposed by other means).

3. Theoretical Resources

Theoretical resources of relevance for the study will be presented in this chapter, which sets the theoretical background and the basis for the study. First, important terms and concepts will be clarified, followed by an outline of ISO 37120 and other standards of relevance. Then, laws, regulations and directives, as well as goals, strategies and trends at national and regional level will be emphasized. Finally, it will be elaborated on environmental impacts of waste, and its interconnection with human society.

3.1 Terms, Concepts and Definitions

As terms may have different definitions and meaning depending on the context it is applied, as well as who uses it, some terms relevant for the study will be clarified. It is important that terms are described and defined, on order to have a common understanding of them (Christensen, 2010). Thus, Table 2 has been constructed. Additionally, some of the terms will be discussed more in detail below.

Table 2: Terms and definitions applied in the study, sorted alphabetically.

Terms	Definitions	Source
Circular economy	Turning waste into resources by re-manufacture, reuse or recycling.	(EC, 2016)
City	Urban community falling under a specific administrative boundary, commonly referred to as a city, municipality or local government	(ISO/TC 268/WG 2, 2015)
Community	Group of people with an arrangement of responsibilities, activities and relationships.	(ISO/TC 268/WG 3, 2015)
Domestic waste	Waste generated by private households	
Environment	Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interaction.	(ISO/TC 268/WG 3, 2015)
Hazardous waste	Waste that is potentially harmful to human beings, property or the environment, plants and animals. A waste shall be defined as hazardous if it shows one or more of the following characteristics: toxicity, flammability, corrosivity or reactivity. They can be in any form – liquids, solids, gases (in containers), or sludge and are produced by manufacturing processes, the chemical industry, the petroleum industry and other industrial sectors. Examples include acids, alkilis, solvents, medical waste, resins, sludge and heavy metals. Hazardous wastes are the substances that require special technologically advance methods of disposal to render them harmless or less dangerous to humans and the environment. Hazardous waste must be treated, stored, and disposed of properly at designated sites. Most hazardous wastes are	(ISO/TC 268/WG 2, 2015)

	eventually disposed in landfills, surface impoundments (which eventually become landfills), land application units, or by deep well injection.	
Indicator	A qualitative, quantitative or descriptive measure.	(ISO/TC 268/WG 2, 2015)
	"An indicator is something that is devised or already exists and that is employed as though it were a measure of a concept. […] Indicators may be direct or indirect in their relationship to the concept for which they stand".	(Bryman, 2008)
Industrial ecology	An approach to the design of industrial products and processes that evaluates such activities through the dual perspectives of product competitiveness and environmental interactions	(Graedel and Allenby, 2010)
Life cycle	Consecutive and interlinked stages of a product system from raw material acquisition or generation from natural resources to end-of-life treatment. Life cycle includes activities, products and services and may include procedure good and services as well as end-of-life treatment of products and delivery of services, for example design, manufacture, transport, packaging and end-use or disposal.	(ISO/TC 268/WG 3, 2015)
Management system	Set of interrelated or interacting elements of an organization to establish policies and objectives and processes to achieve those objectives. A management system can address a single discipline or several disciplines. The system elements include the community's structure, e.g. roles and responsibilities, planning, operation, etc. The scope of a management system may include the whole community, specific and identifies functions in the community or one or more functions across a group of organizations falling under the aegis of a community.	(ISO/TC 268/WG 3, 2015)
Measurement	Process to determine value	(ISO/TC 268/WG 3, 2015)
Monitoring	Determining the status of a system, a process or an activity	(ISO/TC 268/WG 3, 2015)
Municipal solid waste	According to the Pollution Control Act this would mainly be waste from private households – domestic waste.	(KLD, 1981)
	Waste collected by or on behalf of municipalities. Waste flows managed under the responsibility of the local administration including waste collected on behalf of the local authority by private companies or regional associations founded for that purpose. MSW does not include waste from municipal sewage network or treatment, or municipal construction and demolition waste. MSW should include waste originating from: - Households - Commerce and trade, small businesses, office buildings and institutions (e.g. schools, hospitals, government buildings - Bulky waste (e.g. white goods, old furniture, mattresses) - Garden waste, leaves, grass clippings, street sweepings, the content of litter containers, and market cleansing waste, if managed as waste - Waste from selected municipal services, i.e. waste from park and garden maintenance, waste from street cleaning services (e.g. street sweepings, the content of litter containers, market cleansing waste), if managed as waste	(ISO/TC 268/WG 2, 2015)
Performance indicators for sustainable development	Quantitative, qualitative or descriptive measures to periodically assess the performance of a city referring to its Sustainable Development. The indicators provide information about the condition of the sustainable development of a city. Indicators are intended to explain how the	(ISO/TC 268/WG 2, 2015)

	development in cities is changing over the time. Performance is a measurable result.	
Recycling	Recycling is the use of the materials in the production of the same or similar products that were the origin of the waste material. Recycling uses the original material characteristics of the waste. In recycling, waste substitutes for virgin production of the same material. [...]	(Christensen, 2007)
	Recycled materials shall denote those materials diverted from the waste stream, recovered, and processed into new products following local government permits and regulations.	(ISO/TC 268/WG 2, 2015)
Solid waste	"Med avfall forstås kasserte løsøregjenstander eller stoffer. Som avfall regnes også overflødige løsøregjenstander og stoffer fra tjenesteyting, produksjon og renseanlegg m.v. Avløpsvann og avgasser regnes ikke som avfall". It is distinguished between "næringsavfall" (waste from public and private institutions and enterprises), "husholdningsavfall" (waste from private households) and "spesialavfall" (waste that can not be treated together or in the same way as the other categories, due to size, pollution or danger).	(KLD, 1981)
	Non-soluble, discarded solid materials, including sewage sludge, municipal garbage, industrial wastes, agricultural refuse, demolition wastes and mining residues.	(ISO/TC 268/WG 2, 2015)
	Waste is material thought to be of no practical value. One of the goals of industrial ecology is the reuse of resources, and hence the minimization of material regarded as waste.	(Graedel and Allenby, 2010)
Sustainability	State of the global system, including environmental, social and economic aspects, in which the needs of the present are met without compromising the ability of future generations to meet their own needs. The environmental, social and economic aspects interact, are independent and are often referred to as the three dimensions of sustainability. Sustainability is the goal of sustainable development.	(ISO/TC 268/WG 3, 2015)
	Triple bottom line. People, Planet, Prosperity.	UN SDG-report
	In the context of industrial ecology, sustainability is the state in which humans living on Earth are able to meet their needs over time while nurturing planetary life-support systems.	(Graedel and Allenby, 2010)
Sustainable development	The Brundtland report: "Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs".	(WCED, 1987)
	IPCC: Economic growth, protection of the environment, social equity and justice	(IPCC WG3, 2014a)
	ISO: Development that meets the environmental, social and economic needs of the present without compromising the ability of future generations to meet their own needs.	(ISO/TC 268/WG 3, 2015)

3.1.1 Municipal solid waste

There are various definitions on MSW, which differ from countries (Christensen, 2011). What is included as MSW varies, but as stated by Christensen it "*typically ranges from waste arising from private household to that managed by or on behalf of local authorities from any source*" (2011:10). MSW can for instance include park and garden waste, street sweepings

and litter, waste from institutions, commercial establishment and offices, construction and demolition waste, sewage sludge, in addition to household waste (2011). ISO are consistent with terms and definitions and aims at establishing a common understanding of them. Hence, according to the ISO 37120 definition MSW do not include waste generated from municipal sewage network and treatment or waste from municipal construction and demolition processes (ISO/TC 268/WG 2, 2015). As stated in the Norwegian Pollution Control Act, MSW is synonymous with domestic waste (KLD, 1981). In this Act it is separated between waste from public and private institutions and enterprises (næringsavfall) and waste from private households (husholdningsavfall). Additionally there is waste that is not part of any of the other categories, as it can not be treated together- or in the same way due to size, danger and pollution (spesialavfall) (2015b).

3.1.2 Waste management

Combining the definitions of solid waste and management systems, waste management can be described as a set of interrelated elements of an organization to establish policies, objectives and processes with regard to handling of solid waste. The scope may vary, and for this study the strategic level in the community is the focus, in terms of monitoring of performance.

3.1.3 Sustainable development

In the study, the focus will be on the environmental dimension of sustainability and sustainable development, which is called ‘planet’ in UN SDG agenda (UN General Assembly, 2015). This includes the perspectives of sustainable consumption as well as sustainable production and management of resources, which is connected to waste generation and management.

3.1.4 Industrial ecology

By taking ecological principles into industrial processes one will have a life cycle- and circular perspective. The ecological analogy illustrates that natural systems perspective are transferred into industrial ones, by focusing on symbiosis, interconnected relations and efficiency. This principle is important regarding waste management as well, in terms of sustainable handling of resources through recycling and reuse. LCA is an analytical tool that is an important part of the industrial ecology (IE) discipline. Waste is produced at all stages

throughout a products life cycle, such as the resource extraction phase, during production, use phase and at the end of life stage (EEA, 2016). Thus, the IE concept, perspective and discipline are important in order to optimize the systems as well as closing them (closed loop systems) through reuse and recycling. It makes more efficient and sustainable and environmental friendly processes. IE emphasize the importance of taking into consideration the indirect emissions and impact throughout the lifecycle of a product or service.

The term is related to industrial symbiosis which means that there are a mutual beneficial interaction and relationship between participants exchanging materials, energy or information (Graedel and Allenby, 2010). IE considers industrial systems and their interaction with the environment and surroundings, such as of flows of material, energy, information. Hence, it includes both input (resources and services) and output (emission) to the system (Ghisellini et al., 2015). IE is also defined as a sustainability science (Sauvé et al., 2016) that focuses on addressing environmental challenges, problems and aspects through trans-disciplinary research.

3.1.5 Circular economy

Circular economy (CE) can be described as industrial ecology (IE) in practice as both focuses on a life cycle perspective and closed loop systems (Ghisellini et al., 2015). Additionally both perspectives call for a smart, inclusive and sustainable economic growth (EC, 2014b). CE is actually rooted in IE besides environmental and ecological economics (Ghisellini et al., 2015). According to Ghisellini et al., who did an extensive review on CE literature and research, the aim of CE is to increase the overall resource efficiency, in order to decouple economic growth from environmental challenges and pressure. By aiming at achieving a balance between environmental, economic and social aspects, circular economy can be seen as an approach towards development of more sustainable societies. On the other hand, some are claiming that the CE concept are missing the social dimension of sustainability as it focuses more on the economic and environmental aspects (Murray et al., 2015). Therefore, Murray et.al suggested a new definition on CE, which explicitly includes the human dimension:

> "*The Circular Economy is an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being*" (2015:1).

CE is not only about clean production, reuse and recycling of materials, but also shared responsibility and awareness, renewable and clean energy sources and technologies, as well as proper policies and tools. CE is a model for economic development and growth that focuses on the processes production, circulation and consumption, and the interplay between economic and environmental systems. It is the opposite of a linear economy, which is characterized by a "throwaway" culture (Ghisellini et al., 2015). It is not a new concept and approach to development, as it started to emerge in Germany in the middle of the 1970s. However, through regional waste directives and action plans, CE has had an upturn especially the last decade, as a response to increasing waste management challenges globally. Waste management is an important part of the circular economy. CE is still developing and at an early stage considering implementation.

3.1.6 Final reflections

Some of the terms and concept described above overlap as they share the importance of addressing environmental challenges. However, all of them could contribute and be useful when finding solutions with regard to the challenges and problems that our society and planet are facing (Sauvé et al., 2016).

3.2 Standards and Indicators

The standard applied and explored in the study will be presented, as well as the indicators within the solid waste clause. Additionally, some national standards with regard to waste management will shortly be described.

3.2.1 ISO 37120:2014 Sustainable Development in Communities – Indicators for city services and quality of life

The International Organization for Standardization (ISO) has developed a standard to help communities in measuring sustainability performance. ISO 37120 contains a list of 100 indicators within 17 clauses (ISO/TC 268/WG 2, 2015). The standard was developed in order to have international, standardized and consistent indicators, to make comparison across cities and time feasible (ISO/TC 268/WG 2, 2015). According to ISO, already existing indicators were not. Solid waste is one of the topics were resource efficiency and resource use in cities is emphasized. In what follows the aim and purpose of this standard will be presented, as well as

its structure and applicability. Thereafter, the focus will be more precisely on clause 16 and solid waste.

Aim and Purpose

The intention of developing ISO 37120 was to make a universal framework on how to create smart, sustainable and resilient cities and communities (Hov, 2015). Through an integrated and holistic perspective that considers the whole city system, including subsystems with various functions and services, the standard aims at helping and supporting communities (ISO/TC 268/WG 2, 2015). The standard may function as a supportive tool to help cities reaching their respective goals. The standard can help monitoring and tracking performance, progress and development of city services and quality of life over time. Besides measuring and monitoring performance and achievements, ISO 37120 can also be used as a tool in planning and target setting. Additionally, it can also be useful in elaboration of strategies for sustainable development in order to depart from business as usual (ISO/TC 268/WG 2, 2015, ISO/TC 268/WG 1, 2015).

By making such a framework, cities and communities around the world will have the same understanding of relevant concepts and terms, as it is developed a vocabulary with descriptions and definitions that is related to the standard (ISO/TC 268/WG 3, 2015). Comparison between cities on how they perform will be feasible, which previously has been challenging due to variations in indicators and measurement procedures. By implementing ISO 37120, it will also be easier for cities and communities to learn from each other and share experiences and best practice, across a wide range of performance indicators.

Structure

ISO 37120 consists of three types of indicators (ISO/TC 268/WG 2, 2015). First, there are core indicators, which “shall” be applied when implementing the standard. Secondly, supporting indicators “should” be applied and are thus optional. For each indicator there are certain criteria and requirements on how to calculate and measure them, and when implementing the standard one shall report on the indicators in accordance with these descriptions. The city or community is responsible for gathering the data that is needed (ISO/TC 268/WG 3, 2015). The core and supporting indicators of ISO 37120 are categorized within the following themes and clauses: economy, education, energy, environment, finance,

fire and emergency response, governance, health, recreation, safety shelter, solid waste, telecommunication and innovation, transportation, urban planning, wastewater and water and sanitation.

The third type of indicators is utilized to provide background information and statistics about the community. The profile indicators *"(...) provide basic statistics and background information to help cities determine which cities are of interest for comparisons (...)"* (ISO/TC 268/WG 2, 2015). The profile is determined based on indicators within five categories: people, housing, economy, government and geography, and climate (see Appendix G. List of Profile Indicators). Hence, the community's informative reference will make peer comparison feasible by matching up communities with similar profile. For this study, the profile indicators are not quantified, which it should be when implementing the standard.

Applicability

ISO 37120 is not only applicable to cities. Municipalities and local governments could take advantage of this framework as well (ISO/TC 268/WG 2, 2015). As it is an international standard not all indicators might be as relevant in one context as in another one. Hence, the standard should be adjusted to local communities' strategies and targets, as various contexts have different challenges, opportunities, qualifications and needs. Hov (2015) did an analysis on the applicability and relevance of this standard with regard to Trondheim kommune, and found that some indicators were less relevant. In the project, which this study is a continuation of, Stjørdal kommune were the case municipality (Hage, 2015). In terms of Stjørdal, urban residential development and associated environmental challenges were the main focus, as these were challenges the municipality were facing. In this regard it was assessed whether ISO 37120 could contribute in improving Stjørdal's environmental sustainability performance, or not. Results showed that at that point of time, the standard could not be properly implemented as a tool, due to unclear and unspecific goals and targets, which were evaluated to not be measurable. Hence, the standard could be useful as a tool to concretize these goals, and to be an inspiring resource.

ISO 37120 can be also used in combination with other international standards, such as the management systems offered by *"ISO 37101 Sustainable development and resilience of communities – Management system"*, *"ISO 37150 Smart community infrastructures"*, as well

as *"ISO 14001 Environmental management systems"* (ISO/TC 268/WG 1, 2015). In ISO 37120 there are no guidelines in terms of reporting and auditing. Hence, it might be beneficial and useful to combine it with other standards.

Solid Waste

In clause 16 in ISO 37120, solid waste is emphasized and the topic of concern. In total it consist of ten indicators, were three of them are core and the rest are supportive (see Table 3). Waste management is important with regard to the sustainability of a city, as it influence and contribute to public health, the local economy, the environment as well as the social understanding and education (ISO/TC 268/WG 2, 2015). In general, it influences the city health, the cleanliness and quality of life.

> *"A proper solid waste system can foster recycling practices that maximize the life cycle of landfills and create recycling micro-economies; and it provides alternative sources of energy that help reduce the consumption of electricity and/or petroleum based fuels"* (ISO/TC 268/WG 2, 2015:47).

Table 3: List of solid waste indicators in clause 16 in ISO 37120, showing which are core and which are supportive to apply.

16.1	Percentage of city population with regular solid waste collection (residential)	Core
16.2	Total collected municipal solid waste per capita	Core
16.3	Percentage of city's solid waste that is recycled	Core
16.4	Percentage of the city's solid waste that is disposed of in a sanitary landfill	Supportive
16.5	Percentage of the city's solid waste that is disposed of in an incinerator	Supportive
16.6	Percentage of the city's solid waste that is burned openly	Supportive
16.7	Percentage of the city's solid waste that is disposed of in an open dump	Supportive
16.8	Percentage of the city's solid waste that is disposed of by other means	Supportive
16.9	Hazardous Waste Generation per capita (tonnes)	Supportive
16.10	Percentage of the city's hazardous waste that is recycled	Supportive

To each indicator there is added information about its importance, on what is calculated as well as how it shall be calculated. Additionally, there are notes on data sources and data interpretation, information on what type of waste should be included and other requirements. For instance, waste from municipal construction and demolition is not included, as well as municipal sewage network and treatment. In Table 5 in Chapter 3.5.3 an overview of various disposing methods and the environmental consequences related to each of them, are presented. The table does also include composting and transport, which is not part of the solid waste indicators in ISO 37120.

3.2.2 National standards

Standardisation Norway has developed a few standards with regard to waste management, and two of these will be described shortly. The first one is *"NS 9431:2011 Klassifikasjon av avfall"*. This standard includes a detailed list with descriptions and explanations on various waste categories, as well as information about waste registration and reporting. It was developed due to need for standardized waste classification with regard to reporting and waste statistics. NS9431:2011 is utilized in waste statistics to compare quantity across national districts and waste handling plants. The second standard is *"NS 9432:2014 Avfall – Tilrettelegging av renovasjonsløsninger og utførelse av innsamling. Krav og anbefalinger"*. As guidance for local authorities and waste management agencies, this standard can help in planning for waste treatment solutions. The aim is to establish consensus on waste management systems and related issues. In includes several requirements, such as the size of trash cans and garbage truck accessibility.

3.3 Laws, Regulations and Responsibility

With regard to waste management there are certain laws and regulations at national and regional level that must be considered and respected. At the national level the Pollution Control Act (Forurensningsloven) and the Waste Regulations (Avfallsforskriften) are of special importance and at regional level certain waste directives. The regional, national and local levels are connected. In what follows it will be expanded on the laws and regulations that are most relevant and important with regard to the study. The focus will be the national and municipal level, but regional is included as well in order to identify its relation and interconnection, as part of an overall context.

3.3.1 Regional level

At the regional level EU is setting legally binding targets to improve the waste management performance and practice. Through waste directives and decisions, all members of the region are informed about principles and requirements, which guides national policy and regulations (EU, 2008, Christensen, 2011). The legislation functions as drivers to improve waste management in Europe, to stimulate innovation in recycling, limit the use of landfilling, as well as creating incentives to change consumer behaviour (EC, 2016). EU is developing

reports on solid waste, evaluating waste issues, developing performance indicators and doing political analysis.

Directive 2006/12/EC on waste sets the legislative framework for handling and managing, recovery and disposal of waste, while Directive 2008/98/EC focuses on resource efficiency and how to protect the environment and human health (EU, 2008). There are focus on recycling and reuse of products and materials, as well as limiting the use of landfilling (EC, 2016). The directives ensure that waste management systems do not harm the environment, and includes definitions, plans and programs, criteria and requirements. For instance, it is put requirements on producers and their responsibility. According to Christensen (2011:52), *"the waste sector is one of the most regulated sectors in modern society"*.

The EEA (EØS) agreement is also relevant, which emphasizes cooperation on environmental policy by having common regulations and laws in region, for instance regarding solid waste and waste management. These regulations have immediate effect and impact on national politics, and national authorities. Norway is for instance contributing to ambitious waste policies. In Chapter 3.4, specific goals, strategies and trends in the union will be presented, which are based on and connected to the EU legislative framework, its directives and decisions.

3.3.2 National and municipal level

The national framework on waste management is based on EU legislation and directives, such as what the recycling rate should be. Thus, Norwegian politics are interconnected to the regional, European regulations and directives (KLD, 2016). In Norway, the Ministry of Climate and Environment has the main responsibility of the waste management policy, while the Norwegian Environmental Agency administers and manages this policy and set of rules. At the local level, the country governor is the head of responsibility, besides the municipal authorities who are responsible of waste management systems and strategies with regard to domestic waste (KLD, 1981, NEA, 2013, KMD, 2008). The national frameworks, goals and guidelines that are created, must be followed by the municipalities. In Norwegian waste politics there are certain fundamental principles, such as the waste hierarchy. Other principles are the precautionary principle, the cradle to grave principle, the polluter pays principle, the

principles of management-effectiveness and cost-effectiveness, as well as the principle of social profitability.

Domestic waste

As stated in the Norwegian Pollution Control Act, the municipalities and local authorities are responsible of collecting waste generated by private households (KLD, 1981). They shall continuously manage and follow-up issues regarding waste and waste treatment, and arrange and establish a waste management system that treats various types of waste (NEA, 2015a). The local authorities are responsible of establishing a waste management system and making decisions on treatment, disposal, source separation and location (Christensen, 2011).

The Pollution Control Act was first published in 1981, and one of the chapters addresses solid waste and waste management specifically. The overall aim of the act is to promote waste reduction, acceptable and effective waste management systems, as well as environmental protection. Besides this act, there is also the Pollution Regulations, which contains more specific requirements regarding pollution control (KLD, 2004a). Other national regulations of relevance, is the Waste Regulations. The local authorities may develop and define their own regulations, containing specific information, requirements and instructions on management of MSW in that area (KLD, 1981), such as how the waste should be gathered, transported, stored and handled.

Commercial waste is also part of the local authorities' area of responsibility. The businesses that are responsible for the commercial waste generation might be instructed to report to the local authorities. Industries and enterprises in the area can also, by agreement with the local authority, subscribe to get their waste collected by the waste management agency. This does normally depend on what kind of waste is generated, the waste category.

Other Norwegian laws and regulations which are directly or indirectly relevant to MSW:

- Planning and Building Act
- Municipal Health Service Act
- Infection Control Act
- Product Liability Act
- Protection Against Fire and Explosions Act
- Second-Hand Goods Act
- Competition Act
- Public Affairs Act
- Environmental Information Act
- Freedom of Information Act
- Public Administration Act
- Working Environment Act

Financial responsibility

The local authorities (LA) do also have the economic and financial responsibility and power. In Norway, private citizens and house owners are obliged to use the waste collection system offered by the LA in the area, and thus to pay a fee to cover the running cost for operation and maintenance (Christensen, 2011). As the polluter pay principle is part of the national environmental legislation, as well as the European, inhabitants are paying a fee to the LA in order to get the waste handled properly. The waste disposal companies themselves do not profit on the waste treatment, and are private agencies hired by the authorities for collection, transportation and treatment of the domestic waste. This means that the fee shall not be higher than the waste management costs.

KOSTRA and reporting of waste data

In Norway each municipality and district are obliged to report annually on information about resource use, services, activities and management in terms of the Local Government Act (KMD, 2009, KMD, 1992). This is done through a national information system called KOSTRA (Kommune-Stat-Rapportering). The data is officially available at Statistics Norway (SSB). Through this information system, one will for instance be able to assess whether one is close to reaching the national or local goals and targets, or not. It contributes to openness and transparency among the LAs, and also maps out where the focus should be in the future to improve and develop in a sustainable direction. The information system KOSTRA makes comparison among municipalities and districts feasible, within various areas of concern. Through KOSTRA, the LAs do also report on specific performance indicators regarding municipal waste management. The local waste management agencies (WMA) report data on domestic waste to the LA.

3.4 Goals, Strategies and Trends

With regard to solid waste there are certain goals, strategies and trends at global, regional and national level, which will be of concern in the following section.

3.4.1 Global level and the UN SDGs

As mentioned in section 1.1 Background, UN completed the Sustainable Development Goals (SDG) in September 2015. The SDGs consists of 17 global goals (as Figure 3 illustrates), and 169 targets that all countries are obliged to take into consideration. The SDGs are the shared

agenda and working plan on the way to a more sustainable world, socially, economically and environmentally. In the action plan towards reaching the SDGs, the importance of waste reduction, as well as increased recycling and more efficient use of resource (such as water and energy), is emphasized. These topics are part of goal 11 and 12, which will be of concern and discussed in Chapter 7.1.4.

Figure 3: Illustration showing UN SDG topics, derived from the UN News Centre (UN News Centre, 2015)

3.4.2 Regional level and towards a circular economy

There are large differences in waste management practice and performance within Europe (EEA and NEA, 2015, NEA, 2014d). The waste treatment methods and recycling rate varies, as well as the amount of MSW generated per capita (Eurostat, 2016). In a press release 22.03.2016, it was reported that the MSW per capita in EU has decreased by 10 % in 2014 compared to 2002. The waste generation was highest in Denmark with 759 kg per person. In Norway it was generated 423 kg per person. The lowest amount generated, which were less than 300 kg per person, where in Romania, Latvia and Poland. In these countries most of the waste is landfilled. According to EEA (European Environment Agency), waste from the construction industry, mining industry and manufacturing industry is generating most waste

(EEA, 2016). However, domestic waste is also contributing a lot to the total amount of waste in Europe. In Norway the amount of domestic waste per capita is 10 kg lower than the European average, according to data from 2012 (NEA, 2014d).

EUs priority is to follow the waste hierarchy (see Figure 4). The waste hierarchy is a framework and common approach to waste management showing areas of focus and priority (EC, 2010, Christensen, 2011). On top is waste prevention, which is considered to be the most preferable solution. If waste is avoided and prevented, there is no need for management and there will less negative environmental impact (Harrison et al., 2007). The next solution is preparing for reuse, then recycling and the fourth is other recovery. The final and least preferable solution is disposal to landfilling or incineration, with no energy recovery (EC, 2013). Put differently, the priority is to:

> *"reduce the amount of waste that are generated, to maximize recycling and re-use, to limit incineration to non-recyclable materials, to phase out landfilling to non-recyclable and non-recoverable waste and to ensure full implementation of the waste policy targets in all Member States"* (EC, 2016).

EU's waste directives suggest that life cycle thinking should be part of all waste management decision-making (Christensen, 2011), which is the core perspective of industrial ecology. In a life cycle perspective there are mainly four processes and phases within the waste management system: waste generation, collection, transport and treatment (Christensen, 2011). Towards a CE these perspectives, IE and life cycle thinking, are crucial. Figure 5 illustrates this approach, were the circle is closed through reuse, recycling and other recovery. In a linear economy, which is the opposite, disposal would be the solution

Closing the loop – An EU action plan for the Circular Economy

As mentioned in section 1.1 Background, EU published an action plan in December 2015 for development towards a circular economy (EC, 2015a). *Closing the loop – An EU action plan for the Circular Economy* deals with the transition into a circular economy were resource efficiency and reduction in negative environmental impact, in combination with economic growth and increased employment rates, are of concern. With regard to the plan, four changes to the waste directives were suggested (KLD, 2016). The commission suggested that 65 % of the MSW and 75 % of all packaging material should be recycled within 2030. Additionally, there were suggested that there should be a 10 % gradual reduction of MSW transported to

open dump, and that disposal of sorted waste shall not be accepted. There is also a requirement that food waste should be recycled.

The transition into a circular economy can bring not only economic benefits, but also social and environmental (EC, 2014a). By increasing the resource efficiency through energy- and cost savings, saving landfill space, as well as reduce emissions to the air (GHGs), the waste management practices will be improved. Through a circular economy more jobs will be created as well. The EU directives framework on solid waste requires the member nations to consider the goals that are developed and to have a proper waste management strategy. The action plan is also a contribution in reaching the UN SDGs (KLD, 2016), and will influence the waste management sector in Norway (Lystad, 2015).

UN Environmental Action Programme

In 2013 an EU Decision were made on having a general environmental action programme to 2020 (EC, 2013). This action programme, *Living well within the limits of our planet*, had a vision for 2050 that the global society should have a green and sustainable economy leading to less emission and more robust ecosystems and ecosystem's quality. Through a circular economy nothing should be wasted, as a way of making cities more sustainable.

> "*In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society*" (EC, 2015b).

The programme guides regional environmental policy until 2020, and entered into force in 2014 (EC, 2015b). Key objectives are resource efficiency, low-carbon economy, conservation of natural capital and safeguarding from environmental pressure and risks.

Figure 4: EUs waste hierarchy showing the shift from disposal as main solution to prevention (EC, 2010). The most preferable solution is prevention and the least is disposal.

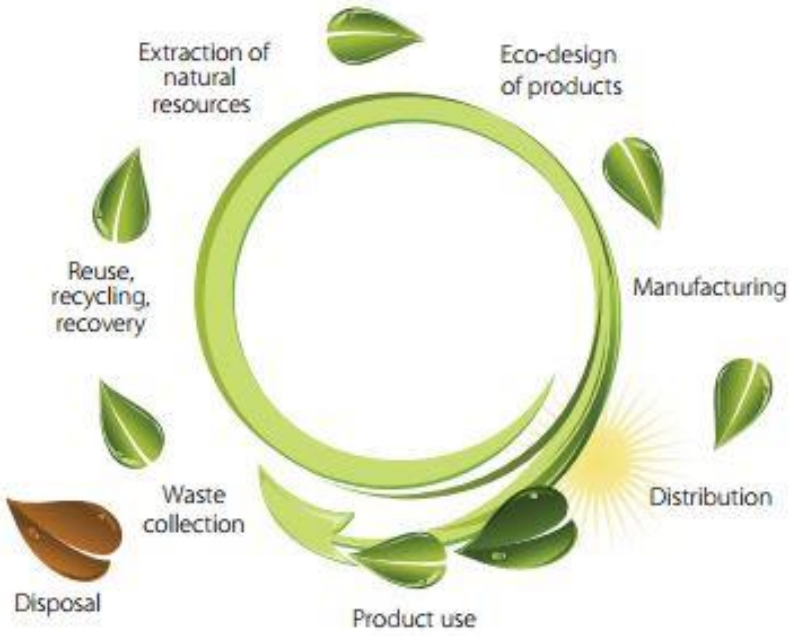

Figure 5: EUs approach to waste management - a life cycle perspective were resources preferably are reused, recycled or recovered (EC, 2010).

The Nordic Countries

The Nordic countries has developed an action plan on environmental issues, *Nordisk miljøhandlingsprogram*, that are valid from 2013 to 2018 (Nordisk ministerråd, 2012). Through this plan, the countries are coordinating and cooperating on environmental goals, strategies and policies. With regard to solid waste, the main goal is that the consumption of resources should be decoupled from economic growth through increased resource efficiency, waste preventions, recycling and reuse of resources.

3.4.3 Norwegian context

In an official document and report from 2013, *Fra avfall til ressurs*, a new waste management strategy was presented by the Ministry of Environment (now the Ministry of Climate and Environment) (KLD, 2013). The strategy focused on waste minimization and encouragement of reuse and recycling of products and materials. The minister of environmental concerns of that period, Bård Vegar Solhjell, pointed out the importance of reducing the amount of waste and to address it as a resource and not a problem. Even though the waste management system in Norway is quite good and is getting better, the amount of waste should be reduced, in order to benefit from reduced environmental impact and economic costs (KLD, 2013).

The waste hierarchy is also part of the Norwegian practice, and the Norwegian Waste Management and Recycling Association (NWMRA) is promoting it. By following the waste hierarchy presented by EU, national goals will be reached. The intention is to choose options and solutions that are as far up in the waste hierarchy as possible. According to Adjunct Professor Sigrun J. Jahren, Norway is one of the countries with the best recycling systems, as it is quite organized and regulated (Jahren, NTNU, 11.05.2016). Jahren suggested that there should be a global standardization of data handling and waste analytics, to keep track of commodities and resources though the life cycle in a circular economy.

Previously, the increase in domestic solid waste was connected to the increase in consumption as well as the changes in household size (which become smaller). According to the European Commission, today these factors, consumption rate and household size, are decoupled from solid waste generation (EC, 2013). As Christensen also pointed out, *"It is desirable in the future to decouple the economic growth from waste generation"* (2010:6). There are national environmental goals and targets that are related to waste management, either directly or

indirectly. In terms of emission of GHGs, local air pollution, toxicity, food security and human health, waste generation are related somehow (KLD, 2013). See Chapter 3.5 Solid Waste and the Environment for more details.

Regarding Norwegian environmental goals and targets, there are six topics, and the fourth is pollution. Within this topic, goal 4.3 deals with waste directly (NEA, 2014a). In terms of this goal, the Norwegian Environment Agency has specified two measurable indicators, as shown in Table 4. Regarding the first indicator, the total amount of waste generated has increased more than the economic growth (NEA, 2014e). From 2012 to 2013, the GDP increased by 1 per cent, while the waste generation by 5 per cent. Hence, in terms of the first indicator the target was not reached. Considering the second indicator within target 4.3, Norway is moving in the right direction (NEA, 2014c). Since 1995 the recovery rate in Norway has increased yearly. In 2013 81 % of all waste was recovered.

Indirectly, Norway's goals regarding climate issues could also be related to waste and waste management, as several disposal methods lead to emissions of GHGs (see Table 5 in Chapter 3.5.3). The goal of Norway being a low-emission society by 2050 and achieve carbon neutrality in 2050 are two examples, as shown in Table 4. Additionally, Norway will contribute in reducing global emissions of greenhouse gases, which is another national environmental goal. Regarding pollution, elimination of releases of hazardous substances is an important national goal that affects the waste management sector. Biodiversity is another topic of concern, which indirectly is connected to waste management. This will be elaborated on in the next section.

Table 4: National environmental goals that are relevant in terms of solid waste and waste management (NEA, 2014a, NEA, 2014b).

Topic	Target	Indicator
4. Pollution	4.3: The growth in the quantity of waste generated will be considerably lower than the rate of economic growth, and the resources in waste will be used as fully as possible through recycling and energy recovery	1: Growth in waste generation relative to economic growth (expressed as change in GDP) 2: Proportion of non-hazardous waste recovered, based on figures for the total quantity of waste for which information on treatment/disposal is available
5. Climate	5.1: Norway will be a low-emission society by 2050	
	5.2: Norway will achieve carbon neutrality in 2050.	National emission trends and use of flexible mechanisms

3.5 Solid Waste and the Environment

Waste is an important sustainability issue that is linked to topics such as consumption, energy, agriculture and food (Houghton, 2015). It will be elaborated shortly on the environmental impact and effects of waste, as well as the interconnection between human society and Earth's natural system. The perspective and concept social metabolism is included, as well as the systems thinking tool and framework DPSIR (Driver-Pressure-State-Impact-Response), as a way of understanding the interconnections.

3.5.1 Social metabolism

Humans have always exchanged materials, energy and waste with the environment (Hertwich, NTNU, 17.09.2014). Human society is an open system that requires stable environmental conditions, and this social system is important to understand when addressing environmental impacts. The geological age we are part of today, the Anthropocene, is dominated and controlled by the human society. During the last century humans has change the environment more than ever before, as a planetary force. How this has happened and had an impact on the environment, has changed through what is called social metabolism (Fischer-Kowalski et al., 2014).

Social metabolism is a concept about how humans transforms and changes their surroundings and environment; it concerns the changes in human society by which it sustains and reproduces itself. The concept of social metabolism contributes in understanding the drivers and challenges with regard to climate, sustainability and the pressure on the environment. These changes are connected to consumption habits and requirements of natural resources. Social metabolism is also described as the entire flow of energy and materials that humans require to sustain their economic activities (Haberl et al., 2011). Three socio-metabolic regimes have been identified, which distinguish from each other due to various consumption patterns, modes of subsistence and metabolic profile (Fischer-Kowalski et al., 2014). The hunters and gatherers, the agrarian societies and lastly the industrial societies, do all have different metabolic profile, which is the annual flow of materials and energy needed for the society to sustain. The modes of subsistence is depended on available technology, and can be calculated using the IPAT equation (Impact = Population * Affluence * Technology). The hunting and gathering mode has least impact on the environment, while the industrial one has the most.

Even though humanity has finally started to learn how to create a good quality of life at lower energy and material use (Hertwich, NTNU, 17.09.2014), the planet are facing several, important sustainability issues that are all interconnected (Houghton, 2015). Global warming and climate change are two of them, but consumption and waste are two other such issues. Due to population growth there will be an increase in demand for resources and energy, resulting in associated environmental implications which contribute to global warming and climate change. A side effect of consumption of material resources and goods is pollution which is linked to processes such as transportation and energy consumption. With regard to waste and recycling, paper that are produced from recycled materials reduces water consumption by 60 % and energy use by 40 %, compared to paper made of sources directly from the forest (Houghton, 2015:353). Additionally, pollution to air and water decreases by 74 % and 35 %.

3.5.2 The DPSIR framework

Population growth and individual prosperity, puts pressure on the natural environment (Harrison et al., 2007). To illustrate the connection and interactions between human and environmental systems, the DPSIR (Driver-Pressure-State-Impact-Responds) model is a nice tool (Burkhard and Müller, 2008). Figure 6 shows the DPSIR framework with regard to society's economic system and earth's natural system, and how these are related (Hertwich, NTNU, 17.09.2014). It has a cause-effect approach, and shows that the human activities within the economic system (extraction of resources, manufacturing, use phase and waste management), are all direct driving forces and actions that causes pressure on the environmental system. Indirect drivers in the model are wellbeing, income and job satisfaction. According to Burkhard and Müller, *"all human activities affecting the environment can be classified as pressures"*, which includes demands for goods and products (2008:968). This pressure on the environment, through emissions and resource use, results in a certain state of the natural system, such as changed air, water or soil quality. Changes in the state will have an impact on human life and the environment, such as decreased provision of ecosystem services and resource scarcity. The response component of the system is where humans take action, depending on context and available options and instruments (Burkhard and Müller, 2008). It could for instance be certain mitigation or adaptation strategies, legislative procedures, development plans or market-oriented instruments.

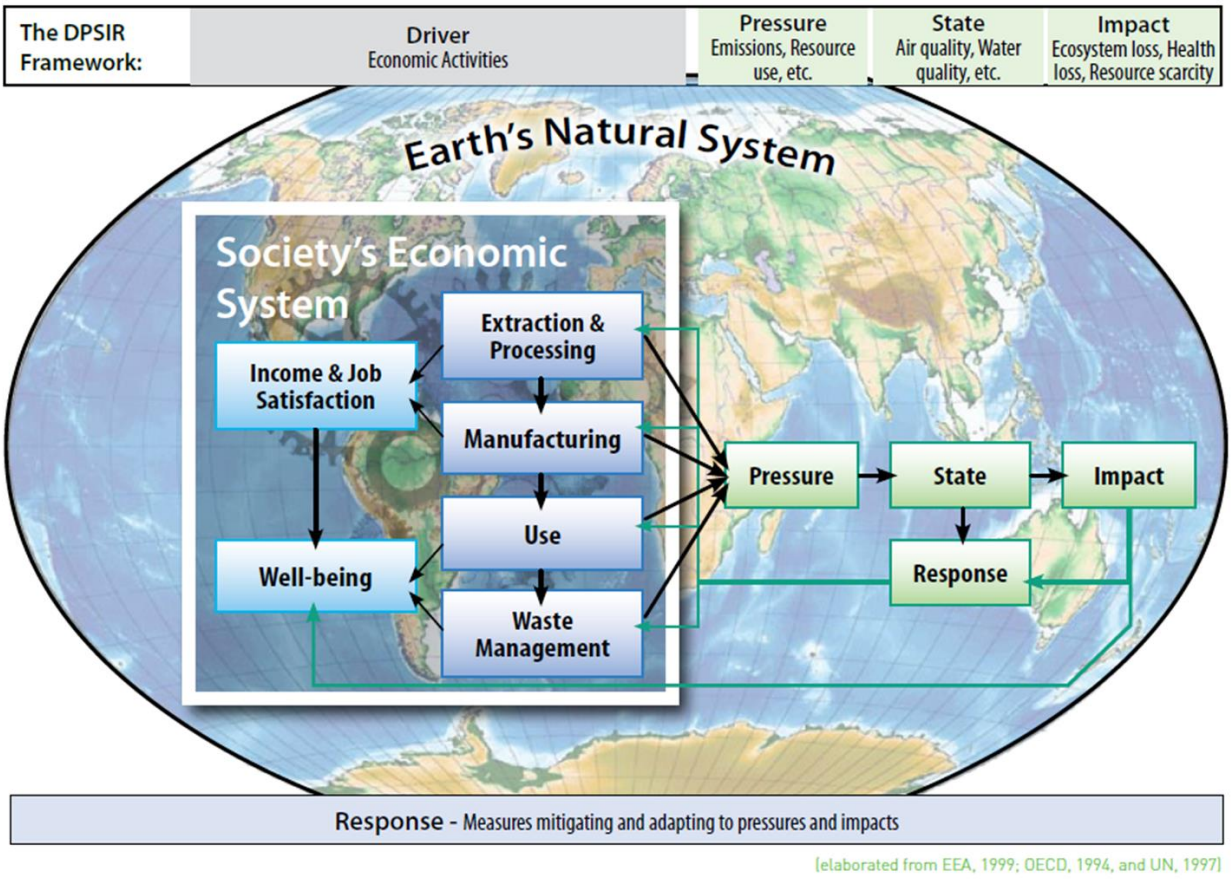

Figure 6: Conceptual model showing the interconnection between society's economic system and Earth's natural system, through a DPSIR-framework (Hertwich, NTNU, 17.09.2014).

3.5.3 Environmental impact

The environmental impact of solid waste, also defined as *"flows of unwanted materials and energy"*, depend on the management method (Harrison et al., 2007). Especially hazardous waste is a risk to the environment, as well as to human health (ISO/TC 268/WG 2, 2015), as many toxics are breaking down quite slowly in the environment (Harrison et al., 2007). By reusing, recycling and reclamation hazardous wastes, risks will be reduced. Additionally, scarce natural resources will be protected and conserved, and the reliance on raw materials and energy will be lower.

Table 5 is derived from Harrison et.al, and gives an informative overview of the various solid waste impact categories within each management method. Emissions to air, pollution, chemicals and toxicity, noise, contamination to air, water and soil, are some of the impact categories. Especially hazardous waste is a risk to the environment, as well as to human

health (ISO/TC 268/WG 2, 2015), as many toxics are breaking down quite slowly in the environment (Harrison et al., 2007). By reusing, recycling and reclamation hazardous wastes, risks will be reduced. Additionally, scarce natural resources will be protected and conserved, and the reliance on raw materials and energy will be lower.

Table 5: Waste management methods and associated environmental impacts (Harrison et al., 2007).

	Landfill	**Composting**	**Incineration**	**Recycling**	**Transport**
Air	Emissions of methane (CH_4) and carbon monoxide (CO) odours	Emissions of methane (CH_4) and carbon monoxide (CO) odours	Emissions of SO_2, NO_x, HCI, HF, NMVOC, CO, CO_2, N_2O, dioxins, furans, heavy metals (Zn, Pb, Cu, As)	Emissions of dust	Emissions of dust, NO_x, SO_2, release of hazardous substances from accidental spills
Water	Leaching of salts, heavy metals, biodegradable and persistent organics to groundwater	N/A	Deposition of hazardous substances on surface water	Wastewater discharge	Risk of surface water and groundwater contamination from accidental spills
Soil	Accumulation of hazardous substances in soil	N/A	Landfilling of ashes and scrap	Landfilling of final residues	Risk of soil contamination from accidental spills
Landscape	Soil occupancy; restriction on other land uses	Soil occupancy; restriction on other land uses	Visual intrusion; restriction on other land uses	Visual intrusion	Traffic
Ecosystems	Contamination and accumulation of toxic substances in the food chain	Contamination and accumulation of toxic substances in the food chain	Contamination and accumulation of toxic substances in the food chain	N/A	Risk of contamination from accidental spills
Urban areas	Exposure to hazardous substances	N/A	Exposure to hazardous substances		Risk of exposure to hazardous substances from accidental spills; traffic

4. Empirical Data

Empirical data applied for analysis and study will be presented in this chapter. The empirical data is collected through a questionnaire, interviews, personal communication and email correspondence. As four municipalities are chosen as examples in the quantification part of the study, these will shortly be described. In what follows, information from interviews and personal communication, as well as data extracted and derived from the survey and quantification, will shortly be presented.

4.1 Questionnaire

A self-completion questionnaire was sent to several local authority administrations as well as local waste management agencies (see Chapter 2.3.2). In total there were 14 responses. However, Bergen and Stavanger responded twice, but with different respondents. One respondent represented the local authority and the other one the local waste management agency. The empirical results presented are based on information in Appendix A. Questionnaire and Summary of Responses and Appendix B. Original Questionnaire Responses, which also makes up the basis for the questionnaire analysis in Chapter 5.1.

The summary of questionnaire responses shows that the respondents have varying working positions. As illustrated in Table 6 below, four are employed in private waste management agencies (WMA) and ten in local, municipal authorities (LA). Most of the municipalities are part of an inter-municipal waste management agency (IKS), and according to some of the WMAs that responded, being part an IKS made it difficult to respond on behalf of one municipality. A considerable amount of the respondents have developed a waste management strategy plan, as well as a communication strategy which also consider the waste section in the municipality.

In the questionnaire it was asked about what is considered to be the main challenges with regard to local waste management. Most responded that increasing the recycling rate is a challenge. Other questions were about what areas within waste management are of focus, the use of data at KOSTRA and challenges with the reporting system. There were also questions with regard to ISO 37120 specifically. The results and responses will be presented more in detail and elaborated on in Chapter 5.1 Questionnaire Analysis.

Table 6: The table shows who responded to the questionnaire, whether they were representing a local waste management agency (WMA) or the local authority (LA), and if the municipality are part of an inter-municipal WMA (IKS).

Municipality	Working position	Waste management agency (WMA) or local authority (LA)	Part of an inter-municipal WMA (IKS)
Asker	Faggruppeleder gjenvinning	LA	No
Oslo	Seniorkonsulent /internasjonalt arbeid, strategiutvikling	LA	No
Hamar	Miljørådgiver	LA	Yes
Nittedal	Konsulent	LA	Yes
Rælingen	Avdelingsleder VA	LA	Yes
Fet	Enhetsleder kommunal-teknikk	LA	Yes
Stavanger and nine neighbouring municipalities (IVAR): Finnøy, Gjesdal, Hå, Klepp, Randaberg, Sandnes, Sola, Strand and Hjelmeland	Fagansvarlig renovasjon, IVAR IKS	WMA	Other: Responds on behalf of an inter-municipal WMA
Gjerdrum	Teknisk leder	LA	Yes
Renovasjonsselskapet for Drammensregionen (RfD). Municipalities: Drammen, Lier, Nedre Eiker, Øvre Eiker, Modum, Røyken, Hurum, Sande and Svelvik	Senior prosjektleder	WMA	Other: Responds on behalf of an inter-municipal WMA
Bergen and eight neighbouring municipalities (BIR): Askøy, Fusa, Kvam, Os, Osterøy, Samnanger, Sund and Vaksdal	FOU sjef i BIR As	WMA	Yes
Sandnes	Seksjonsleder, miljø og renovasjon	LA	Yes
Time, Rennesøy og Kvitsøy (TRK)	Driftssjef	WMA	Yes
Stavanger	Miljøvernsjef	LA	Yes
Bergen	Miljøsjef	LA	Yes

4.2 Interview and Personal Communication

The empirical data from interviews and personal communication is based on two face-to-face interviews (with NWMRA and SN), three telephone interviews (Bergen kommune, Asker kommune and RfD), as well as email correspondence with SSB (see Chapter 2.3.1). The face-to-face interviews were informative and technical and made the basis for the questionnaire. The telephone interviews were conducted based on the questionnaire result for further elaboration.

Norwegian Waste Management and Recycling Association (NWMRA)

According to Bratland (2016) in NWMRA the ISO standard might be just another tool to be concerned with for those applying and implementing it, as it already are certain tools to apply. It is informed that some of the indicators are not relevant in a Norwegian context, such as the amount of waste that is burned openly, as this is illegal. However, the standard might for instance be useful with regard to communication. As it is a relatively new standard that few have heard about, the interest might be low. There are large variations in waste management practise, thus there are no proper standard for waste management yet.

Norwegian Standardisation (SN)

Tveter (2016b) in SN explains that ISO 37120 can be useful as a tool to monitor performance over time in order to continuously improve. The standard is developed to establish consensus and a common understanding of sustainable development of communities. ISO is quite consequent in the use of terms and definitions, and has developed a vocabulary related to ISO 37120. The aim and intention of the standard is among others to make comparison feasible. As a tool it can be useful within internal (and external) communication, for instance to establish a common understanding between different levels of the organization. It can contribute in making consensus with regard to definitions of terms and concepts, how to report and use the indicators, and in comparison with other cities and municipalities. It can also be useful in planning for future needs, in setting goals and targets, as well as in development of strategies.

Waste management agency in Drammen area (RfD)

On questions with regard to waste statistics and reporting, the inter-municipal waste management agency in Drammen (RfD), informs that KOSTRA is not utilized actively

(Svendsvoll, 2016). The waste agency reports data to the local authorities and as it is an inter-municipal agency, the data is not separated for each municipality. Thus, in KOSTRA the data are separated based on population or other factors. This is also a reason why RfD do not trust KOSTRA data and do not compare themselves with other municipalities based on this information system. Instead, a benchmarking system and program, offered by NWMRA, is applied by RfD. It is a quite comprehensive system that is voluntary to apply, and those applying it reports data every 2nd year. It is targeted towards waste management agencies and activities. RfD expresses that the ISO standard is quite expensive and that the solid waste indicators it includes will not contribute with any new insight or knowledge with regard to local environmental management. However, other standards are applied and considered, which are developed by Norwegian Standardisation, such as the guiding standard NS 9432 (see Chapter 3.2.2).

Asker kommune

In Asker, as well as in Drammen (RfD), the benchmarking tool developed by NWMRA is utilized. According to Bjørnson (2016), this is very useful and gives a nice indication on local performance, as well as it gives an indication on what direction one is developing. It is also valuable being compared with similar waste management agencies or municipalities within Norway, which the tool offers. Asker and Drammen has been compared to each other several times.

Bergen kommune

In terms of Akervold (2016), who is a special adviser within city development in Bergen kommune, KOSTRA is good at making consensus and common understanding of data. However, the quality of the data is still weak as the waste management practice varies across municipalities. Thus, there are lack of trust in data due to uncertainty and inaccuracy. But KOSTRA is utilized anyways, as there are not any other data that are better to use. Bergen uses this data in comparison with other big cities, such as Oslo, Trondheim and Stavanger. It is informed that it do not exist any good standard on waste management to be applied, which is why it was responded in the questionnaire that the management systems are not considered to be satisfying (see Appendix C. Categorized Questionnaire Results). Additionally, there is an impression that in the waste management industry, the interest in standards is low. One

wants to do it simple and in the same way as before, Akervold claims, which is considered a disadvantage with regard to further development. In terms of ISO 37120, it is emphasised that as it is a quite new standard, Bergen kommune do not know much about it. If the standard were evaluated to be useful, it is assumed that one would already have been informed about it.

At the launch of the NWMRA's Redu-project at NTNU, Igesund (2016) were also contacted, who responded to the survey on behalf of the WMA in Bergen area (BIR). Igesund informed that one needs all waste disposal methods and solution, as there are some waste categories that should not be recycled. Sometimes incineration would be the best solution, which is the case regarding certain types of food waste. As an example, some food contains chemicals and crop spray, and this is something one does not want to compost and turn back into the soil. Thus, Igesund is sceptical to the goal of 65 % recycling of all MSW, because *"how far should the focus on increasing the recycling rate go, if it is not sustainable after all?"*

Statistics Norway (SSB)

SSB was contacted with regard to KOSTRA. Table 7 shows the questions that were asked and the responses, extracted from email correspondence with Vinju (2016). Thus, the language is Norwegian. Based on the responses, SSB is in general confident with KOSTRA data and reporting, and consider it to be satisfying. The main challenge with reporting, though, is assumed to be differentiating between commercial and domestic waste at the recycling plants.

Table 7: Shows questions sent to SSB with regard to KOSTRA, and original answers from Vinju (2016).

Question	Response
1. I hvilken grad er dataene som blir rapportert inn ansett som gode og nøyaktige?	Til bruk i statistikk, dvs beregning av tall for hele landet, blir tallene ansett som gode. På kommunenivå kan det nok variere noe, men de fleste kommuner kar god kontroll på avfallsmengdene fra husholdningene sine. Men vi ser at kg avfall pr innbygger varierer ganske mye. Årsakene kan være at det er reelle forskjeller. F.eks at det er mer hageavfall i kommunene rundt Oslofjorden, og mindre i Lofoten. Eller årsakene kan være forskjeller i registrering, f.eks i hvilken grad kommunen har kontroll på innblanding av næringsavfall på gjenvinningsstasjonene. Det vil også være litt mangelfulle tall for EE-avfall og farlig avfall som leveres direkte til forhandlere.
2. I hvilken grad er dere fornøyde med hvordan det rapporteres og måles?	Vi er stort sett fornøyde med innrapporteringen fra kommuner og interkommunale avfallsselskaper. Fler og fler rapporterer inn innen fristen og antallet feil går ned.
3. Hva er ansett som hovedutfordringene med slik rapportering, sett fra deres side?	Hovedutfordringen er nok å kunne skille på husholdningsavfall og næringsavfall på gjenvinningsstasjonene. I tillegg mangler vi litt data for hvitevarer og annet EE-avfall, og farlig avfall som leveres direkte til forhandlere.

4.3 Quantification of Solid Waste Indicators in ISO 37120

The intention with choosing four municipalities (Oslo, Bergen, Drammen and Asker) is to illustrate how the standard can be applied. Oslo is the capitol in Norway and the biggest city in the country. At the west coast is Bergen, which is also a big city in a Norwegian context. Both cities have a large population and comprehensive waste management systems. Drammen is a smaller city close to Oslo, characterized by industry activity. Asker is a suburb and outer city in between Drammen and Oslo. This area has traditionally been characterized by agriculture, farming and forestry, but is now increasing its population and becoming more urbanized. According to data derived from SSB, the population are increasing in all four municipalities, which can be seen in Appendix D. Quantification Parameters.

The household size decreased gradually from 2012 until 2014 in all municipalities, and then increased in 2015. In Drammen and Bergen the household size has been almost exactly the same throughout the four years of concern. The biggest differences are between Oslo and Asker (1.97 and 2.41 respectively in 2015), which geographically are quite close to each other. In 2015 the national average were 2.20 per household (SSB, 2016b). The household size aspect will be reflected on and discussed in Chapter 7.1.5.

The municipalities Drammen, Asker, Oslo and Bergen have all developed their own waste regulations that are available to the public online (Asker kommune, 2010, Oslo kommune, 2012, Bergen kommune et al., 2007, Drammen kommune, 2003). Bergen kommune has developed one in cooperation with eight neighbouring municipalities, which are all part of- and owns BIR, the inter-municipal waste management agency in the area. Drammen kommune and RfD has developed an official regulation specifically with regard to open burning of waste, which is strictly regulated.

5. Analysis

"ISO 37120 Sustainable Development in Communities – Indicators for city services and quality of life" will be analysed and explored with focus on solid waste, in order to assess its possibility of being applied as a management tool. It will be tested whether the standard can contribute in waste management processes at a local level in Norwegian context. In the following sections each part of the triangulation method will be addressed. First, the questionnaire responses will be analysed, broken down and classified. Secondly, the indicators on solid waste in ISO 37120 will be quantified and explored. Thirdly, the two sections will be related to the interviews and shortly discussed.

5.1 Questionnaire Analysis

The questionnaire analysis is based on data in Appendix A. Questionnaire and Summary of Responses and Appendix C. Categorized Questionnaire Results. Table 6 in Chapter 4.1 showed that there were ten different LAs that responded and four WMAs. As two groups responded to the questionnaire the analysis focus on the distinctions and similarities among these. This fact may have affected whether the respondents were able to answer all the questions or not, and what response categories were chosen. To illustrate the level of agreement and consistency in the responses, Appendix D. Categorized Questionnaire Results Distinguished between WMA and LA, were constructed. To illustrate the responses to some of the questions in an easily understood way, graphs and tables has been constructed.

5.1.1 Areas of focus and challenges at the local level

In order to identify the relevance of ISO 37120, the respondents were asked about the main challenges with regard to waste management at the local level, as well as the main areas of focus. Among both WMAs and LAs there is highest agreement on the importance of increasing the recycling rate as well as keeping the communication with the private households at a beneficial and satisfying level (see Table 8). At the same time increasing the recycling rate is evaluated to be one of the main challenges among the WMAs, which explains why it is an important area of focus. Among the LAs, though, the main challenge is considered to be reduction of negative environmental impact. Figure 7 illustrates the response distribution with regard to waste management challenges. Responses from both WMA and LA are included. One respondent (Gjerdrum kommune) selected all response categories, and

thus considered and identified all of them to be challenges. This was the only one responding that 'reporting and measuring' is a challenge. RfD, on the other hand, selected all options except 'reporting and measuring'. Thus, in general terms reporting of data are not considered to be a challenge. Communication (internally/externally) is not considered being one of the main challenges either, as three out of fourteen responded it was.

Table 8: Shows the responses on question 5 in questionnaire on what is the main focus within waste management in the community. The table is extracted from Appendix D and translated into English.

Q5. What is the main focus within waste management in your municipality?				
Response category	**Local authority**	**Number**	**Waste management agency**	**Number**
New technology and solutions	Asker, Oslo, Hamar, Fet, Sandnes, Stavanger, Bergen	7	RfD, BIR, TRK	3
Increase of recycling rate / effective use of resources	Asker, Oslo, Hamar, Gjerdrum, Sandnes, Stavanger, Bergen	7	IVAR, RfD, BIR, TRK	4
Strategies to reduce amount of solid waste	Asker, Oslo, Hamar, Rælingen, Sandnes, Stavanger, Bergen	7	IVAR, BIR, TRK	3
Communication with private households	Asker, Oslo, Hamar, Fet, Gjerdrum, Sandnes, Stavanger, Bergen	8	RfD, BIR, TRK	3
Cooperation with industry with regard to commercial waste	Oslo, Hamar, Bergen	3		
I don't know / I can't answer				
Other	Nittedal ("*We are following ROAF's strategies*")	1	BIR ("*Recycling quality and reduction of GHG emissions*")	1

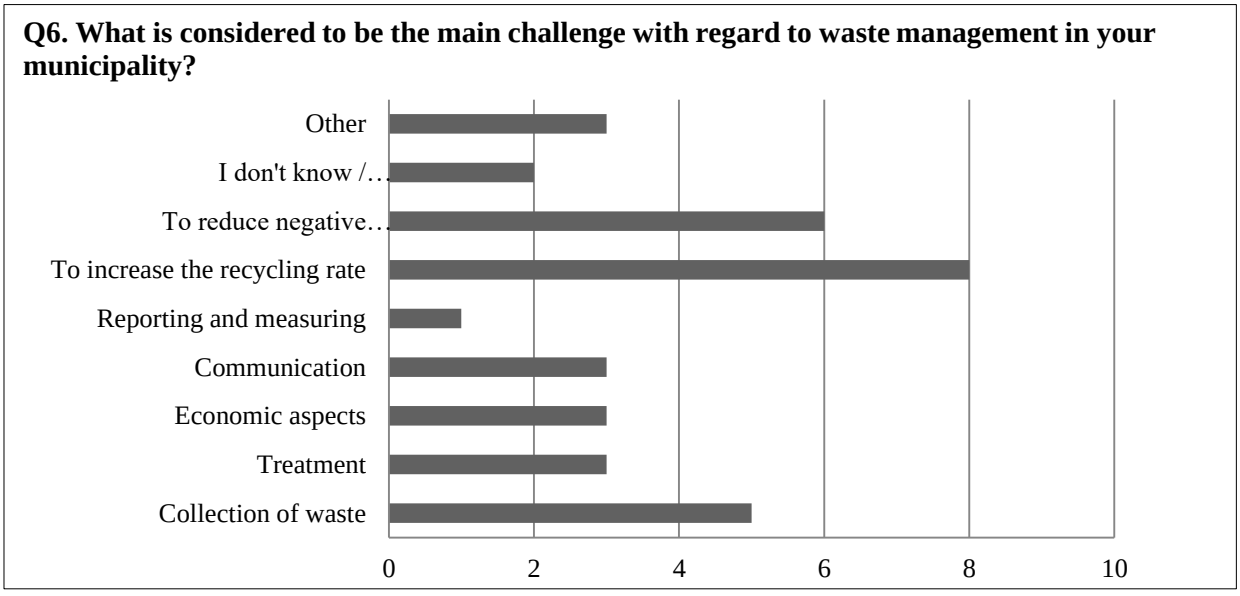

Figure 7: Shows the results and share of response categories to question 6 in the questionnaire: What is considered to be the main challenged with regard to waste management in your municipality?

5.1.2 Management systems

The management systems are considered to be good, as on a scale from 1 to 5, were 5 is 'to a great extent' and 1 'to a low extent', most answered 4. There is high agreement among the WMAs on this question, which Table 9 shows. However, as both the LA and the local WMA (BIR) in Bergen responded to the questionnaire, it is interesting to notice their contrasting responses. The questionnaire results do also indicate that the cooperation and communication between the LA and local WMA is considered to be quite good as well. It was also questioned if ISO 14001 on environmental management systems (EMS) are implemented, and if waste management is part of this system. Two responded 'yes' (Gjerdrum and Asker), five respondents answered 'no' and five did not know or could not answer. Bergen kommune informed that few enterprises within the municipality are certified according to ISO 14001 and that Eco-Lighthouse certification is more common. It was also informed that waste management are not part of the local EMS. According to BIR though, some of their subsidiary companies are certified, which has waste management as their core activities (see Appendix D. Categorized Questionnaire Results Distinguished between WMA and LA).

Table 9: Shows the responses to question 10 on to what extent the waste management systems are considered to be satisfying.

Q10. To what degree are today's management systems in your municipality with regard to solid waste considered to be good and satisfying?				
Likert scale	**Local authority**	**Number**	**Waste management agency**	**Number**
1 (low degree)				
2	Bergen	1		
3 (undecided)	Rælingen	1		
4	Asker, Hamar, Nittedal, Fet, Gjerdrum, Sandnes, Stavanger	7	IVAR, RfD, BIR, TRK	4
5 (high degree)	Oslo	1		

5.1.3 KOSTRA

Another interesting result is the responses with regard to whether data at KOSTRA is being applied and utilized actively or not (see Table 10 and Figure 8). Among the LAs the responses are more positive, as three are answering 'yes' and two 'partly'. None of the WMAs are utilizing it. It is informed that being part of an inter-municipal WMA (IKS) makes it difficult to use and trust data from KOSTRA. The respondent representing the WMA for the municipalities Time, Rennesøy and Kvitsøy (TRK) explains that KOSTRA can be applied to an extent to identify big trends, but that it does not give any accurate and precise results as

long as the municipality are part of an IKS. BIR does not trust data at KOSTRA either which is also an inter-municipal agency. Two of the respondents answered that they are not utilizing KOSTRA actively at all: the MWA in the Stavanger area (IVAR) and Bergen kommune. Thus, both Bergen and BIR are sceptical to KOSTRA. Those using it partly or actively apply it for several reasons, which Figure 9 illustrates. Selection of multiple options was possible (see note column in Appendix A. Questionnaire and Summary of Responses). In total nine responded to question about KOSTRA, and most of them are utilizing the data for all the five last categories. Questioning what the main challenge with the information and reporting system is, there is high agreement among both WMAs and LAs that data accuracy and quality is the main one (see Figure 10). One responded that there are no challenges with KOSTRA at all (Fet kommune), which also responded that they are utilizing it partly, and only in their internal communication.

Table 10: Shows the responses to question 7 in the questionnaire on whether data at KOSTRA is being utilized actively or not.

Q7. Are data from KOSTRA being utilized actively when working with environmental issues and waste management?				
Response category	**Local authority**	**Number**	**Waste management agency**	**Number**
Yes	Asker, Oslo, Gjerdrum	3		
No	Bergen	1	IVAR	1
Partly	Fet, Stavanger	2	RfD, TRK	2
I don't know / I can't answer	Hamar, Nittedal, Rælingen, Sandnes	4		
Other			BIR ("*We are continuously working to improve the quality of reporting*")	1

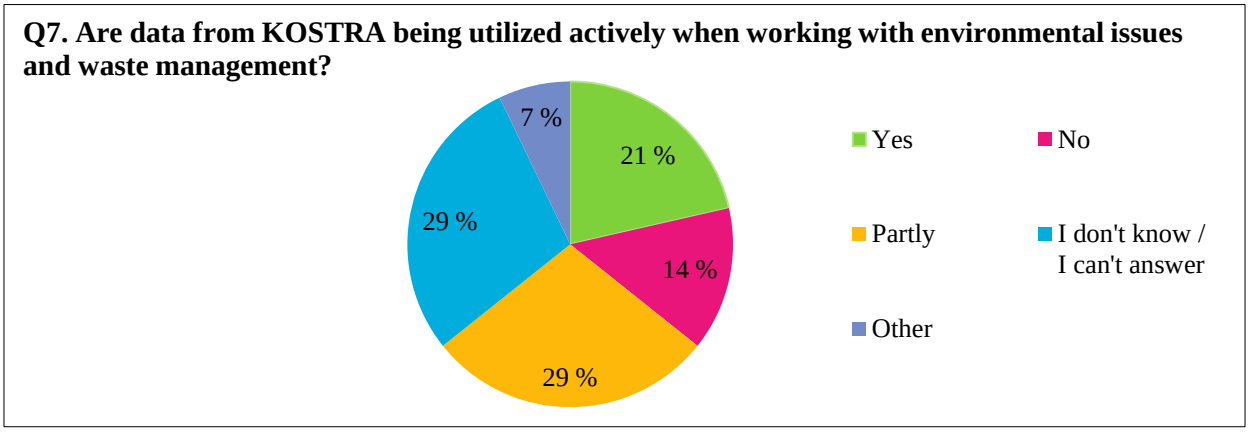

Figure 8: The diagram shows the distribution of answers to the various response categories for question 7 on whether KOSTRA are being utilized actively within environmental issues and waste management.

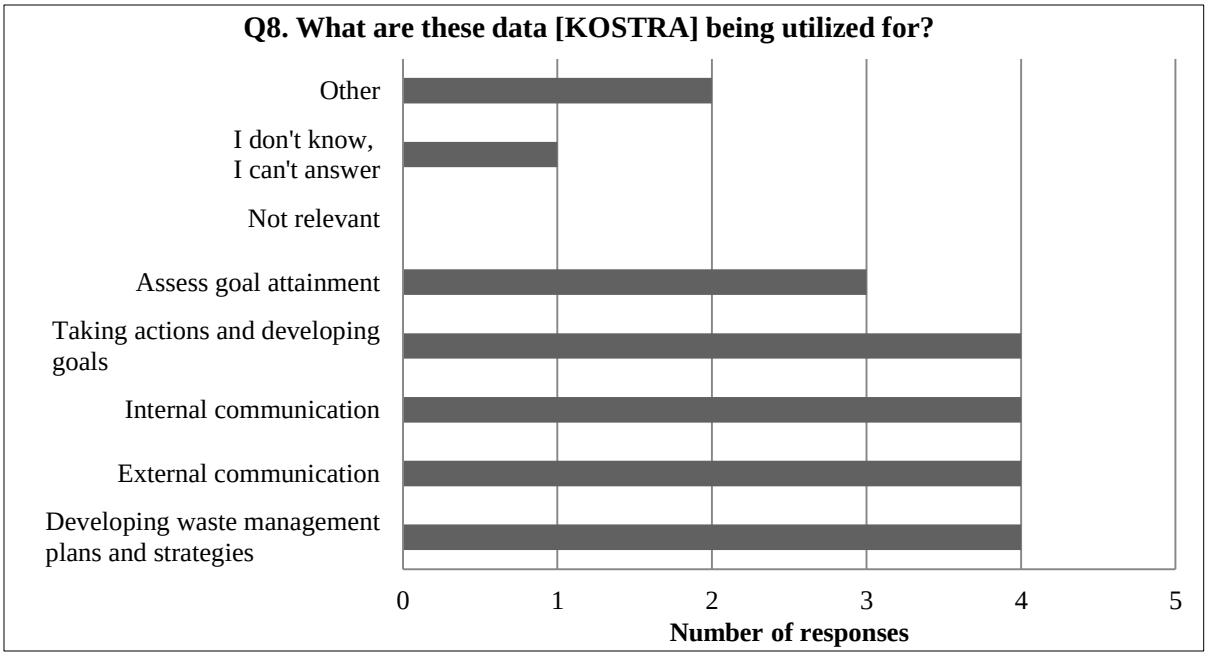

Figure 9: Responses to question 8 in survey on what KOSTRA data are being used for.

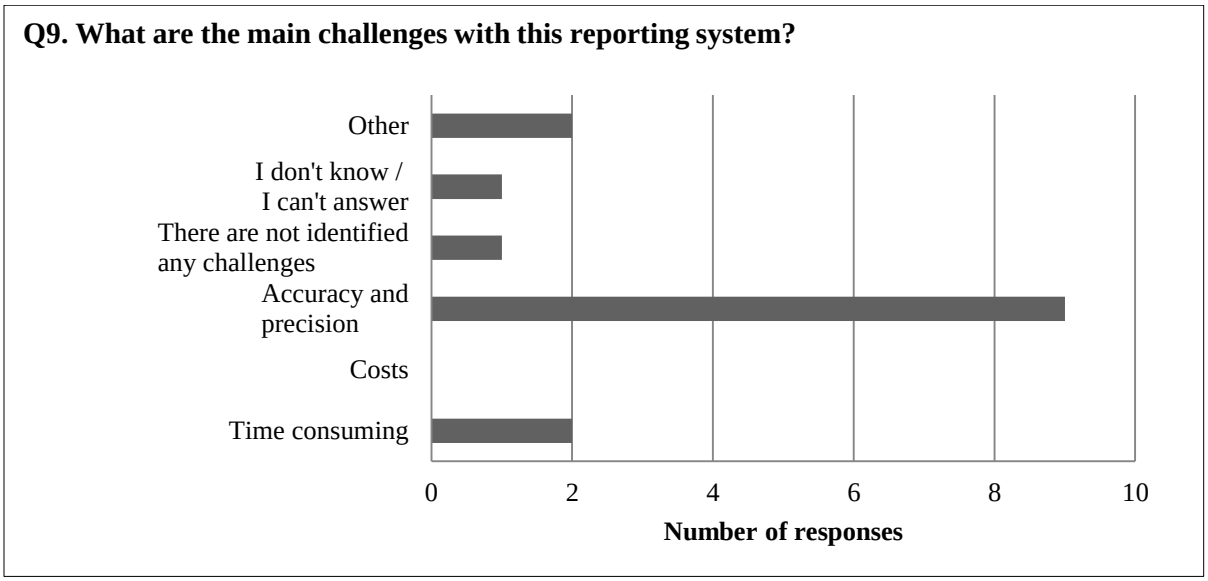

Figure 10: Responses to question 9 in the survey on what the main challenges with KOSTRA are.

5.1.4 ISO 37120

Most of the respondents are not sure if someone in the community has heard about the standard, as Figure 11 shows. Nine out of fourteen responded that they were not sure, which indicates that it is not a well-known standard. Four responds that they do not know about it and one responds ‘yes’, which is due to previous contact with NTNU and the pilot project on sustainable cities and communities.

The responses on question 14 (see Table 11 and Figure 12), was based on a short, informative description on the standard, which was given in the survey (see Appendix F. Description of ISO 37120 in Norwegian). Most of the respondents are undecided on whether ISO 37120 could be useful as a tool or not. Most answered 3 on a scale from 1 (not interested) to 5 (very interested), which means that they are undecided and neither interested or not interested. Table 11 shows who responded what, separated between LA and WMA, while Figure 12 shows the overall results graphically to the same question. IVAR and Bergen kommune are least positive, while the municipalities Oslo and Sandnes are the most positive respondents. Both Oslo and Sandnes kommune are interested in more information about the standard, as well as being compared with similar communities outside of Norway, with regard to waste management and performance. With regard to more information about the standard, Asker and TRK are interested as well, which both were undecided about the possibility of applying it as a tool.

The results are quite varying and distinctive with regard to question 16 about being compared with other societies, as Figure 14 shows. In addition to Oslo and Sandnes, three other municipalities are interested in this as well (Fet, Stavanger and Bergen). However, completely uninterested is Gjerdrum kommune as well as the WMAs IVAR and RfD. Even though Bergen kommune are interested in being compared, they are not interested at all in more information about the standard. The results indicate anyway that the LAs in general are more interested in the standard, than the WMAs.

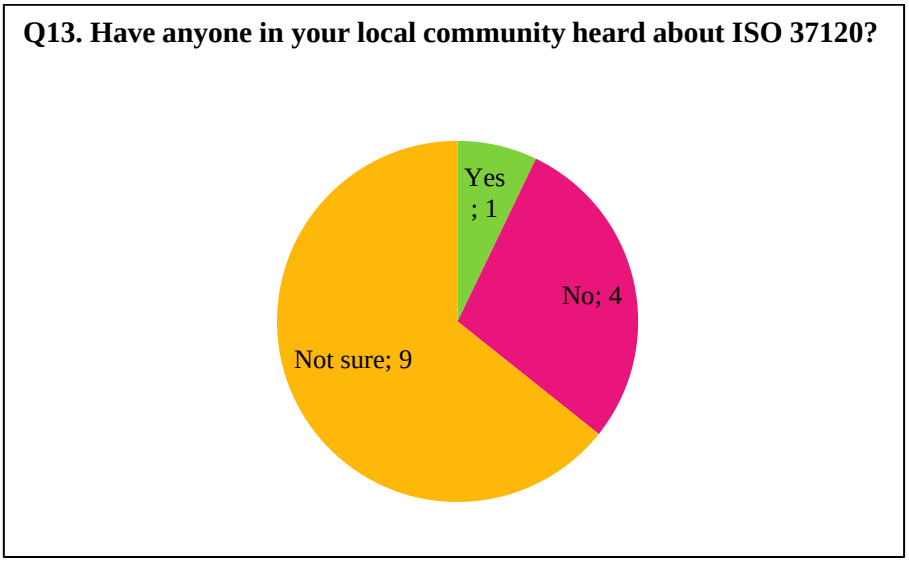

Figure 11: Responses to question 13 in the survey on knowledge about ISO 37120 in the community.

Table 11: The table shows what option each respondent chose with regard to question 14 in the questionnaire on ISO 37120 as a tool, extracted from Appendix D. Categorized Questionnaire Results Distinguished between WMA and L.

Q14. To what degree do you think ISO 37120 could be useful as a tool to your municipality with regard to waste management?				
Response category	**Local authority**	**Number**	**Waste management agency**	**Number**
1 (Low degree)	Bergen	1	IVAR	1
2			RfD, BIR	2
3 (Undecided)	Asker, Hamar, Nittedal, Rælingen, Fet, Gjerdrum, Stavanger	7	TRK	1
4	Oslo, Sandnes	2		
5 (High degree)				

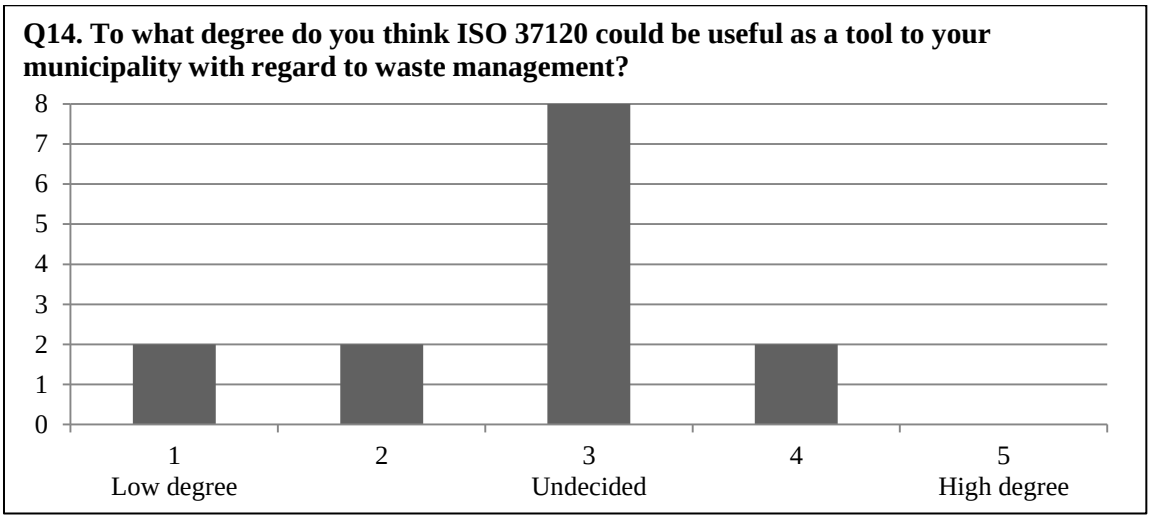

Figure 12: Responses to question number 14 on to what degree it is assumed that ISO 37120 would be useful in local waste management.

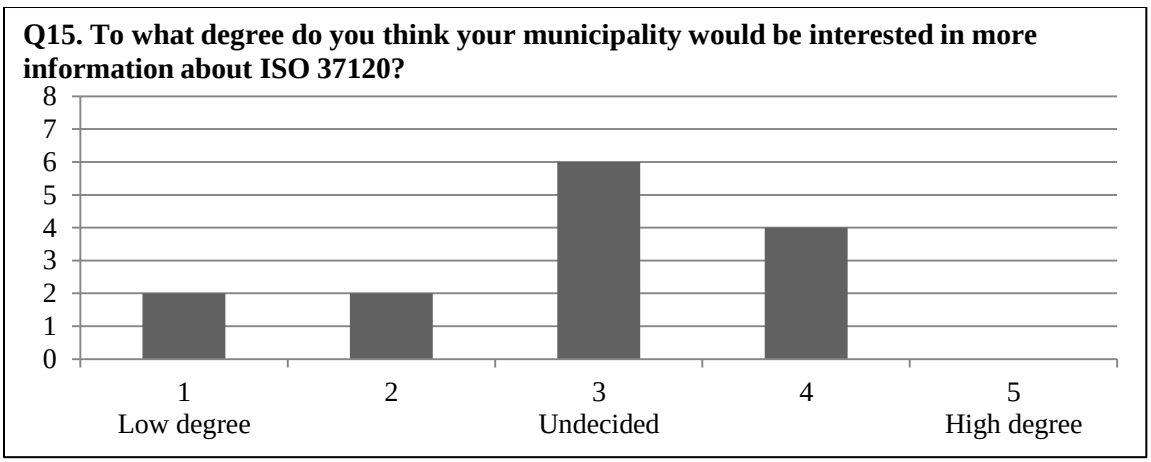

Figure 13: Results from question 15 in questionnaire showing the distribution of responses with regard to interest in more information about ISO 37120.

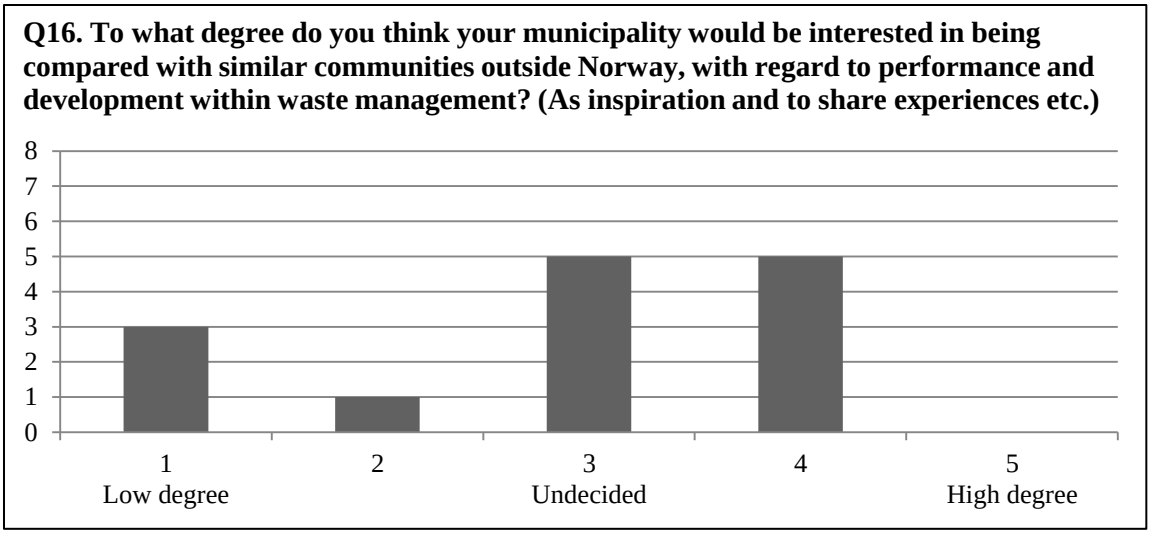

Figure 14: Result from question 16 in the survey about the interest in being compared with similar communities outside Norway.

5.1.5 Questionnaire summarized

The management systems are considered to be satisfying among both institutions, as well as the communication between them, which indicates that in this regard the standard might not contribute extensively. Communication with households is a focus area, which ISO 37120 potentially could contribute, as an external communication tool.

As KOSTRA data has been utilized for the quantification, it was natural to ask if is utilized actively among the LAs and WMAs. Results show that none of the WMAs uses it, while a few LAs are, either partly or actively. These respondents use it to assess goal attainment, in developing new goals and waste management plans and strategies, as well as in internal and external communication. These are areas in which the ISO standard potentially could contribute as well. There is high agreement on the limitations with the data quality and accuracy in KOSTRA.

Most are undecided and unsure whether the standard could be useful and contribute with new insight. However, some are also positive to being compared with similar societies outside Norway, as well as interested in more information about the standard. The results indicate that the LAs in general are more positive to ISO 37120 than the WMAs.

5.2 Quantification of data using KOSTRA

In order to evaluate possible application of ISO 37120, with focus on solid waste, a quantification of the indicators has been performed. The intention is to show how the standard and indicators could be applied and how the results can be analysed and illustrated. With the aim of presenting the results in an easy and readable way, each indicator are illustrated with a graph and commented on. Note that the y-axis' value are not the same for all the graphs. All graphs and tables show four distinctive municipalities (Oslo, Bergen, Drammen and Asker) and how they performed with regard to the indicators in the period from 2012 and until 2015. By analysing the values, one will be able to see how the communities have developed.

5.2.1 Solid waste and local performance

Table 12 shows the results of the quantification of solid waste indicators in ISO 37120. Values are found using KOSTRA (see Appendix E. Quantification Parameters for details). The three first indicators are core and mandatory to apply when implementing the standard, while the others are optional. In KOSTRA all relevant information with regard to these indicators are given in tons. In the standard, the values shall be given in tons per capita or as a percentage, which makes it easier to compare results across communities. The amount of MSW that is generated, are dependent upon the total population, thus per capita is a nice unit in this context. N/A means that data or information is not available.

The municipality generating most per capita with regard to solid waste is Drammen, as Figure 15 shows. This is the case for the whole period from 2012 to 2015. In general the results are quite stable for all the municipalities, and most stable is Drammen. Comparing values for 2012 and 2015 (see Table 13), only Bergen has a negative change, were the amount of solid waste per capita has increased with almost 6 per cent. Oslo has the most positive change, with an 11 per cent decrease. With regard to indicator 16.3 and how much solid waste is recycled, the results varies a bit from year to year (see Figure 16 and Table 14). Overall the trend is almost the same comparing the municipalities against each other. Asker is recycling the highest percentage of its municipal waste, while Bergen the least. Oslo has increased the recycling rate the most since 2012, with 5 per cent.

Table 12: Quantification of clause 16 solid waste in ISO 37120, based on data at KOSTRA (see Appendix D).

Indicator		Year	Oslo	Bergen	Drammen	Asker	Unit	NOTE
16.1 (core)	Percentage of city population with regular solid waste collection (residential)		N/A	N/A	N/A	N/A	%	This indicator does not exist in KOSTRA. However, it is assumed that this service is available for the whole Norwegian population (Hov, 2015).
Description	*The percentage of city population with regular solid waste collection shall be calculated as the number of people within the city that are served by solid waste collection (numerator) divided by the total city population (denominator). The result shall then be multiplied by 100 and expressed as a percentage.* *The number of households in the city serviced with regular solid waste collection shall first be determined. The number of households being serviced by the regular solid waste collection service shall then be multiplied by the current average household size for that city to determine the number of persons serviced with regular solid waste collection.*							
16.2 (core)	Total collected municipal solid waste per capita	2012	3.83E-01	4.04E-01	5.40E-01	4.34E-01	t/cap	
		2013	3.80E-01	4.34E-01	5.77E-01	4.55E-01		
		2014	3.66E-01	4.49E-01	5.65E-01	4.08E-01		
		2015	3.41E-01	4.27E-01	5.38E-01	3.99E-01		
Description	*The total collected municipal solid waste per capita shall be expressed as the total municipal solid waste produced in the municipality per person. This indicator shall be calculated as the total amount of solid waste (household and commercial) generated in tonnes (numerator) divided by the total city population (denominator). The result shall be expressed as the total municipal solid waste collected per capita in tonnes.*							
16.3 (core)	Percentage of city's solid waste that is recycled	2012	79.42	77.54	82.32	83.23	%	
		2013	78.85	78.42	80.54	83.11		
		2014	79.05	74.42	80.60	80.88		
		2015	83.40	78.00	85.25	86.97		
Description	*The percentage of the city's solid waste that is recycled shall be calculated as the total amount of the city's solid waste that is recycled in tonnes (numerator) divided by the total amount of solid waste produced in the city in tonnes (denominator). The result shall then be multiplied by 100 and expressed as a percentage.*							
16.4 (supportive)	Percentage of the city's solid waste that is disposed of in a sanitary landfill	2012	3.63	0.12	N/A	2.80	%	
		2013	3.28	0.14	2.64	2.43		
		2014	3.16	5.06	2.92	3.01		
		2015	3.27	5.94	2.97	3.45		
Description	*The percentage of the city's solid waste that is disposed of in a sanitary landfill shall be calculated as the amount of the city's solid waste that is disposed of in a sanitary landfill in tonnes (numerator) divided by the total amount of solid waste produced in the city in tonnes (denominator). The result shall then be multiplied by 100 and expressed as a percentage.*							
16.5 (supportive)	Percentage of the city's solid waste that is disposed of in an incinerator	2012	56.49	65.43	50.62	41.74	%	
		2013	55.80	68.98	48.32	40.55		
		2014	56.72	66.86	49.22	45.47		
		2015	57.94	69.81	51.04	41.64		
Description	*The percentage of the city's solid waste that is disposed of in an incinerator shall be calculated as the amount of the city's solid waste that is disposed of in an incinerator in tonnes (numerator) divided by the total amount of solid waste produced in the city in tonnes (denominator). The result shall then be multiplied by 100 and expressed as a percentage.*							

16.6 (supportive)	Percentage of the city's solid waste that is burned openly		N/A	N/A	N/A	N/A	%	Burning solid waste openly is not legal or part of Norwegian practice (KLD, 2004b, KLD, 1981). Thus, the indicator is not relevant in this context.
Description	*The percentage of the city's solid waste that is burned openly shall be calculated as the amount of the city's solid waste that is burned in tonnes (numerator) divided by the total amount of solid waste produced in the city in tonnes (denominator). The result shall then be multiplied by 100 and expressed as a percentage.*							
16.7 (supportive)	Percentage of the city's solid waste that is disposed of in an open dump		N/A	N/A	N/A	N/A	%	Open dump is referred to "*an uncovered space or hole where solid waste is disposed of without further treatment*" (ISO/TC 268/WG 2, 2015). In KOSTRA, values exist for waste that is disposed of at a "deponi", which is a permanent disposing site for waste, a sanitary landfill. These values are applied for indicator 16.4. In Norway waste disposal is strictly regulated (KLD, 2004b).
Description	*The percentage of the city's solid waste that is disposed of in an open dump shall be calculated as the amount of the city's waste that is disposed of in an open dump in tonnes (numerator) divided by the total amount of solid waste produced in the city in tonnes (denominator). The result shall then be multiplied by 100 and expressed as percentage.*							
16.8 (supportive)	Percentage of the city's solid waste that is disposed of by other means	2012	N/A	2.25	1.30	N/A	%	Relevant indicators exist in KOSTRA, but some values are missing.
		2013	N/A	N/A	0.24	N/A		
		2014	N/A	N/A	0.05	N/A		
		2015	N/A	N/A	0.05	N/A		
Description	*The percentage of the city's solid waste that is disposed of by other means shall be calculated as the total amount of the city's solid waste that is disposed of by other means in tonnes (numerator) divided by the total amount of solid waste produced in the city in tonnes (denominator). The result shall then be multiplied by 100 and expressed as a percentage.*							
16.9 (supportive)	Hazardous Waste Generation per capita (tonnes)	2012	3.66E-03	8.47E-03	1.87E-02	9.78E-03	t/cap	
		2013	4.33E-03	8.92E-03	1.97E-02	9.25E-03		
		2014	5.43E-03	1.02E-02	2.05E-02	1.11E-02		
		2015	5.31E-03	1.12E-02	2.17E-02	1.38E-02		
Description	*The hazardous waste generation per capita shall be calculated as the annual total amount of hazardous waste in tonnes (numerator) divided by total city population (denominator). The result shall be expressed as total hazardous waste generated per capita in tonnes.*							
16.10 (supportive)	Percentage of the city's hazardous waste that is recycled	2012	11.71	9.00	10.09	10.51	%	
		2013	13.35	20.00	13.65	12.62		
		2014	10.14	12.59	8.26	9.23		
		2015	12.94	11.90	7.79	3.77		
Description	*The percentage of the city's hazardous waste that is recycled shall be calculated as the total amount of hazardous waste that is recycled in tonnes (numerator) divided by the total amount of a\hazardous waste that is generated in tonnes (denominator). The result shall then be multiplied by 100 and expressed as a percentage.*							

Figure 17 shows the results with regard to how much of the city's solid waste that is disposed of in a sanitary landfill. It clearly shows that in this case Bergen has changed the most and increased its use of sanitary landfill from 2012 to 2015, with about 6 per cent. As values do not exist for Drammen in 2012, the graph shows 0 this year. Interpreting the graph, Oslo is the only one that has decreased its use of sanitary landfill in this period.

The results for indicator 16.5 on waste that is disposed of in an incinerator are quite stable for all the municipalities in the period of concern (see Figure 18). This is the most stable results, and shows a trend that is quite constant and not changing remarkably. Anyhow, the percentage is quite distinctive comparing Asker and Bergen, while Oslo and Drammen are more identical in this case. With regard to hazardous waste generation per capita, though, it is completely different (see Figure 19). For all the municipalities the values have increased. The graph shows that Asker has increased its amount of hazardous waste per capita the most, but overall Drammen generates more. In Oslo kommune the amount is lowest throughout the whole period. Note the values in the y axis. The changes and differences are not that significant.

Considering the percentage of the city's hazardous waste that is recycled, the trend is quite distinctive and not stable at all when comparing the municipalities (see Figure 20 and Table 15). Asker has decreased its recycling rate the most, with over 60 per cent, and Drammen with 22 per cent. In terms of Bergen, the recycling rate has changed a lot. In 2013 Bergen recycled significantly more hazardous waste compared to 2012, 2014 and 2015. However, comparing values from 2012 and 2015, the rate has increased in Bergen with over 30 per cent. In both 2012 and 2015 Oslo recycled the most. It is remarkable that Oslo, Asker and Drammen, which geographically are close to each other, differ that much regarding this indicator.

It is assumed that adding results for indicator 16.3, 16.4, 16.5, 16.6 and 16.7 should be 100 %, which it is not in this case. The reason might be that KOSTRA data used for recycling (indicator 16.3) overlap with values used for incineration (indicator 16.5), as the parameter used for 16.3 does include material recycling, biological treatment and energy recovery from waste. It is not completely clear by ISO what should be included with regard to recycling.

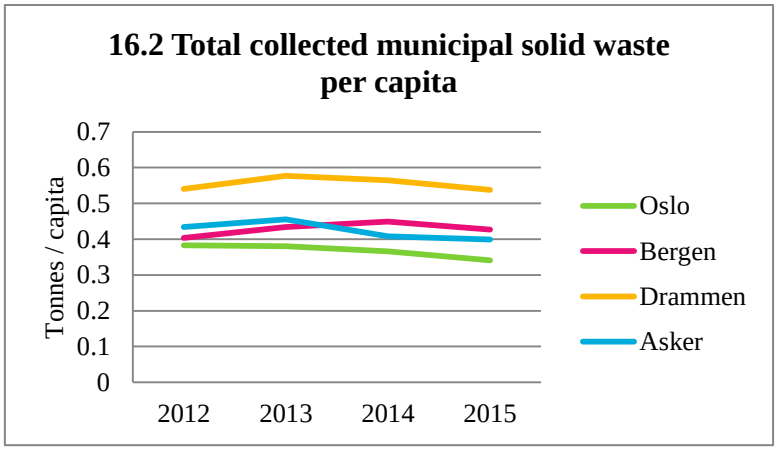

Figure 15: Illustrates the results for indicator 16.2 in ISO 37120: Total collected municipal solid waste per capita [t/cap].

Table 13: Percentage change in total collected municipal solid waste per capita between 2012 and 2015 based on data in Appendix D. Quantification Parameters

Year	Oslo	Bergen	Drammen	Asker
2012 [ton/cap]	0.38	0.40	0.54	0.43
2015 [ton/cap]	0.34	0.43	0.54	0.40
Change [%]	-10.93	5.78	-0.41	-7.93

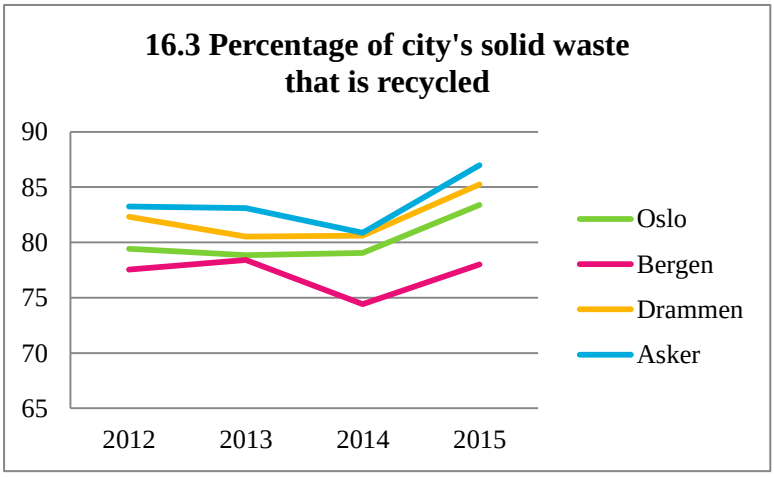

Figure 16: Graph showing results for indicator 16.3 in ISO 37120: Percentage of city's solid waste that is recycled [%].

Table 14: Percentage change of city's solid waste that is recycled between 2012 and 2015, based on data in Appendix D. Quantification Parameters.

Year	Oslo	Bergen	Drammen	Asker
2012 [%]	79.42	77.54	82.32	83.23
2015 [%]	83.40	78.00	85.25	86.97
Change [%]	*5.01*	*0.59*	*3.56*	*4.49*

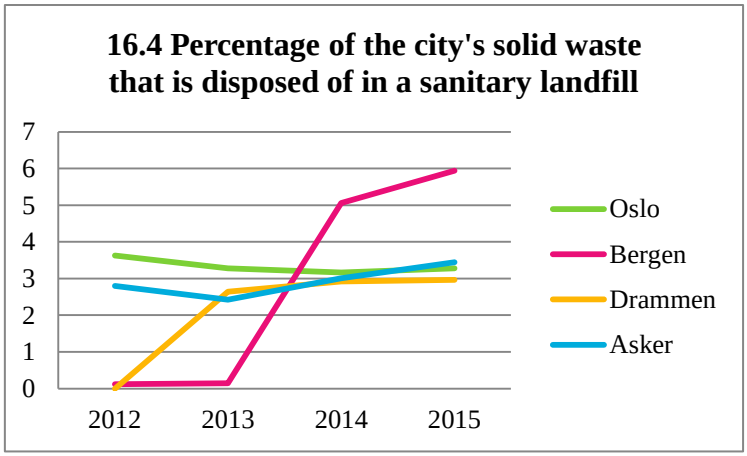

Figure 17: Graph showing results for indicator 16.4 in ISO 37120: Percentage of the city's solid waste that is disposed of in a sanitary landfill [%].

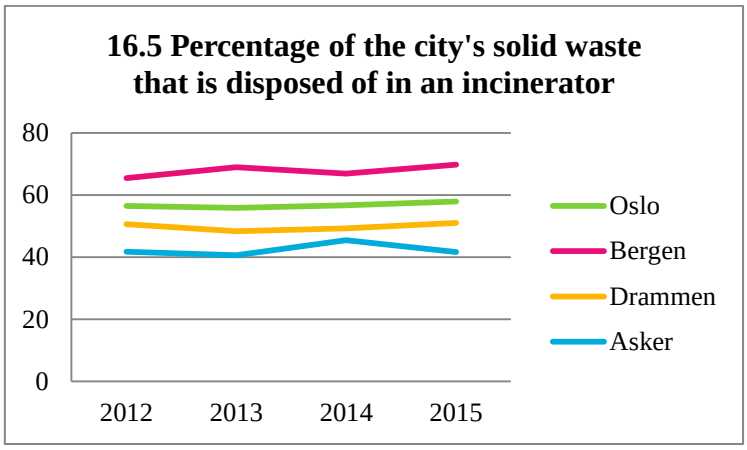

Figure 18: Graph showing results for indicator 16.5 in ISO 37120: Percentage of the city's solid waste that is disposed of in an incinerator [%].

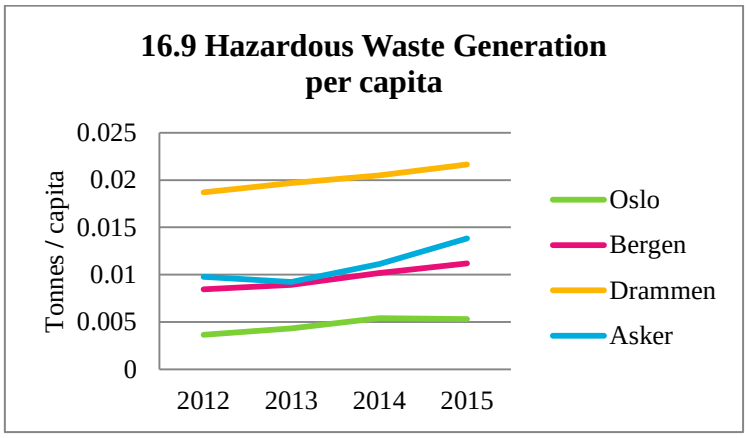

Figure 19: Graph showing results for indicator 16.9 in ISO 37120: Hazardous Waste Generation per capita [t/cap].

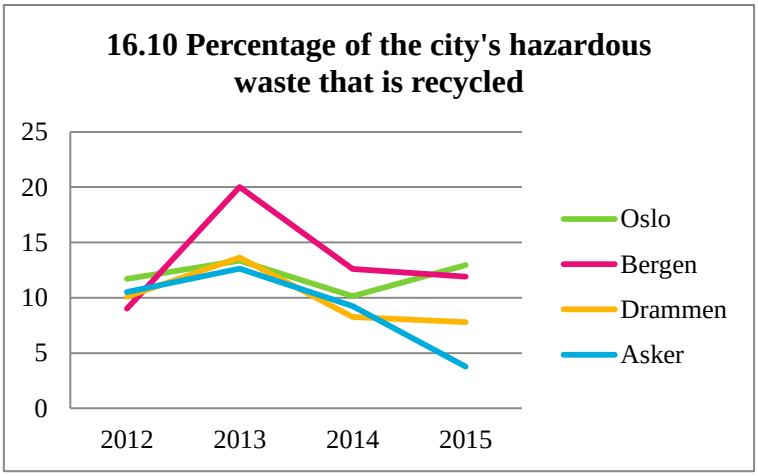

Figure 20: Graph showing results for indicator 16.10 in ISO 37120: Percentage of the city's hazardous waste that is recycled [%]

Table 15: Percentage change of city's hazardous waste that is recycled

	Oslo	**Bergen**	**Drammen**	**Asker**
2012 (%)	11.7	9.0	10.1	10.5
2015 (%)	12.9	11.9	7.8	3.8
Change (%)	*10.5*	*32.2*	*-22.8*	*-64.2*

5.2.2 Quantification summarized

Quantification shows that it is absolutely feasible and possible applying ISO 37120 regarding solid waste by using KOSTRA data. These are the best data available with regard to management of municipal solid waste. However, for some of the indicators data does not exist. It is possible compare municipalities and cities with regard to performance over time, and to identify trends and tendencies.

5.3 Relating Analysis to Empirical data

The questionnaire analysis and quantification will be connected more closely with empirical data and analysed together, as these are all parts of the mixed methods triangulation.

5.3.1 Questionnaire

The waste management systems is overall considered and evaluated to be satisfying. However, Bergen kommune and BIR had quite distinctive responses. Bergen kommune was the most negative respondent with regard to the question on to what extent the system was

considered to be satisfying. Bergen responded it was satisfying to a low extent as it does not exist any proper waste management standard. According to Bratland (2016) there are not developed a standard due to variations in waste management practice. Akervold's (2016) impression, on the other hand, is that in the waste management industry, one is a bit conservative and do thing the way one has always done it, which is disadvantageous with regard to future development. On the contrary, BIR is quite confident with the management system, compared to Bergen kommune. In general, there is high agreement among the respondents that the waste management systems are satisfying. This might be related to the fact that most of the respondents answered that it is developed a strategy plan and a communication plan with regard to waste management locally, as well as some are certified according to ISO 14001 or Eco Lighthouse.

According to the questionnaire responses and result, what is least challenging (in terms of the response categories formulated and defined), is reporting and measuring. However, the main challenge with reporting and measuring itself, is the accuracy. The study and questionnaire indicates that there is lack in trust in KOSTRA data. Especially the WMAs are sceptical to the quality of it, and are not utilizing it to monitor activities and performance. With regard to LAs, other data with better quality do not exist (Akervold, 2016). Thus, the best data available is through KOSTRA. In terms of the questionnaire, a reason is the inter-municipal agencies collection of waste and data, which is not separated for each municipality. Thus, precise waste data from each municipality is not available, as the waste is collected and transported to the same handling plant. As a result, data is based on parameters and factors such as population. Collected and reported data are total values for the whole area, which might be incorrect when distributing to each municipality. Another reason for the imprecise data might be the variations in waste management practise. Despite the lack of trust in data, SBB are on the other hand content and satisfied with the data quality and reporting. Their impression is that the main challenges are differentiating between commercial and domestic waste at the recycling plants.

As the questionnaire results show, none of WMA are utilizing KOSTRA data actively, such as RfD. According to BIR, internal data and information are applied instead and there is a high focus on improving the reporting procedures and data quality. Some are also part of NWMRA's waste management benchmarking program, which are targeting towards agencies

and their activities. Asker and Drammen (RfD) are for instance part of the program. Through this program best practise is shared, as well as comparison across agencies is performed.

RfD do not think the standard will contribute with any new insight or knowledge. As there already exist several reporting systems (KOSTRA with regard to monitoring of activities at local level and a benchmarking system to the WMAs), the solid waste indicators will not directly contribute with new insight or new data. As KOSTRA is not actively utilized, and since most does not know if it is used or uses it partly, ISO 37120 might be more easily adapted and applied as it is less comprehensive. Compared to KOSTRA data shall be presented differently, as percentages and tonnes per capita, which might be more comprehensible. This is beneficial and may contribute with regard to communication of performance and results across levels in the organization and to stakeholders.

ISO 37120 is a standard few have heard of, as Bratland (2016), Tveter (2016b) and other respondents indicate. However, it can contribute in creating consensus and common understanding on important topics, which also is one of the functions of KOSTRA. But as mainly the LAs apply and utilize this reporting system, and the WMAs other benchmarking systems, the standard might be useful to connect these institutions. Additionally, the questionnaire shows that an important area of focus is communication with households. This is important to both groups and institutions. Thus, the standard can contribute in this regard, in internal and external communication, even though communication is not one of the main challenges.

5.3.2 Quantification

Quantification analysis shows that data are available for most of the indicators, and that application of standard is that case is possible. Despite difficulties with regard to controlling and monitor exact data and values for local waste management, application is possible. There are data available to be applied. Additionally, the KOSTRA system is much more comprehensive than ISO 37120, as it consists of more indicators.

KOSTRA is good at making consensus and common understanding of data, but this weakens the data, as the practise is different across communities and districts (Akervold, 2016). There is also the impression that within the WM industry, there is low interest in standards. The

quantification makes comparison feasible across communities, which also KOSTRA does. However, according to BIR, KOSTRA is not any good at comparison. The reason might be due to inaccurate data and data quality, or that to a WMA the comparison is not feasible.

As Bratland and RfD indicates, some indicators within solid waste in ISO 37120 are not relevant in Norwegian context. Anyway, as the standard shall be adjusted to the local context the most relevant ones may be selected. However, core indicators must be included when implementing the standard. Even though all the indicators themselves might not contribute extensively, it can be relevant as a communication tool. Additionally, such quantification would be interesting across nations and cities, in an international perspective and context, especially if the whole standard is considered. It could be applied as a benchmarking tool.

Overall, management system, communication procedures and measuring and reporting are all considered being satisfying, even though there is lack in trust with regard to data quality. Because these aspects are satisfying and not main challenges and issues, ISO 37120 and clause 16 on solid waste is evaluated to not be directly relevant in a Norwegian context. Additionally, through KOSTRA comparison with other municipalities is possible. On the other hand, the interest in being compared with communities outside Norway is varying, but some are quite positive. Thus, ISO 37120 can contribute in this regard, as it is an international standard that have different contexts and nationalities in mind.

6. Results

Findings and results of the analysis will be presented. By having analysed the questionnaire responses and the quantification process in relation to other qualitative data, findings with regard to possible application of ISO 37120 will shortly be presented.

6.1 Possible Application of ISO 37120 in Waste Management

Qualitative results indicate that waste management systems are considered to be satisfying at the local level. Additionally, measuring and reporting is not one of the main challenges, neither are communication (internally/externally). On the other hand, increasing the recycling rate, reduction of negative environmental impact and collection of waste is considered to be the most challenging aspects locally.

Quantification indicates that performance indicators on solid waste can be applied to local communities in Norway. Oslo, Bergen, Drammen and Asker were utilized as examples to illustrate how solid waste indicators can be applied. It shows that most data needed to calculate the indicators are available through KOSTRA and SSB. Analysing the results, there are variations regarding how the municipalities perform, depending on each indicator. But overall, the municipalities share the same trends, as the graphs shows.

In general terms, it is practically possible to apply solid waste performance indicator in ISO 37120 at a local level in a Norwegian context. However, the standard does not contribute with any new solid waste indicators, except that values shall be presented as percentages and tonnes per capita. If implementing the solid waste indicators alone, it is assumed that in a Norwegian context this would be most useful with regard to comparison with communities and cities outside Norway, to share experiences and best practice. The questionnaire shows that some local authorities would be interested in such comparison, as most of the respondents are either interested or undecided.

7. Discussion

The results will be discussed and connected to theoretical resources, background and context, as well as more closely to the research issue. This chapter is separated in three parts. In the first part the results of the analysis is discussed, and secondly a final evaluation of possible application of *"ISO 37120 Sustainable Development in Communities – Indicators for city services and quality of life"* is presented. Finally, the validity and reliability of the study is emphasized.

7.1 Results and Research Issue with regard to Context and Theoretical Resources

Could ISO 37120 be useful and utilized by Norwegian municipalities as a tool regarding solid waste management and associated environmental challenges, to improve environmental sustainability performance? Practically it is possible to apply solid waste performance indicators in ISO 37120 at a local level in a Norwegian context, but how useful it would be and how it could contribute will be discussed further, by relating it to theoretical resources, context and background of the study. As an introduction, the interconnection between human society, environmental challenges and waste generation will be emphasized further.

7.1.1 Human society, environmental challenges and waste generation

There are three systemic characteristics that are common to most environmental challenges that the world are facing today (EEA and NEA, 2015). First of all, human health, prosperity and standard of living are influencing the natural environment and Earth system. Secondly, consumption patterns and resource use, and thirdly European and Global trends are common characteristics. Accumulation of solid waste in society has environmental consequences as shown (Harrison et al., 2007). Historically, waste has been removed from human environment due to public health problems. The industrial society developed management systems quite rapidly during the second half of 20th century, to reduce health risks and to protect the environment and resources. In the industrial society, the main challenge has been the connection between waste generation and wealth and prosperity creation, and in the future, it is desirable to decouple these factors - the economic growth - from waste generation (Christensen, 2011). The planet has certain ecological limits, and consumption and production must take place within these limits (Ghisellini et al., 2015).

According to Christensen there are some waste management criteria that should be considered in all waste management planning. One of these criteria's is that the load on the environment should be as low as possible (in terms of noise, contamination to air, water and soil). There should be greener solutions and better waste management, with the aim of reducing the reliance on landfill. Proper management of solid waste will not only reduce negative environmental impact, but also result in increased resource efficiency. These are important aspects in order to avoid long-term negative consequences to health, environment, nature and climate. Waste management systems that follow the waste hierarchy will be good for the environment, as well as it will make humanity less dependent upon primary, natural resources. The waste hierarchy is one of the main waste policy principles, and waste is starting to be addressed as a resource and not a problem. By closing the loop through reuse, recycling or other resource recovery, natural resources will be saved and there will be less negative environmental impact and health related problems (Harrison et al., 2007).

Proper knowledge about waste generation is a prerequisite for planning and designing good waste management systems (Christensen, 2011). In this regard, social metabolism and the DPSIR-framework are two concepts that can be useful in understanding such processes. Social metabolism and the transition into industrial societies are connected to consumption habits and the increasing requirements of natural resources, and the DPSIR (Driver-Pressure-State-Impact-Response) model illustrates the connection and interactions between human and environmental systems. As the planet are facing several, important sustainability issues that are all interconnected (Houghton, 2015), ISO 37120 could be part of the response category, as a management tool, as 'response' can be certain mitigation or adaptation strategies. Global warming and climate change are two of such sustainability issues, but consumption and waste generation are two other (Burkhard and Müller, 2008).

7.1.2 Waste management performance

In local environmental management, MSW is an important component (ISO/TC 268/WG 2, 2015). In an international perspective, many cities generate more waste than what they can handle and dispose of, which contribute to environmental problems. Thus, a proper waste management system is crucial. Some places open dumping and burning of waste as well as unsanitary landfills are common disposal methods, especially in places with budgetary limitations. Only in a limited amount of cities worldwide, sanitary landfills are the norm,

compared to unsanitary ones. As shown in Table 5 in Chapter 3.5.3, there are various environmental consequences and impacts depending on disposal method, such as emissions and contaminations of substances and chemicals to air, water and soil. Thus, an international standard to monitor and benchmark solid waste management, are useful.

Domestic waste is contributing a lot to the total amount of waste in Europe, and the amount in each country varies (EEA, 2013). In Norway the amount of domestic waste per capita is actually 10 kg lower than the European average, according to data from 2012 (NEA, 2014d). Additionally, the recycling rate is increasing. In 2013, 81 % of the Norwegian waste was recycled (NEA, 2015c). The study and quantifications shows that in 2015 the percentage of MSW that was recycled (indicator 16.3) was even higher for three of the municipalities of concern. In Oslo, 83.4 % of MSW was recycled, in Drammen 85.2 % and in Asker as much as 86.9 %. In Drammen it was lower than the national average, as 78 % was recycled in 2015. Relating this to the target suggested by the EU commission with regard to the action plan towards a circular economy, 65 % of the MSW should be recycled within 2030. Hence, in a Norwegian context the target is already reached.

7.1.3 Performance indicators

In the national report on EU issues of priority to the Norwegian Ministry of Climate and Environment, it is mentioned that EU is suggesting that the environmental reporting and monitoring requirements are assessed (KLD, 2016). This to evaluate if these are still functional and suitable. A consistent method to measure changes, development, performance and goal attainment, will contribute to - and ensure that EU's goals regarding waste management is achieved. In this regard, international standards such as ISO 37120 and performance indicators could contribute and be related, as indicators can be considered as *"tools to build support for needed change and guide the actions of management"* (Skaar, NTNU, 17.09.15).

As a way of contributing to sustainable waste management, ISO 37120 is a possible tool to be applied, to measure performance. There are several articles about performance indicators with regard to waste management, whereas many are suggesting one or two indicators for specific contexts (Zaman and Lehmann, 2013, Sanjeevi and Shahabudeen, 2015, Wilson et al., 2015, Huang et al., 2011, Mendes et al., 2013, Font Vivanco et al., 2012, Rigamonti et al., 2016).

Some are for instance suggesting zero waste indexes and indicators to measure waste management performance in cities (Zaman and Lehmann, 2013, Rigamonti et al., 2016) and others waste management indicators for benchmarking of city performance, aiming at raising stakeholder awareness of local solid waste management systems (Wilson et al., 2015). However, none of them mention ISO 37120. This might be because this standard does not only consider solid waste but other topics and city services as well.

There are lot of various indicators that are suggested to monitor MSW management, but ISO has tried to make it simple and understandable with a global context in mind. According to Rigamonti et al. (2016) the main challenge is to define simple and at the same time comprehensive indicators that may be understood and calculated by other than scientists and experts, such as local administrators and managers. With reference to quantification of solid waste indicators in ISO 37120, it is evaluated that ISO in this case has managed to develop a simple framework which can be applied at a local level by local administrators.

Manfredi and Goralczyk (2013) call for more detailed and quality-assured waste statistics, especially statistics which covers different treatment operations and options. In a Norwegian context there are detailed waste statistics for different treatment options, but as the study shows the data quality can be improved. Among both local authorities and waste management agencies, there is a lack in trust in the data quality of the reporting and information system. With regard to international solid waste management, other claims that there exists a twofold problem (Wilson et al., 2015). First, there is a lack of data, and secondly, a lack of consistent data to allow comparison between cities. Hence, in this regard ISO 37120 could contribute to an extent as well.

KOSTRA and ISO 37120

Compared to ISO 37120, KOSTRA has more indicators within solid waste as it is a comprehensive system. The system separates between materials and resources, as well as different treating solutions such as “plastic delivered to recycling plant”. KOSTRA do also include data related to biogas and composting, reuse and energy recovery, which ISO does not. ISO 37120 do not offer as comprehensive and detailed solid waste indicators as KOSTRA. On the other hand, the ISO indicators are more easily understandable and can be applied by others than scientists. Thus, it does also make comparison between cities feasible, as the standard also consists of profile indicators to categorize various cities and communities.

Hence cities with similar profile will be compared to each other. This way, it is assumed that the indicators also can contribute in stakeholder awareness as an external communication tool. However, communication is not identified as a main challenge with regard to local waste management in Norway, but it is an important area of focus, especially with regard to the private households. The standard could be applied to make indicators and performance visible in an easy understandable way to stakeholders.

With a Norwegian context of consideration, the study shows that some indicators are not relevant, such as 16.1 which actually is a core indicator that examines the percentage of the population with regular solid waste collection (see Table 12 in Chapter 5.2.1). This indicator does not exist in KOSTRA as it is assumed that this service is available to the whole Norwegian population (Hov, 2015). In addition, indicator 16.6 and 16.7 are not relevant. Burning of solid waste openly (16.6) is not legal or part of Norwegian practice (KLD, 2004b, KLD, 1981). As 'open dump' is referred to *"an uncovered space or hole where solid waste is disposed of without further treatment"* by ISO (ISO/TC 268/WG 2, 2015), and since waste disposal is strictly regulated in Norway, indicator 16.7 is evaluated to not be relevant as well (KLD, 2004b).

According to Hov (2015), data is available for 6 out of 10 indicators within solid waste, having Trondheim kommune as a case. This is also the case with regard to Oslo, Bergen, Drammen and Asker. In addition some data was available for a seventh indicator (indicator 16.8) in Bergen and Drammen in 2012 only. Thus, indicator 16.8 does exist in the KOSTRA system, but with most data missing. This is the case regarding indicator 16.4 (percentage of the city's solid waste that is disposed of in a sanitary landfill) as well, as it exist in the KOSTRA system, but with no data available. Thus, data are missing in the KOSTRA system with regard to both indicators 16.4 and 16.8.

7.1.4 Goals and strategies

According to Skaar (NTNU, 17.09.2015) *"Indicators communicate information about progress towards stated goals"*. In this regard, there are not any concrete goals developed by the ISO framework, or no description of when the society can be identified as sustainable, based on the indicators. As the standard should be adjusted to the local context, is could be related to national and local goals and strategies when selecting what to focus on and what is

most relevant. In terms of Norway, national environmental goals with regard to pollution would be relevant (see Chapter 3.4 Goals, Strategies and Trends). Indirectly, Norway's goals regarding climate issues could also be related to waste and waste management, as several disposal methods lead to emissions of GHGs, such as emission of methane due to landfilling or composting. Additionally, it could be related to regional and international goals and strategies as these guides the national ones, such as UN SDGs, the EU agenda towards a circular economy and regional waste directives.

UN SDGs of relevance

According to Hov (2015), three of the SDG targets are of relevance with regard to clause 16 on solid waste in the standard: Target 11.6, 12.4 and 12.5 (see Table 16). However, target 12.3 does also consider waste management, and more precisely food waste. Thus, it is not related to any of the solid waste indicators in ISO 37120, as there are no indicators on food waste specifically. Food waste is one of the main areas of focus in the regional waste directives. Thus, in a regional, as well as a national and global perspective, a food waste indicator would be useful. KOSTRA does not have an indicator on food waste specifically either, but a 'wet organic waste' indicator which includes food wastes. Recycling of food waste is common practice in most Norwegian municipalities, but not in all of them as there are variations in the systems. The SDG targets are focusing on both consumption and waste generation, which are interconnected topics.

Table 16: UN SDGs of relevance with regard to solid waste indicators in ISO 37120

Goal	Description	Target	Description
11 Sustainable cities and communities	Make cities and human settlements inclusive, safe, resilient and sustainable	11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
12 Sustainable consumption and production	Ensure sustainable consumption and production patterns	12.3	By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses
		12.4	By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
		12.5	By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

Towards a Circular Economy

The high agreement among both WMAs and LAs on the importance of increasing the recycling rate might be due to the growing trend and focus on a circular economy (CE). In light of the transition into a CE, ISO 37120 clause 16 solid waste may contribute as a tool. However, by adding several indicators that consider various waste categories more specifically, as well as reuse of resources, the standard would be even more relevant. Thus, the existing framework is insufficient in terms of the CE, as it should to be more detailed. The European Commission is suggesting that 75 % of all packaging material should be recycled, as a result of the CE action plan. Neither ISO 37120 nor KOSTRA consider packaging material by having it as an isolated and single indicator. However, in KOSTRA it is separated between plastics, glass, paper and other materials. Thus, packaging in considered indirectly.

The European Commission has also suggested a 10 % gradual reduction of MSW transported to open dump. Indicator 16.7 in ISO 37120 considers this disposal method, but data at KOSTRA is not available. Other relevant indicators in regard of the CE concept is indicator 16.3 on percentage of city's solid waste that is recycled, as well as 16.9 Hazardous Waste Generation per capita. Even more important is indicator 16.10 Percentage of the city's hazardous waste that is recycled. Recycling is not only beneficial in terms of primary resource extraction, but also in terms of landfill space saved. There are both social and economic advantages by recycle and reuse material and resources. According to EEA (2013), recycling are generating economic growth, promoting innovation and creating workplaces. It is an important part of the transition into a green and more sustainable economy – an economy that generates growth at the same time as it is preserving the natural environment and human society. According to the waste hierarchy what is even more important than recycling, is waste prevention and reuse of resources. In this regard, an ISO indicator on how much of a certain waste category or resource is reused would be useful.

7.1.5 Opportunities and challenges of standard

Even though the study indicates that the overall interest of applying ISO 37120 is low, it might be useful to an extent. Several respondents commented that KOSTRA are not good at comparison and thus it was not utilized actively. Additionally, another respondent identifies measuring and reporting as a challenge with regard to local waste management. In terms of these aspects, the standard might be useful to an extent.

Reporting and measuring

According to Jahren (NTNU, 11.05.2016) Norway has one of the best waste management systems, as it is strictly organized and regulated (see Chapter 3.3 Laws, Regulations and Responsibility). In general, the waste sector is one of the most regulated sectors in modern society (Christensen, 2011). At the same time, the study indicates that there are insufficiencies with regard to reporting and measuring, which is exemplified below.

According to Harrison et.al (2007) smaller households tend to create more waste in some countries, but in terms of EC (2013) these factors, consumption rate and household size, are decoupled from solid waste generation. As the parameters utilized for quantifying the solid waste indicators in the study shows, the household size decreased a little bit from 2012 until 2014 in all municipalities, and then increased in 2015. These parameters clearly show that the bigger the city is (in terms of population) the lower is the household size. Thus, for all years of consideration, the household size is lowest in Oslo and highest in Asker. But by addressing results for indicator 16.2 “Total collected municipal solid waste per capita”, the tendency is not as Harrison et.al claimed. The amount of waste, tonnes per capita, is actually higher in Asker than in Oslo for all years of consideration. This might be due to different reasons, such a tendency of more garden waste in Asker than in Oslo, as an example, or variations in reporting and data quality were separations of commercial and domestic waste is incorrect (Vinju, 2016).

This indicates that KOSTRA might not be as good at comparison, due to practical variations, which several of the questionnaire respondents indicated as well (Bjordal, 2016, Igesund, 2016, Austigard, 2016, Svendsvoll, 2016). As ISO 37120 aims at making consensus on what shall be included and how the indicators are calculated, the standard might be a sufficient tool with regard to making feasible comparisons on performance.

Terms and common understanding

According to Christensen (2011) "*A terminology is important for understanding the waste management system and for communication, but a generally accepted terminology do not exist within the solid waste community*". In Norway there is an established waste management terminology, which is utilized consistently. Some terms are for instance defined in laws and regulations of relevance (see Chapter 3.3.2). Terms are described and defined, but with a

Norwegian context in mind. In a Norwegian perspective, adding other definitions from ISO might be confusing, and create more confusion and "chaos" than order. But in an international perspective, a solid waste terminology would be useful. ISO and Norway do share the understanding of some terms and definitions, but there are also some differences. For instance, there are variations in how MSW is defined and what it includes (see Chapter 3.1). Also national guiding standards exist (see Chapter 3.2.2) which focus on waste statistics and terminology, as well as comparison of facility plant across districts.

An advantage of ISO 37120 is that cities and communities around the world will have the same understanding of relevant concepts and applying the same indicators. Terms are clearly defined, as well as how the indicators shall be applied and calculated.

Application

There are larger differences in waste management practises around the world (Christensen, 2011). There are variations on how the waste is handled, for different reasons. Thus, all performance indicators within solid waste in ISO 37120 might not be just as important one place as in another place. In a Norwegian context, the indicator on how much waste is burned openly, are for instance not relevant as this is not legal. As the waste management systems are not as good in developing countries, it is assumed that the standard might contribute more in these areas. However, if Norwegian cities and communities apply the standard, it could be useful to cities in other parts of the world, by developed countries such as Norway being "role models" and good examples. Using the standard as a benchmarking tool, this could inspire other countries and cities. By implementing the standard it will be easier for cities, communities and municipalities to learn from each other and share experiences and best practice. The indicators can help monitoring and tracking performance, progress and development (of city services and quality of life) over time. It is assumed that the standard would be more useful in comparing performance across countries, even though it also could be useful within them.

7.2 Final Evaluation of ISO 37120

As the standard addresses sustainable development of cities and communities, it can be related to the UN SDGs and also the transitions towards a circular economy. All the initiatives are developed to, and with the intention of, solving challenges. One of these challenges are

connected the natural environment and climate, which is the approach and angle of incidence for the study. There are several initiatives on this area, and several agreements, action plans and goals at all levels. As the challenges are global, an international standard with regard to sustainable development is useful. Thus, the connection between ISO 37120, the circular economy concept and UN SDGs, is that these are suggesting solutions towards a sustainable development of our economy and the society. The action plan towards a circular economy is actually a contribution in reaching the SDGs. Sustainability and sustainable development is complex, and ISO has tried to capture the complexity and developed a standard to measure performance across local contexts.

7.2.1 Contribution at a local level in Norway

As the focus in the study is on solid waste, the whole standard is not included and emphasized. However, in a local context in Norway, results indicate that the solid waste clause alone would not be directly relevant and contribute extensively with new insight. On the other hand, if the whole standard is implemented locally, in a city or community, it is assumed that the standard would be more useful, such as in planning processes and in decision- and policy- making. If only considering solid waste, it can be useful in comparison across nations and cultures, as the standard makes international comparison feasible through an established consensus on important topics, aspects, terms and definitions.

As a comprehensive reporting and information system, which also considers waste management, already exists in Norway (KOSTRA), ISO 37120 would not contribute extensively as a reporting and measuring tool. Within KOSTRA it is possible to compare various municipalities against each other. These systems are more comprehensive and data intensive, as it includes more indicators on solid waste than ISO 37120. The study indicates that the interest of ISO 37120 is lowest among the WMAs, which might be due to an already existing benchmarking tool, as well as lack in trust in KOSTRA data, which is applied for the quantification.

7.2.2 Suggestions for possible solid waste performance indicator in ISO 37120

Even though the standard could be more comprehensive with regard to solid waste indicators, it is developed with a global context in mind. As there are various waste management practices around the world, the standard include ten important indicators that may be

applicable to various nations and cultures. At the same time, the standard are to be adjusted to the local context, by selecting the most important and relevant indicators. Thus, it should also be possible to add certain indicators, for instance in Europe in terms of the transition into an economy that is more circular than linear.

In light of existing indicators in KOSTRA, the transition towards a circular economy and the UN SDGs, there is identified certain aspects that should be considered within the solid waste section in ISO 37120 as well. In order to be more sufficient the standard should include indicators with regard to food waste and composting. Food waste is important in the regional waste directives as well as in the UN SDGs. Additionally, reuse of resources and recycling rate of packaging material, is also evaluated to be relevant and beneficial in terms of the initiatives.

7.3 Validity and Reliability

In social research validity and reliability are crucial criteria, which can be high or low (Bryman, 2008). The validity indicates how well one has assessed and addressed what one was supposed to study. To what degree are the results of the study well-founded and accurate? The study is considered to be valid as several actors within local waste management has been contacted and taken into consideration when addressing the research issue. The theoretical background is well-founded, which makes the basis for the research methods. However, as the study is based on limited sample, the external validity (which indicates whether it is possible to generalize the results if it is based on a limited sample) could have been more robust. The results would have been more robust if there were more respondents to the questionnaire along with more in-depth interviews.

Reliability, on the other hand, indicates whether the results are consistent, stable and trustworthy. Are the questionnaire responses consistent and repeated? It is evaluated as a strength that both local authorities and local waste management agencies responded to the questionnaire, even though some questions were difficult to answer. It would have been favourable if there were more respondents, to increase reliability and quality of the results. Potentially, there could have been more qualitative data extracted from the survey if the respondent were able to write the answers themselves, without response categories, presumed that they would take their time to answer in a complete and informative way.

The analysis is performed based on some limitations. If there were more respondents to the questionnaire, the results and conclusion would have been more well-founded, robust and reliable. Even though the intention was to focus on a Norwegian context and local communities, a regional and international perspective has been included as well. This is the case as the standard of consideration is an international one that aims at making feasible comparisons across nations.

8. Recommendations, Conclusion and Further Work

A few recommendations with regard to local waste management and ISO 37120 will be suggested based on the study, followed by a final conclusion. Lastly, possible further work will be presented.

8.1 Recommendations

When implementing the standard, all of the clauses and sections should be included, even though solid waste were the focus for the study, as part of the sustainability challenges and transition towards a circular economy. It is important to consider several city services and indicators across themes, to get a complete impression of the sustainability performance of a city or community. Waste management is not an isolated topic and issue regarding urban development, as it is connected and related to other important topics such as human health, quality of life, cleanliness, local economy, social understanding and education, and environment (ISO/TC 268/WG 2, 2015).

8.2 Conclusion

The study shows and indicates that in a Norwegian context the solid waste section in ISO 37120 will contribute as a waste management tool to a limited degree, even though it is practically possible to implement it. Through KOSTRA and benchmarking systems, comprehensive indicators already exist. However, the standard can contribute on some areas. If implementing the solid waste indicators alone, it is assumed it would be useful in comparison with communities and cities outside Norway, to share experiences and best practice. Even though Norway has efficient and well run waste management systems compared to other societies and nations, the standard could be relevant as a benchmarking tool to inspire other societies and contribute in making more sustainable systems in other cities and regions. Thus, the standard might not be, in terms of the solid waste section, directly relevant in a Norwegian context, but indirectly. With regard to overall sustainability performance of city or community, the whole standard should be implemented. It is assumed that ISO 37120 would be more relevant in a Norwegian context if the whole standard were implemented and applied, and not only one topic. Hence, comparisons among cities and communities within the country would be more beneficial as well.

8.3 Further Work

In further research and work an international context will be useful, for instance by comparing implementation of ISO 37120 across regions and nations. It is also recommended that the whole standard and all its clauses are assessed, by not focusing on one of them. Another suggestion for further work is to compare the UN SDG indicator framework (which is not launched and completed yet) with ISO 37120, in terms of measurement of sustainable development.

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BJORDAL, H. 2016. Miljøsjef. Bergen kommune [Email correspondence, Survey]
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BRATLAND, H. 2016. Fagrådgiver. Avfall Norge [Email correspondence and interview]
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MEISSNER, R. 2016. Fagansvarlig renovasjon, IVAR IKS. Stavanger kommune med flere [Survey]
NÅRSTAD, M. 2016. Enhetsleder kommunalteknikk. Fet kommune [Survey]
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Appendix A. Questionnaire and Summary of Responses

The table below shows all questions, a summary of the results and the number of responses to each question. Additionally, some notes are included in the column to the right. Three respondents are marked with stars, to illustrate that these are inter-municipal agencies that responded on behalf of more than one municipality (Stavanger*, Drammen** and Bergen***). In addition, Stavanger and Bergen is marked with stars in order to distinguish the responses from the local authorities and the waste management agencies.

Survey Questions		**Results**	**Number of Responses**	**Note**
1	Stilling / ansvarsområde	Faggruppeleder gjenvinning, Seniorkonsulent/internasjonalt arbeid - strategiutvikling, Miljørådgiver, Konsulent, Avdelingsleder VA, Enhetsleder kommunalteknikk, Fagansvarlig renovasjon - IVAR IKS, Tekniske tjenester, Senior prosjektleder, FOU-sjef i BIR AS, Seksjonsleder for miljø og renovasjon, Driftssjef, Miljøvernsjef, Miljøsjef	14	Respondents from waste management agencies and local authorities
2	Hvilken kommune besvares spørsmålene for?	Asker, Oslo, Hamar, Nittedal, Rælingen, Fet, Stavanger***, Gjerdrum, Drammen/RfD*, Bergen/BIR**, Sandnes kommune, kommunene Time, Rennesøy og Kvitsøy, Stavanger, Bergen kommune	14	Bergen and Stavanger responded more than once
3	Er kommunen med i et interkommunalt avfallsselskap?	Ja: 10 Nei: 2 Annet: 2	14	
4	Har kommunen en egen avfallsstrategi (delplan/handlingsplan for avfallshåndtering)?	Ja: 8 Nei: 5 Annet: 1	14	
5	Hva fokuseres det på i din kommune innen avfallsområdet?	Ny teknologi / nye løsninger for innsamling: 10 Økning av gjenvinningsgraden / effektiv utnyttelse av ressurser: 11 Strategier for å redusere avfallsmengden: 10 God kommunikasjon med husholdningene: 11 Samarbeid med næringslivet mtp løsninger for næringsavfall: 3 Vet ikke, kan ikke svare: 0 Annet: 2	14	Multiple options possible. Checkboxes.
6	Hva blir ansett som hovedutfordringene innen avfallsområdet i din kommune?	Innsamlingen av avfallet: 5 Selve håndteringen etter innsamling: 3 Det økonomiske / kostnadene: 3 Kommunikasjon mellom ulike aktører: 3 Rapportering og måling: 1 Å øke gjenvinningsgraden: 8 Å redusere negativ miljøpåvirkning: 6 Vet ikke, kan ikke svare: 2 Annet: 3	14	Multiple options possible. Checkboxes.
7	Gjennom KOSTRA-systemet rapporteres det inn data om avfallshåndtering til SSB. Blir disse dataene brukt aktivt i miljøarbeidet innen avfallsområdet i din kommune?	Ja: 3 Nei: 2 Delvis: 4 Vet ikke, kan ikke svare: 4 Annet: 1	14	

8	Dersom "ja" på forrige spørsmål: Hva blir dataene brukt til?	Utforming av nye avfallsplaner- og strategier: 4 Ekstern kommunikasjon: 4 Intern kommunikasjon: 4 Tiltak og mål: 4 Vurdering av måloppnåelse: 3 Ikke relevant: 0 Vet ikke, kan ikke svare: 1 Annet: 2	9	Multiple options possible. Checkboxes.
9	Hva er hovedutfordringene med slik rapportering?	Tidkrevende: 2 Kostander: 0 Nøyaktigheten: 9 Det er ikke identifisert noen utfordringer: 1 Vet ikke, kan ikke svare: 1 Annet: 2	12	Multiple options possible. Checkboxes.
10	I hvilken grad er dagens styringssystemer innen avfallsområdet i din kommune ansett som gode?	1 (liten grad): 0 2: 1 3: 1 4: 11 5 (høy grad): 1	14	
11	I hvilken grad vil du si at samarbeidet mellom kommuneadministrasjonen og renovasjonsselskapet i din kommune fungerer godt?	1 (liten grad): 0 2: 0 3: 1 4: 7 5 (høy grad): 6	14	
12	Har din kommune utarbeidet en kommunikasjonsplan/-strategi, som også gjelder for avfallsseksjonen?	Ja: 6 Nei: 4 Vet ikke, kan ikke svare: 1 Annet: 3	14	
13	Er din kommune kjent med standarden (ISO 37120) som er beskrevet ovenfor?	Ja: 0 Nei: 4 Usikker: 9 Annet: 1	14	The answering option "ja" was missing in the survey, unfortunately. Thus, the one that responded "annet", have heard about the standard.
14	I hvilken grad tror du denne standarden kunne vært aktuell som et verktøy for din kommune innen avfallsarbeidet?	1 (liten grad): 2 2: 2 3: 8 4: 2 5 (høy grad): 0	14	
15	I hvilken grad kunne din kommune vært interessert i mer informasjon om denne standarden?	1 (liten grad): 2 2: 2 3: 6 4: 4 5 (høy grad): 0	14	
16	I hvilken grad kunne din kommune vært interessert i å bli sammenlignet med lignende kommuner og lokale samfunn utenfor Norge, med tanke på prestasjon og utvikling innen	1 (liten grad): 3 2: 1 3: 5 4: 5 5 (høy grad): 0	14	

	avfallsområdet? (For erfaringsutveksling og inspirasjon etc.)			
17	Har din kommune implementert ISO 14001 om miljøstyring?	Ja: 2 Nei: 5 Vet ikke, kan ikke svare: 5 Annet: 2	14	
18	Hvis "ja" på forrige spørsmål: Inngår avfallshåndteringa som en del av denne?	Ja: 3 Nei: 1 Delvis: 0 Vet ikke, kan ikke svare: 0 Annet: 1	5	
19	Eventuelle kommentarer	**See Appendix B. Original Questionnaire Responses**	6	

*Drammen: Besvarelse utført av Renovasjonsselskapet i Drammensregionen (RfD), derfor er det også svart for kommuene Lier, Nedre Eiker, Øvre Eiker, Modum, Røyken, Hurum, Sande og Svelvik

**Bergen: Besvarelse utført av Bergensområdets Interkommunale Renovasjonsselskap (BIR), som eies av kommunene Askøy, Fusa, Kvam, Os, Osterøy, Samnanger, Sund og Vaksdal

***Stavanger: Besvarelse utført av IVAR IKS, på vegne av kommunene Stavanger + ni nabokommuner (Finnøy, Gjesdal, Hå, Klepp, Randaberg, Sandnes, Sola, Strand og Hjelmeland)

Appendix B. Original Questionnaire Responses

B.1, B.2 and B.3 shows all responses and original answers from the various respondents. B.1 shows questions 1 to 6, B.2 questions 7 to 13, and B.3 questions 14 to 19.

B.1: Question 1 to 6 in questionnaire

Kommune / selskap	1. Stilling / ansvarsområde	2. Hvilken kommune besvares spørsmålene for?	3. Er kommunen med i et interkommunalt avfallsselskap?	4. Har kommunen en egen avfallsstrategi (delplan/ handlingsplan for avfallshåndtering)?	5. Hva fokuseres det på i din kommune innen avfalls- området?	6. Hva blir ansett som hovedutfordringene innen avfallsområdet i din kommune?
Asker	Faggruppeleder gjenvinning	Asker	Nei	Ja	Ny teknologi / nye løsninger for innsamling, økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, strategier for å redusere avfallsmengden, god kommunikasjon med husholdningene	Å øke gjenvinningsgraden, å redusere negativ miljøpåvirkning
Oslo	Senior-konsulent/ internasjonalt arbeid, strategiutvikling	Oslo	Nei	Ja	Ny teknologi / nye løsninger for innsamling, økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, strategier for å redusere avfallsmengden, god kommunikasjon med husholdningene, samarbeid med næringslivet mtp løsninger for næringsavfall	Å øke gjenvinningsgraden, å redusere negativ miljøpåvirkning
Hamar	Miljørådgiver	Hamar	Ja	Ja	Ny teknologi / nye løsninger for innsamling, økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, strategier for å redusere avfallsmengden, god kommunikasjon med husholdningene, samarbeid med næringslivet mtp løsninger for næringsavfall	Å redusere negativ miljøpåvirkning

Nittedal	Konsulent	Nittedal	Ja	Nei	Annet: Følger ROAFs strategier	Annet: Som ROAF
Rælingen	Avdelingsleder VA	Rælingen	Ja	Nei	Strategier for å redusere avfallsmengden	Vet ikke, kan ikke svare
Fet	Enhetsleder kommunal-teknikk	Fet	Ja	Nei	Ny teknologi / nye løsninger for innsamling, god kommunikasjon med husholdningene	Vet ikke, kan ikke svare
IVAR	Fagansvarlig renovasjon, IVAR IKS	Stavanger pluss 9 nabo-kommuner	Annet: Vi er et regionalt interkommunalt selskap	Ja	Økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, strategier for å redusere avfallsmengden	Innsamlingen av avfallet, å øke gjenvinnings-graden
Gjerdrum	Teknisk leder	Gjerdrum	Ja	Nei	Økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, god kommunikasjon med husholdningene	Innsamlingen av avfallet, selve håndteringen etter innsamling, det økonomiske / kostnadene, kommunikasjon mellom ulike aktører, rapportering og måling, å øke gjenvinningsgraden, å redusere negativ miljøpåvirkning
RfD	Senior prosjektleder	Renovasjonsselskapet for Drammensregionen, kommunene Drammen, Lier, Nedre Eiker, Øvre Eiker, Modum, Røyken, Hurum, Sande og Svelvik	Annet: Jeg svarer på vegne av det inter-kommunale avfallsselskapet	Ja	Ny teknologi / nye løsninger for innsamling, økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, god kommunikasjon med husholdningene	Innsamlingen av avfallet, selve håndteringen etter innsamling, det økonomiske / kostnadene, kommunikasjon mellom ulike aktører, å øke gjenvinningsgraden, å redusere negativ miljøpåvirkning

BIR	FOU sjef i BIR As	Bergen m.fl. (se bir.no)	Ja	Annet: BIR har en felles avfallsstrategi for alle 9 kommuner, behandlet i alle eierkommuner	Ny teknologi / nye løsninger for innsamling, økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, strategier for å redusere avfallsmengden, god kommunikasjon med husholdningene, annet: kvalitetsgjenvinning og reduksjon av klimautslipp	Selve håndteringen etter innsamling, å øke gjenvinningsgraden, å redusere negativ miljøpåvirkning
Sandnes	Seksjonsleder, miljø og renovasjon	Sandnes kommune	Ja	Ja	Ny teknologi / nye løsninger for innsamling, økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, strategier for å redusere avfallsmengden, god kommunikasjon med husholdningene	Annet: Stimulere til avfalls-minimering
TRK	Driftssjef	Time, Rennesøy og Kvitsøy	Ja	Ja	Ny teknologi / nye løsninger for innsamling, økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, strategier for å redusere avfallsmengden, god kommunikasjon med husholdningene	Å øke gjenvinnings-graden
Stavanger	Miljøvernsjef	Stavanger	Ja	Ja	Ny teknologi / nye løsninger for innsamling, økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, strategier for å redusere avfallsmengden, god kommunikasjon med husholdningene	Innsamlingen av avfallet, det økonomiske /kostnadene, å øke gjenvinningsgraden
Bergen	Miljøsjef	Bergen	Ja	Nei	Ny teknologi / nye løsninger for innsamling, økning av gjenvinningsgraden / effektiv utnyttelse av ressurser, strategier for å redusere avfallsmengden, god kommunikasjon med husholdningene, samarbeid med næringslivet mtp løsninger for næringsavfall	Innsamlingen av avfallet, kommunikasjon mellom ulike aktører, å redusere negativ miljøpåvirkning, annet: matsvinn

B.2: Question 7 to 13 in questionnaire

Kommune / selskap	7. Gjennom KOSTRA-systemet rapporteres det inn data om avfallshåndtering til SSB. Blir disse dataene brukt aktivt i miljøarbeidet innen avfallsområdet i din kommune?	8. Dersom "ja" på forrige spørsmål: Hva blir dataene brukt til?	9. Hva er hovedutfordringene med slik rapportering?	10. I hvilken grad er dagens styringssystemer innen avfallsområdet i din kommune ansett som gode? [Skala fra 1 til 5 hvor 1 er liten grad og 5 er høy grad]	11. I hvilken grad vil du si at samarbeidet mellom kommuneadministrasjonen og renovasjonsselskapet i din kommune fungerer godt? [Skala fra 1 til 5 hvor 1 er liten grad og 5 er høy grad]	12. Har din kommune utarbeidet en kommunikasjonsplan/-strategi, som også gjelder for avfallsseksjonen?	13. Er din kommune kjent med standarden (ISO 37120) som er beskrevet ovenfor?
Asker	Ja	Ekstern kommunikasjon, intern kommunikasjon, tiltak og mål, vurdering av måloppnåelse	Nøyaktigheten	4	5	Ja	Usikker
Oslo	Ja	Utforming av nye avfallsplaner- og strategier, ekstern kommunikasjon, intern kommunikasjon, tiltak og mål, vurdering av måloppnåelse	Nøyaktigheten	5	5	Ja	Usikker
Hamar	Vet ikke, kan ikke svare	Ingen svar	Ingen svar	4	4	Annet: Det interkommunale avfallsselskapet som har utarbeidet det	Annet: Ja, vet at den finnes, men har ikke noe forhold til den
Nittedal	Vet ikke, kan ikke svare	Ingen svar	Vet ikke, kan ikke svare	4	5	Nei	Usikker
Rælingen	Vet ikke, kan ikke svare	Vet ikke, kan ikke svare	Ingen svar	3	3	Vet ikke, kan ikke svare	Usikker
Fet	Delvis	Intern kommunikasjon	Det er ikke identifisert noen utfordringer	4	4	Ja	Usikker

IVAR	Nei	Ingen svar	Nøyaktigheten	4	5	Nei	Nei
Gjerdrum	Ja	Utforming av nye avfallsplaner- og strategier, ekstern kommunikasjon, tiltak og mål	Tidkrevende, nøyaktigheten	4	5	Ja	Usikker
RfD	Delvis	Ekstern kommunikasjon, intern kommunikasjon	Tidkrevende	4	4	Annet: Dette blir et umulig spørsmål å svare på når jeg svarer på vegne av et interkommunalt selskap.	Nei
BIR	Annet: Vi jobber for å bedre kvalitet på innrapportering	Annet: Stoler ikke på KOSTRA-tall	Nøyaktigheten, annet: sammenlignbarhet	4	4	Annet: BIR har egen kommunikasjonsstrategi	Nei
Sandnes	Vet ikke, kan ikke svare	Ingen svar	Nøyaktigheten	4	4	Nei	Usikker
Time, Rennesøy og Kvitsøy (TRK)	Delvis	Utforming av nye avfallsplaner- og strategier, tiltak og mål, annet: Kostra-tall benyttes til en viss grad, men gir ingen nøyaktighet så lenge kommunen er med i interkommunalt samarbeid. Kostratallene kan dermed bare benyttes til å se de store trendene.	Nøyaktigheten, annet: Statistikk unøyaktig da kommunene er med i interkommunalt arbeid som rapporterer inn fellestall for alle medlemskommunene. Mengden avfall fordeles på befolkningstall i hver kommune. Egen intern statistikk i kommunen er derfor den korrekte, og den som benyttes til ekstern og intern kommunikasjon.	4	4	Ja	Usikker

Stavanger	Delvis	Utforming av nye avfallsplaner- og strategier, vurdering av måloppnåelse	Nøyaktigheten	4	5	Ja	Usikker
Bergen	Nei	Ingen svar	Nøyaktigheten	2	4	Nei	Nei

B.3: Question 14 to 19 in questionnaire

Kommune / selskap	14. I hvilken grad tror du denne standarden kunne vært aktuell som et verktøy for din kommune innen avfallsarbeidet? [Skala fra 1 til 5 hvor 1 er liten grad og 5 er høy grad]	15. I hvilken grad kunne din kommune vært interessert i mer informasjon om denne standarden? [Skala fra 1 til 5 hvor 1 er liten grad og 5 er høy grad]	16. I hvilken grad kunne din kommune vært interessert i å bli sammenlignet med lignende kommuner og lokale samfunn utenfor Norge, med tanke på prestasjon og utvikling innen avfallsområdet? (For erfaringsutveksling og inspirasjon etc.) [Skala fra 1 til 5 hvor 1 er liten grad og 5 er høy grad]	17. Har din kommune implementert ISO 14001 om miljøstyring?	18. Hvis "ja" på forrige spørsmål: Inngår avfallshåndteringa som en del av denne?	19. Eventuelle kommentarer
Asker	3	4	3	Ja	Ja	Ingen
Oslo	4	4	4	Vet ikke, kan ikke svare	Ja	Ingen
Hamar	3	3	3	Nei	Ingen svar	Kommunen har ingen veldig aktiv rolle som renovatør siden vi er med i et interkommunalt avfallsselskap. Derfor har vi heller ikke sett aktivt på ISO-sertifiseringene - det må i så fall gå via styret for avfallsselskapet hvor kommunen selvsagt er representert. Kostrarapporteringen gjøres via en annen enhet (teknisk) og jeg kjenner derfor ikke til den. Avfallsplanen er interkommunal.
Nittedal	3	3	3	Vet ikke, kan ikke svare	Ingen svar	Avfallsinnsamling og -behandling, samt avfallsstrategisk arbeid gjøres av vårt interkommunale selskap, ROAF.
Rælingen	3	3	3	Vet ikke, kan ikke svare	Ingen svar	Ingen

Fet	3	3	4	Nei	Ingen svar	Ingen
IVAR	1	1	1	Nei	Ingen svar	Jeg svarte delvis for IVAR (hvor jeg jobber og som bl.a. driver med avfallsbehandling for 10 kommuner i Sør-Rogaland) og delvis for Stavanger kommune (hvor jeg tidligere jobbet som fagsjef renovasjon), som fortsatt har ansvar for selve avfallsinnsamlingen. Det er ikke mange kommuner igjen i Norge som har renovasjon igjen i sin kjernevirksomhet. Derfor blir nok spørsmål om kommunens strategier, anvendelser av ISO-standarder mm. Litt vanskelig å besvare.
Gjerdrum	3	3	1	Ja	Ja	Ingen
RfD	2	2	1	Vet ikke, kan ikke svare	Ingen svar	Jeg tror det hadde vært mer hensiktsmessig for deg å spørre en miljøansvarlig i en av kommunene som eier Renovasjonsselskapet for Drammensregionen siden spørsmålene dine dreier seg mer om overordnet miljøstyring og avfallshåndteringens plass i denne. Renovasjonsselskapet er mer utførende.
BIR	2	2	2	Annet: Noen datterselskap er sertifisert	Annet: De døtre driver med avfallshåndtering	Ingen
Sandnes	4	4	4	Nei	Ingen svar	Ingen

TRK	3	4	3	Vet ikke, kan ikke svare	Ingen svar	Jeg svarer som driftssjef for renovasjonstjenesten i kommunene, men er i prinsippet leid inn fra IVAR IKS som disse kommunene benytter til diverse VAR-tjenester. Time, Rennesøy og Kvitsøy er medeiere i Ivar.
Stavanger	3	3	4	Nei	Ingen svar	Ingen
Bergen	1	1	4	Annet: Miljøfyrtårn, kun få ISO 14001	Nei	Relativt lite relevant for oss. Kommunen har vedtatt men enda ikke helt gjennomført miljøledelse. Sentraladmn. har Miljøfyrtårn, få enheter med ISO 14001.

Appendix C. Categorized Questionnaire Results

The table below shows the various response categories for each question, and who responded what.

3. Er kommunen med i et interkommunalt avfallsselskap?	
Svarkategori	*Kommuner / avfallsselskap*
Ja	Hamar, Nittedal, Rælingen, Fet, Gjerdrum, Bergen m.fl. (BIR), Sandnes, Time, Rennesøy og Kvitsøy, Stavanger, Bergen
Nei	Asker, Oslo
Annet	Stavanger (regionalt interkommunalt selskap, svar på vegne av IVAR IKS), Drammen (svar på vegne av det interkommunale avfallsselskapet RfD)
4. Har kommunen en egen avfallsstrategi (delplan/handlingsplan for avfallshåndtering)?	
Svarkategori	*Kommuner / avfallsselskap*
Ja	Asker, Oslo, Hamar, Stavanger*, Drammen**, Bergen***, Sandnes, Time, Rennesøy og Kvitsøy, Stavanger
Nei	Nittedal, Rælingen, Fet, Gjerdrum, Bergen
Annet	
5. Hva fokuseres det på i din kommune innen avfallsområdet?	
Svarkategori	*Kommuner / avfallsselskap*
Ny teknologi / nye løsninger for innsamling	Asker, Oslo, Hamar, Fet, Drammen*, Bergen*, Sandnes, Time, Rennesøy og Kvitsøy, Stavanger, Bergen
Økning av gjenvinningsgraden / effektiv utnyttelse av ressurser	Asker, Oslo, Hamar, Stavanger*, Gjerdrum, Drammen*, Bergen*, Sandnes, Time, Rennesøy og Kvitsøy, Stavanger, Bergen
Strategier for å redusere avfallsmengden	Asker, Oslo, Hamar, Rælingen, Stavanger*, Bergen*, Sandnes, Time, Rennesøy og Kvitsøy, Stavanger, Bergen
God kommunikasjon med husholdningene	Asker, Oslo, Hamar, Fet, Gjerdrum, Drammen*, Bergen*, Sandnes, Time, Rennesøy og Kvitsøy, Stavanger, Bergen
Samarbeid med næringslivet mtp. løsninger for næringsavfall	Oslo, Hamar, Bergen
Vet ikke, kan ikke svare	
Annet	Nittedal (følger ROAFs strategier), Bergen* (kvalitetsgjenvinning og reduksjon av klimautslipp)
6. Hva blir ansett som hovedutfordringene innen avfallsområdet i din kommune?	
Svarkategori	*Kommuner / avfallsselskap*
Innsamlingen av avfallet	Stavanger*, Gjerdrum, Drammen*, Stavanger, Bergen
Selve håndteringen etter innsamling	Gjerdrum, Drammen*, Bergen*
Det økonomiske / kostadene	Gjerdrum, Drammen*, Stavanger
Kommunikasjon mellom ulike aktører	Gjerdrum, Drammen*, Bergen
Rapportering og måling	Gjerdrum

Å øke gjenvinningsgraden	Asker, Oslo, Stavanger*, Gjerdrum, Drammen*, Bergen*, Time, Rennesøy og Kvitsøy, Stavanger
Å redusere negativ miljøpåvirkning	Asker, Oslo, Hamar, Gjerdrum, Drammen*, Bergen*, Bergen
Vet ikke, kan ikke svare	Rælingen, Fet
Annet	Nittedal (som definert i ROAF), Sandnes (stimulere til avfallsminimering), Bergen (matsvinn)
7. Gjennom KOSTRA-systemet rapporteres det inn data om avfallshåndtering til SSB. Blir disse dataene brukt aktivt i miljøarbeidet innen avfallsområdet i din kommune?	
Svarkategori	*Kommuner / avfallsselskap*
Ja	Asker, Oslo, Gjerdrum
Nei	Stavanger*, Bergen
Delvis	Fet, Drammen*, Time, Rennesøy og Kvitsøy, Stavanger
Vet ikke, kan ikke svare	Hamar, Nittedal, Rælingen, Sandnes
Annet	Bergen* (vi jobber for å bedre kvalitet på innrapportering)
8. Dersom "ja" på forrige spørsmål: Hva blir dataene brukt til?	
Svarkategori	*Kommuner / avfallsselskap*
Utforming av nye avfallsplaner- og strategier	Oslo, Gjerdrum, Time, Rennesøy og Kvitsøy, Stavanger
Ekstern kommunikasjon	Asker, Oslo, Gjerdrum, Drammen*
Intern kommunikasjon	Asker, Oslo, Fet, Drammen*
Tiltak og mål	Asker, Oslo, Gjerdrum, Time, Rennesøy og Kvitsøy
Vurdering av måloppnåelse	Asker, Oslo, Stavanger
Ikke relevant	
Vet ikke, kan ikke svare	Rælingen
Annet	Bergen* (stoler ikke på KOSTRA-tall), Time, Rennesøy og Kvitsøy (kostra-tall benyttes til en viss grad, men gir ingen nøyaktighet så lenge kommunen er med i interkommunalt samarbeid. Kostra-tallene kan dermed bare benyttes til å se de store trendene)
Ingen svar	Hamar, Nittedal, Stavanger*, Sandnes, Bergen
9. Hva er hovedutfordringene med slik rapportering?	
Svarkategori	*Kommuner / avfallsselskap*
Tidkrevende	Gjerdrum, Drammen*
Kostnader	
Nøyaktigheten	Asker, Oslo, Stavanger*, Gjerdrum, Bergen*, Sandnes, Time, Rennesøy og Kvitsøy, Stavanger, Bergen
Det er ikke identifisert noen utfordringer	Fet
Vet ikke, kan ikke svare	Nittedal
Annet	Bergen* (sammenlignbarhet), Time, Rennesøy og Kvitsøy (statistikk unøyaktig da kommunene er med i interkommunalt arbeid som rapporterer inn fellestall for alle medlemskommunene. Mengden avfall fordeles på befolkningstall i hver kommune. Egen intern statistikk i kommunen er derfor den korrekte, og den som benyttes til ekstern og intern kommunikasjon)

Ingen svar	Hamar, Rælingen
10. I hvilken grad er dagens styringssystemer innen avfallsområdet i din kommune ansett som gode?	
1 (liten grad)	
2	Bergen
3 (hverken eller)	Rælingen
4	Asker, Hamar, Nittedal, Fet, Stavanger*, Gjerdrum, Drammen**, Bergen***, Sandnes, Time, Rennesøy og Kvitsøy, Stavanger
5 (høy grad)	Oslo
11. I hvilken grad vil du si at samarbeidet mellom kommuneadministrasjonen og renovasjonsselskapet i din kommune fungerer godt?	
1 (liten grad)	
2	
3 (hverken/eller)	Rælingen
4	Hamar, Fet, Drammen**, Bergen***, Sandnes, Time, Rennesøy og Kvitsøy, Bergen
5 (høy grad)	Asker, Oslo, Nittedal, Stavanger*, Gjerdrum, Stavanger
12. Har din kommune utarbeidet en kommunikasjonsplan/-strategi, som også gjelder for avfallsseksjonen?	
Svarkategori	*Kommuner / avfallsselskap*
Ja	Asker, Oslo, Fet, Gjerdrum, Time, Rennesøy og Kvitsøy, Stavanger
Nei	Nittedal, Stavanger*, Sandnes, Bergen
Vet ikke, kan ikke svare	Rælingen
Annet	Hamar (det interkommunale avfallsselskapet har utarbeidet dette), Drammen* (vanskelig å svare på, respondenten svarer på vegne av et interkommunalt selskap), Bergen* (BIR har egen kommunikasjonsstrategi)
13. Er din kommune kjent med standarden (ISO 37120) som er beskrevet ovenfor? (Se Appendix E. Description of ISO 37120 in Norwegian)	
Svarkategori	*Kommuner / avfallsselskap*
Ja	
Nei	Stavanger*, Drammen*, Bergen*, Bergen
Usikker	Asker, Oslo, Nittedal, Rælingen, Fet, Gjerdrum, Sandnes, Time, Rennesøy og Kvitsøy, Stavanger
Annet	Hamar (Ja, vet at den finnes, men har ikke noe forhold til den)
14. I hvilken grad tror du denne standarden kunne vært aktuell som et verktøy for din kommune innen avfallsarbeidet?	
1 (lav grad)	Stavanger*, Bergen
2	Drammen, Bergen*
3 (hverken/eller)	Asker, Hamar, Nittedal, Rælingen, Fet, Gjerdrum, Time, Rennesøy og Kvitsøy, Stavanger
4	Oslo, Sandnes
5 (høy grad)	
15. I hvilken grad kunne din kommune vært interessert i mer informasjon om denne standarden?	

1 (lav grad)	Stavanger*, Bergen
2	Drammen, Bergen*
3 (hverken/eller)	Hamar, Nittedal, Rælingen, Fet, Gjerdrum, Stavanger
4	Asker, Oslo, Sandnes, Time, Rennesøy og Kvitsøy
5 (høy grad)	

16. I hvilken grad kunne din kommune vært interessert i å bli sammenlignet med lignende kommuner og lokale samfunn utenfor Norge, med tanke på prestasjon og utvikling innen avfallsområdet? (For erfaringsutveksling og inspirasjon etc.)	
1 (lav grad)	Stavanger*, Gjerdrum, Drammen
2	Bergen*
3 (hverken/eller)	Asker, Hamar, Nittedal, Rælingen, Time, Rennesøy og Kvitsøy
4	Oslo, Fet, Sandnes, Stavanger, Bergen
5 (høy grad)	

17. Har din kommune implementert ISO 14001 om miljøstyring?	
Svarkategori	*Kommune / avfallsselskap*
Ja	Asker, Gjerdrum
Nei	Hamar, Fet, Stavanger*, Sandnes, Stavanger
Vet ikke, kan ikke svare	Oslo, Nittedal, Rælingen, Drammen*, Time, Rennesøy og Kvitsøy
Annet	Bergen* (noen datterselskap er sertifisert), Bergen (Miljøfyrtårn, kun få ISO 14001)

18. Hvis "ja" på forrige spørsmål: Inngår avfallshåndteringen som en del av denne?	
Svarkategori	*Kommune / avfallsselskap*
Ja	Asker, Oslo, Gjerdrum
Nei	Bergen
Delvis	
Vet ikke, kan ikke svare	
Annet	Bergen* (Datterselskapene driver med avfallshåndtering)
Ingen svar	Hamar, Nittedal, Rælingen, Fet, Stavanger*, Drammen*, Sandnes, Time, Rennesøy og Kvitsøy, Stavanger

Drammen* = RfD

Bergen* = BIR

Stavanger* = IVAR

Appendix D. Categorized Questionnaire Results Distinguished between WMA and LA

The table shows what the waste management agencies (WMA) and local authorities (LA) responded, as well as number of respondent on each response category for both groups.

3. Er kommunen med i et interkommunalt avfallsselskap?				
Svarkategori	**Kommuner**	**Antall**	**Avfallsselskap**	**Antall**
Ja	Hamar, Nittedal, Rælingen, Fet, Gjerdrum, Sandnes, Stavanger, Bergen	8	BIR, TRK (Time, Rennesøy og Kvitsøy)	2
Nei	Asker, Oslo	2		
Annet			Stavanger (regionalt interkommunalt selskap, svar på vegne av IVAR IKS), Drammen (svar på vegne av det interkommunale avfallsselskapet RfD)	2
4. Har kommunen en egen avfallsstrategi (delplan/handlingsplan for avfallshåndtering)?				
Svarkategori	**Kommuner**	**Antall**	**Avfallsselskap**	**Antall**
Ja	Asker, Oslo, Hamar, Sandnes, Stavanger	5	IVAR, BIR, TRK, RfD	4
Nei	Nittedal, Rælingen, Fet, Gjerdrum, Bergen	5		
Annet				
5. Hva fokuseres det på i din kommune innen avfallsområdet?				
Svarkategori	**Kommuner**	**Antall**	**Avfallsselskap**	**Antall**
Ny teknologi / nye løsninger for innsamling	Asker, Oslo, Hamar, Fet, Sandnes, Stavanger, Bergen	7	RfD, BIR, TRK	3
Økning av gjenvinningsgraden / effektiv utnyttelse av ressurser	Asker, Oslo, Hamar, Gjerdrum, Sandnes, Stavanger, Bergen	7	IVAR, RfD, BIR, TRK	4
Strategier for å redusere avfallsmengden	Asker, Oslo, Hamar, Rælingen, Sandnes, Stavanger, Bergen	7	IVAR, BIR, TRK	3
God kommunikasjon med husholdningene	Asker, Oslo, Hamar, Fet, Gjerdrum, Sandnes, Stavanger, Bergen	8	RfD, BIR, TRK	3
Samarbeid med næringslivet mtp. løsninger for næringsavfall	Oslo, Hamar, Bergen	3		
Vet ikke, kan ikke svare				
Annet	Nittedal (følger ROAFs strategier)	1	BIR (kvalitetsgjenvinning og reduksjon av klimautslipp)	1
6. Hva blir ansett som hovedutfordringene innen avfallsområdet i din kommune?				
Svarkategori	**Kommuner**	**Antall**	**Avfallsselskap**	**Antall**
Innsamlingen av avfallet	Gjerdrum, Stavanger, Bergen	3	IVAR, RfD	2
Selve håndteringen etter innsamling	Gjerdrum	1	RfD, BIR	2
Det økonomiske / kostnadene	Gjerdrum, Stavanger	2	RfD	1
Kommunikasjon mellom ulike aktører	Gjerdrum, Bergen	2	RfD	1

Rapportering og måling	Gjerdrum	1		
Å øke gjenvinningsgraden	Asker, Oslo, Gjerdrum, Stavanger	4	IVAR, RfD, BIR, TRK	4
Å redusere negativ miljøpåvirkning	Asker, Oslo, Hamar, Gjerdrum, Bergen	5	RfD, BIR	2
Vet ikke, kan ikke svare	Rælingen, Fet	2		
Annet	Nittedal (som definert i ROAF), Sandnes (stimulere til avfallsminimering), Bergen (matsvinn)	3		

7. Gjennom KOSTRA-systemet rapporteres det inn data om avfallshåndtering til SSB. Blir disse dataene brukt aktivt i miljøarbeidet innen avfallsområdet i din kommune?

Svarkategori	Kommuner	Antall	Avfallsselskap	Antall
Ja	Asker, Oslo, Gjerdrum	3		
Nei	Bergen	1	IVAR	1
Delvis	Fet, Stavanger	2	RfD, TRK	2
Vet ikke, kan ikke svare	Hamar, Nittedal, Rælingen, Sandnes	4		
Annet			BIR (vi jobber for å bedre kvalitet på innrapportering)	1

8. Dersom "ja" på forrige spørsmål: Hva blir dataene brukt til?

Svarkategori	Kommuner	Antall	Avfallsselskap	Antall
Utforming av nye avfallsplaner- og strategier	Oslo, Gjerdrum, Stavanger	3	TRK	1
Ekstern kommunikasjon	Asker, Oslo, Gjerdrum	3	RfD	1
Intern kommunikasjon	Asker, Oslo, Fet	3	RfD	1
Tiltak og mål	Asker, Oslo, Gjerdrum	3	TRK	1
Vurdering av måloppnåelse	Asker, Oslo, Stavanger	3		
Ikke relevant				
Vet ikke, kan ikke svare	Rælingen	1		
Annet			BIR (stoler ikke på KOSTRA-tall), TRK (kostra-tall benyttes til en viss grad, men gir ingen nøyaktighet så lenge kommunen er med i interkommunalt samarbeid. Kostra-tallene kan dermed bare benyttes til å se de store trendene)	2
Ingen svar	Hamar, Nittedal, Sandnes, Bergen	4	IVAR	1

9. Hva er hovedutfordringene med slik rapportering?

Svarkategori	Kommuner	Antall	Avfallsselskap	Antall
Tidkrevende	Gjerdrum	1	RfD	1
Kostnader				
Nøyaktigheten	Asker, Oslo, Gjerdrum, Sandnes, Stavanger, Bergen	6	IVAR, BIR, TRK	3
Det er ikke identifisert noen utfordringer	Fet	1		
Vet ikke, kan ikke svare	Nittedal	1		

Annet			BIR (sammenlignbarhet), TRK (statistikk unøyaktig da kommunene er med i interkommunalt arbeid som rapporterer inn fellestall for alle medlemskommunene. Mengden avfall fordeles på befolkningstall i hver kommune. Egen intern statistikk i kommunen er derfor den korrekte, og den som benyttes til ekstern og intern kommunikasjon)	2
Ingen svar	Hamar, Rælingen	2		

10. I hvilken grad er dagens styringssystemer innen avfallsområdet i din kommune ansett som gode?

1 (liten grad)				
2	Bergen	1		
3 (hverken eller)	Rælingen	1		
4	Asker, Hamar, Nittedal, Fet, Gjerdrum, Sandnes, Stavanger	7	IVAR, RfD, BIR, TRK	4
5 (høy grad)	Oslo	1		

11. I hvilken grad vil du si at samarbeidet mellom kommuneadministrasjonen og renovasjonsselskapet i din kommune fungerer godt?

1 (liten grad)				
2				
3 (hverken/eller)	Rælingen	1		
4	Hamar, Fet, Sandnes, Bergen	4	RfD, BIR, TRK	3
5 (høy grad)	Asker, Oslo, Nittedal, Gjerdrum, Stavanger	5	IVAR	1

12. Har din kommune utarbeidet en kommunikasjonsplan/-strategi, som også gjelder for avfallsseksjonen?

Svarkategori	**Kommuner**	**Antall**	**Avfallsselskap**	**Antall**
Ja	Asker, Oslo, Fet, Gjerdrum, Stavanger	5	TRK	1
Nei	Nittedal, Sandnes, Bergen	3	IVAR	1
Vet ikke, kan ikke svare	Rælingen	1		
Annet	Hamar (det interkommunale avfallsselskapet har utarbeidet dette)	1	RfD (vanskelig å svare på, svarer på vegne av et interkommunalt selskap), BIR (BIR har egen kommunikasjonsstrategi)	2

13. Er din kommune kjent med standarden (ISO 37120) som er beskrevet ovenfor?

Svarkategori	**Kommuner**	**Antall**	**Avfallsselskap**	**Antall**
Ja				
Nei	Bergen	1	IVAR, RfD, BIR	3
Usikker	Asker, Oslo, Nittedal, Rælingen, Fet, Gjerdrum, Sandnes, Stavanger	8	TRK	1
Annet	Hamar (Ja, vet at den finnes, men har ikke noe forhold til den)	1		

14. I hvilken grad tror du denne standarden kunne vært aktuell som et verktøy for din kommune innen avfallsarbeidet?

1 (lav grad)	Bergen	1	IVAR	1
2			RfD, BIR	2

3 (hverken/eller)	Asker, Hamar, Nittedal, Rælingen, Fet, Gjerdrum, Stavanger	7	TRK	1
4	Oslo, Sandnes	2		
5 (høy grad)				

15. I hvilken grad kunne din kommune vært interessert i mer informasjon om denne standarden?

1 (lav grad)	Bergen	1	IVAR	1
2			RfD, BIR	2
3 (hverken/eller)	Hamar, Nittedal, Rælingen, Fet, Gjerdrum, Stavanger	6		
4	Asker, Oslo, Sandnes	3	TRK	1
5 (høy grad)				

16. I hvilken grad kunne din kommune vært interessert i å bli sammenlignet med lignende kommuner og lokale samfunn utenfor Norge, med tanke på prestasjon og utvikling innen avfallsområdet? (For erfaringsutveksling og inspirasjon etc.)

1 (lav grad)	Gjerdrum	1	IVAR, RfD	2
2			BIR	1
3 (hverken/eller)	Asker, Hamar, Nittedal, Rælingen	4	TRK	1
4	Oslo, Fet, Sandnes, Stavanger, Bergen	5		
5 (høy grad)				

17. Har din kommune implementert ISO 14001 om miljøstyring?

Svarkategori	**Kommune**	**Antall**	**Avfallsselskap**	**Antall**
Ja	Asker, Gjerdrum	2		
Nei	Hamar, Fet, Sandnes, Stavanger	4	IVAR	1
Vet ikke, kan ikke svare	Oslo, Nittedal, Rælingen	3	RfD, TRK	1
Annet	Bergen (Miljøfyrtårn, kun få ISO 14001)	1	BIR (noen datterselskap er sertifisert)	1

18. Hvis "ja" på forrige spørsmål: Inngår avfallshåndteringen som en del av denne?

Svarkategori	**Kommune**	**Antall**	**Avfallsselskap**	**Antall**
Ja	Asker, Oslo, Gjerdrum	3		
Nei	Bergen	1		
Delvis				
Vet ikke, kan ikke svare				
Annet			BIR (de døtre driver med avfallshåndtering)	1
Ingen svar	Hamar, Nittedal, Rælingen, Fet, Sandnes, Stavanger	6	IVAR, RfD, TRK	3

Appendix E. Quantification Parameters

Parameters used for quantification of clause 16 Solid Waste in ISO 37120 are shown below. Four municipalities are selected for the quantification: Oslo, Bergen, Drammen and Asker. Each parameter shows values from 2012 to 2015. All data is derived from Statistics Norway.

Parameters	Year	Oslo	Bergen	Drammen	Asker	Unit	Resources	NOTE
Total (city) population	2012	613285	263762	64597	56447	cap	SSB, Statistikkbanken: Folkemengde og befolkningsendringar. Tabell: 07459: Folkemengde, etter kjønn og ettårig alder. 1 januar (K) (SSB, 2015c)	Population is increasing in all four municipalities.
	2013	623966	267950	65473	57418			
	2014	634463	271949	66214	58338			
	2015	647676	275112	67016	59571			
Average household size	2012	1.91	2.11	2.11	2.45	cap/house-hold	SSB, Statistikkbanken: Familier og husholdninger. Tabell 09747: Privathusholdninger, personer i privathusholdninger og personer per privathusholdning (K) (B) (SSB, 2015b)	Household size decreased gradually from 2012 until 2014 in all municipalities, and then increased in 2015.
	2013	1.90	2.10	2.10	2.40			
	2014	1.88	2.04	2.07	2.35			
	2015	1.97	2.10	2.14	2.41			
Total amount of solid waste (household and commercial) generated/produced	2012	234949	106469	34890	24483	ton [t]	KOSTRA: I. Avfall og renovasjon - Mengder (justert for grovavfall og næringsavfall), grunnlagsdata, Reviderte tall per 26.06.2015 / Ureviderte tall per 09.04.2016. "Husholdningsavfall (justert for grovavfall og næringsavfall) inkl bilvrak". (SSB, 2015d)	At KOSTRA only waste from households are included and not commercial waste. But car wreck is included.
	2013	237058	116213	37806	26136			
	2014	232367	122040	37379	23783			
	2015	221010	117471	36049	23790			
Total amount of solid waste that is recycled	2012	186597	82558	28722	20378	ton [t]	KOSTRA: I. Avfall og renovasjon - Mengder (justert for grovavfall og næringsavfall), grunnlagsdata, Reviderte tall per 26.06.2015. "Levert til gjenvinning (materialgjenvinning, biologisk behandling og energiutnyttelse) i alt". (SSB, 2015d)	What is in included in this indicator are directly related to KOSTRA, except that industrial waste is not included.
	2013	186912	91129	30448	21721			
	2014	183680	90821	30129	19236			
	2015	184324	91627	30732	20691			
Total amount of solid waste that is disposed of in a sanitary landfill	2012	8520	128	N/A	686	ton [t]	KOSTRA: I. Avfall og renovasjon - Mengder (justert for grovavfall og næringsavfall), grunnlagsdata, Ureviderte tall per 09.04.2016. "Levert til deponi i alt". (SSB, 2015d)	It is assumed that "farlig avfall" is included in "i alt". All numbers in "Levert til deponi" is assumed included in "Levert til deponi i alt",
	2013	7779	167	999	634			
	2014	7349	6177	1092	715			
	2015	7237	6982	1069	820			

								and are thus not added to original numbers.
Total amount of solid waste that is disposed of in an incinerator	2012	132731	69667	17663	10219	ton [t]	KOSTRA: I. Avfall og renovasjon - Mengder (justert for grovavfall og næringsavfall), grunnlagsdata, Ureviderte tall per 09.04.2016. "Levert til forbrenning i alt". (SSB, 2015d)	
	2013	132284	80169	18267	10597			
	2014	131799	81598	18398	10814			
	2015	128043	82004	18401	9906			
Total amount of solid waste that is burned openly		N/A	N/A	N/A	N/A	ton [t]	Data not available	
Total amount of solid waste that is disposed of in an open dump		N/A	N/A	N/A	N/A	ton [t]	Data not available	
Total amount of solid waste that is disposed of by other means	2012	N/A	2396	455	N/A	ton [t]	KOSTRA: I. Avfall og renovasjon - Mengder (justert for grovavfall og næringsavfall), grunnlagsdata, Ureviderte tall per 09.04.2016. "Levert til annen behandling i alt". (SSB, 2015d)	Indicators exist, but some values are missing or not reported.
	2013	N/A	N/A	90	N/A			
	2014	N/A	N/A	18	N/A			
	2015	N/A	N/A	18	N/A			
Annual total amount of hazardous waste						ton [t]		Covered in "Total amount…" below, as all data and values in KOSTRA are reported annually.
Total amount of hazardous waste that is recycled	2012	263	201	122	58	ton [t]	KOSTRA: I. Avfall og renovasjon - Mengder (justert for grovavfall og næringsavfall), grunnlagsdata, Ureviderte tall per 09.04.2016. "Farlig avfall til materialgjenvinning". (SSB, 2015d)	
	2013	361	478	176	67			
	2014	349	349	112	60			
	2015	445	367	113	31			
Total amount of hazardous waste that is generated	2012	2245	2233	1209	552	ton [t]	KOSTRA: I. Avfall og renovasjon - Mengder (justert for grovavfall og næringsavfall), grunnlagsdata, Ureviderte tall per 09.04.2016. "Utsortert mengde farlig avfall fra husholdningene" (SSB, 2015d).	Hov (2015): Numbers were identified by adding several indicators, which is not done in this study. Instead an already summarized indicator is applied. Some data on "Farlig avfall til annen behandling" and "farlig avfall til ombruk" were not available for some of the municipalities.
	2013	2704	2390	1289	531			
	2014	3442	2771	1356	650			
	2015	3439	3084	1451	823			

Appendix F. Description of ISO 37120 in Norwegian

Description of ISO 37120 in Norwegian based on unpublished work by Standardization Norway (Tveter, 2016a), which was added in the questionnaire:

ISO 37120 "Sustainable development in communities" - en internasjonal standard for bærekraftig samfunnsutvikling

ISO 37120 er en standard utarbeidet av ISO (International Organisation for Standardization) som er en global organisasjon med 162 medlemmer. Det er det enkelte lands standardiseringsorganisasjon som er medlem i ISO, der det norske medlemmet er Standard Norge.

Bærekraft og bærekraftig utvikling er sentrale begreper i standardiseringsarbeidet i ISO. Målsettingen med ISO 37120 er å legge til rette for en bærekraftig utvikling i byer og samfunn. Standarden fokuserer også på livskvalitet. For at det enkelte samfunn og den enkelte by skal kunne få mulighet til å måle utvikling, har standarden definert indikatorer innen 17 områder i samfunnet, deriblant for fast avfall. De andre områdene er: Økonomi, utdanning, energi, miljø, finans, brann- og ulykkeshåndtering, styring, helse, rekreasjon, sikkerhet, ly, telekommunikasjon og innovasjon, transport, urban planlegging, avløpsvann, vann og sanitær.

ISO 37120 er utarbeidet etter de tre prinsippene som gjelder for standardisering:
Frivillighet – det er frivillig å delta i arbeidet
Åpenhet – standardisering er åpne prosesser
Konsensus – den fagkomiteen som utarbeider standarden har i utgangspunktet ulikt syn på temaet og arbeider seg frem til konsensus - løsninger som alle parter kan tolerere.

Standarden definerer to typer indikatorer:
- Kjerneindikatorer som skal måles
- Støtteindikatorer som bør måles

Den enkelte by/samfunn kan også sammenligne seg med andre byer/samfunn som det er relevant å sammenligne seg med, i tillegg til å måle sin egen utvikling. Derfor er det også utviklet og definert profilindikatorer som inneholder bakgrunnsmateriale og statistikk. Disse muliggjør sammenligning mellom samfunn som ligner på hverandre, da indikatorene er veldefinert.

Standarden har i alt 100 indikatorer, der 10 av disse er innen avfall, og det legges opp til at de skal beregnes årlig. Standarden angir ikke nedre eller øvre grenseverdier for noen av indikatorene. Standarden er utarbeidet av en ISO komité, ISO/TC 268, som arbeider videre med flere standarder for bærekraftig utvikling.

Ref: Standard Norge v/ Trine Tveter

Appendix G. List of Profile Indicators

The table shows the profile indicators in ISO 37120. Most of these are not quantified in the study, except total city population.

Profile Indicators		
People	Total city population	
	Population density (per square kilometre)	
	Percentage of country's population	
	Percentage of population that are children (0-14)	
	Percentage of population that are youth (15-24)	
	Percentage of population that are audult (25-64)	
	Percentage of population that are senior citizen (65+)	
	Male to female ratio (number of males per 100 females)	
	Annual population change	
	Population dependency ratio	
	Percentage of population that are foregin born	
	Percentage of population that are new immigrants	
	Percentage of residents who are not citizens	
Housing	Total number of households	
	Total number of occupied dweling units (owned & rented)	
	Persons per unit	
	Dwelling density (per square kilometre)	
Economy	Average household income (USD)	
	Annual inflation rate based on average of last 5 years	
	Cost of living	
	Income distribution (Gini Coefficient)	
	Country's GDP (USD)	
	Country's GDP per capita (USD)	
	City Product per capita (USD)	
	City Product as a percentage of Country's GDP	
	Employment percentage change based on the last 5 years	
Government	Type of government (e.g. local, regional, county)	
	Gross operating budget (USD)	
	Gross operating budget per capita (USD)	
	Gross capital budget (USD)	
	Gross capital budgetper capita (USD)	
Geography and climate	Region	Number of native species
	Climate type	Annual average temperature (Celsius)
	Land area (square kilomotres)	Average annual rain (mm)
	Percentage of non-residential area (square kilometres)	Average annual snowfall (cm)