

Business waste collection: Public decision making factors

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4-5-2020

Abstract

Business waste collection in the Netherlands is a free for all market. That leads to an inefficient market and in some cases interventions by market or government. Despite the availability of literature on improving waste management and waste collection on a technical level, the motivations are academic, assumed or unclear. In this paper, a series of interviews will be conducted to build a multi criteria decision analysis framework that will be showcased with an exemplary comparison of initiatives that are being executed at this moment. Conclusion is that socio-political factors are the most important factors on which government acts on this regard, followed by environmental factors and even further followed by economic factors.

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1. Introduction

Environmental economics is growing in its importance. Ever since the works of [Pigou \(1932\)](#) on formalising externalities it has been growing into an important field of economics. When it comes to public choice, much has been written by [E. Ostrom \(2009\)](#) who strongly advocates not just to focus on a national and international treaty-like manner to solve this problem. She rises the idea to take on the environmental problems from multiple angles, because it affects multiple levels of government. One main practice local governments implement policy of becoming more environmentally robust is with circularity.

A circular economy rises to be one of the frequently recurring goals of public administration in order to improve welfare and reduce environmental impact ([McDowall et. al., 2017](#)). The idea behind the circular approach is to close the circle on resources and to keep re-using the materials that are in the system. That should lead to less extraction of resources and less waste overall ([European Commission, 2015](#)). An important part in this process, although maybe without the correct nomenclature, is waste management.

Waste management consists of the entire process of waste. This begins with the production of waste and ends at the recycling or burning of materials that are obsolete to the (end) user ([Bourguignon, 2015](#)). Waste collection is an essential part of waste management and thus important for circular economical processes. Progress on improving waste collection has been wide and thoroughly researched. There have been taxonomy analysis ([Rodrigues, Martinho & Pires, 2016](#)), routing analysis ([Das & Bhattacharyya, 2015](#); [Hannan et. al., 2018](#)) and GIS analysis ([Erfani Et. Al., 2018](#); [Vu, Ng & Fallah., 2018](#); [Vu, et. al., 2019](#)). These papers have helped understand how to improve waste collection on multiple levels. However, neither of these have assessed the situation in the Netherlands. The papers all consider MSW, short for Municipal Solid Waste. That term encapsulates all waste, from households and all other household-like waste from other sources ([Bourguignon, 2015](#)) that is solid and easy to move around. However, in the Netherlands, the ‘municipal’ waste is just the waste from households ([Marketline, Datamonitor, 2019](#)).

The Dutch market for business waste is an open market where processors of waste have individual contracts and collect and process individually. However, policymakers want to optimize the process of collection for business waste. The idea is to improve the efficiency of the collection of the business waste, but the issue is that there has been no research regarding which basis this policy is made upon. The public administration shows its ambitions in coalition agreements and Green Deals.. However, research is needed to understand what drives public administration decisions when it comes to the collection of business waste. None of the aforementioned references have done research into that specific niche. Considering that, this paper will fit in that hiate.

The question that arises from these premises is: Which factors contribute to public decision making regarding business waste collection? To answer that question extensive literature research will

help gain insights into which factors have been reviewed earlier and which to use for this analysis. The hypotheses that will be investigated are ‘Economic, socio-political and environmental based factors have effects on the decision making process regarding business waste collection.’ and ‘Environmental factors have the most weight on public decision making regarding business waste collection.’ When the possible factors have been researched, there will be a multicriteria analysis performed on the factors to showcase these factors.

Literature review

The literature will be built up to consider a few important segments along the way. The first segment goes into the commons problem and why pollution due to ineffective collection is happening. The second is on externalities that arise from this problem and the issues with solutions to the externalities. The third will deal with polycentricity of the issue and the last part will be an extensive overview of the current waste management literature, exploring the hiatus in the literature and formulating hypotheses which will be tested in the methodology.

Why pollute? A view on the tragedy of the commons and public procurement.

Natural resources are scarce. It might seem like the globe we live on is an infinite supply of materials waiting to be extracted, but where one person extracts something from the earth, it usually does not return for multitudes of lifetimes. That invisible scarcity leads to too much use of a certain resource. Where that happens, a tragedy of the commons is taking place ([Hardin, 1968](#)). Too many sheep graze a field and the result will be that the marginal yields of the field drops until it is no longer useful. Too many fishers in the sea and the sea becomes empty. In the example of the field and the sheep, adding one sheep for a herder adds one more sheep to sell, while the negative utility for the shepherd is a fraction of that sheep when you look at the whole of the field. However, if everyone has that same type of utility calculation, the overall cost (overgrazing) is larger than foreseen and leads to a larger depreciation of the overall wealth of the whole group of shepherds. This approach can be taken for the business waste situation in the Netherlands as well.

Due to the free market aspect of the business waste market in the Netherlands, it is possible that in one street multiple waste collectors are active for the same type of waste. So for example a small local shopping street can have 4 stores with all different individual collection contracts. However, with every individual contract, there is less waste to be collected. One extra collector in the playing field depreciates the amount of waste collectable to one specific competitor by a relatively small amount, but overall all free market players have to divide the total amount of waste even more, leading to more depreciation of the profitability of the market. This is why it is possible to look at this specific market as a situation where a commons tragedy can be identified.

The Dutch market for business waste is a free-for-all market. As long as you have the right permit to collect waste, you can do it for business waste. This is in contrast to household waste, which is being collected by a party contracted by a municipality via a tendering process¹. Government regulation or the conscious non-involvement of government in the provision of services is a long standing debate. (Neo) Liberal thinkers tend to go back to the concept of the invisible hand where the government only needs to step in when failure arises ([Macleod, 2007](#)). That would mean that for this situation government intervention might be justified if we argue that through the case of the tragedy of the commons negative externalities occur and the market has failed in this particular case.

Theory on government intervention has been worked out into theories on efficiency of government stepping in on specific markets such as the running of prisons ([Hart, Shleifer, & Vishny, 2010](#)). The latter paper considers outside contracting versus government provision of, in the first case, prisons as an example for a framework for a broader examination. Their conclusions are that when there is a lot of corruption in contraction and when deterioration of quality by cost cutting is high, either by malevolent behaviour or contract incompleteness, government provision is better than private contracting. To elaborate on that, public procurement in the European Union has been well documented and researched. On the subject of environmental policy and the use of public procurement for the goal of environmental policy, the effectiveness of the means to the end are debatable ([Lundberg & Marklund, 2018](#)). In terms of multi-goal pursuits and effectiveness the instrument is lacking and multiple goal setting through this method is not effective as well. The main thing it can contribute to is with a clear set goal the provision of one certain service. In order to measure effectiveness of the procurement it would be possible to contract parties with clear defined contracts with measurable goals defined in the contract. So when it comes to waste management, these goals and their measures should be clearly defined in order to be able to be a part of a more effective and measurable environmental policy.

To summarize this section, the Dutch market for business waste can be identified as a market with a commons problem. Government intervention might be an option when government goals of the public administration are clearly defined.

Externalities and negating those

Besides the direct effects of collecting more waste than per collector would be sustainable, there are also external effects regarding the collection of waste with too many parties. One of them is that the same way of looking at the commons can be done with congestion. The more people go on the road, the more its efficiency depletes. That can be reduced to vehicle loss hours, a scale used for how bad traffic is. The overall concept of this is even worsened by the concept of induced traffic, where the adding of more infrastructure (overall adding more mobility) leads to more congestion

¹ Tendering is basically a Vickrey auction of a public service contract

([Goodwin, 1996](#)). Basically this means that in relation to the commons problem, there is no possibility to just ‘increase’ the amount of available commons without getting into more, deeper common problems.

According to [Pigou \(1932\)](#), who formalised the commons problem further, the overestimation of the social value of externalities by producers leads to the overproduction of these goods. That overproduction in turn leads to the (negative) externalities. The idea of Pigou is to have a tax on the specific good in order to reduce demand and offset the externalities to the point where social negative cost is reduced to a social optimum. Another option for reducing negative externalities is a fee-system, where there is a limited amount of externalities that are monetized rights to produce that externality is traded. However, governmental flaws in calculating social cost of a certain externality lead to suboptimal outcomes of the policy implied on producers ([Rosen, Gayer & Civan, 2014](#)). So for the case of waste collection, it could be possible to charge some congestion charge in order to prevent congestion as an example. That would, however, mean that there should be a calculation of the social cost of congestion to offset the cost by reducing the congestion to the point of (optimal) equilibrium without the social cost. However, due to government flaws that calculation would be imperfect, causing the measure to be suboptimal to the initial equilibrium (without social cost).

Furthermore, the theorem of [Coase \(1960\)](#) implies that when there are perfectly known property rights, there should always be a possibility to trade and get to a point where externalities would be diminished. To exemplify with the case of waste collection, if congestion would be an issue and that issue would be defined as ‘too many vehicles on the public road’, there would be a right to be on the road at a specific time slot and within that time slot one could operate its business. This would be more like a cap and trade system, where rights are sold and can be traded between agents operating on that road ([Millard-Ball, 2009](#)). In a carbon emission system that would not be effective for environmental policy. To set such a system up, all costs for the rights should be known, as seen with the Pigouvian tax proposal, the social costs are now always known to a government whom should appoint and regulate these rights to emit/drive. Therefore this system would also be imperfect to implement on the business waste collection as is.

Even further underlying of this issue of imperfect estimation and policy making is that the human mind is biased and that might even lead to less optimal decision making from governments ([Bukzar, 1999](#)). Biased decision making by the government overall can lead to inefficient measures being taken. All in all, if the market in this regard fails to deliver on reducing negative externalities and the government might not make the best decisions due to bias, it is important to research what the goals of government are in the process and to check whether the policy which is implemented actually works to achieve the goals that a government wants to achieve.

To summarize, this section shows a few interventions that would be possible on market failures where externalities occur. However, estimation issues and bias in government decision making counteract these measures, leading to suboptimal results. Applied to the case of business

waste collection this leads to difficulty intervening on the market with taxes and or cap and trade systems.

Polycentrism and on which level to act

Further elaborating on common problems, [Ostrom \(2000\)](#) went further into formulating components that make up the commons scenario. In that paper, she analyses multiple possible policy options that have implications on the problem of commons. Some possibilities in the paper were working with sanctions and applying rules to control the common good. Furthermore, the centrality of the situation is addressed briefly, where there are more than one specific actor on different levels involved in working with commons. Further elaborated on, [Ostrom \(2009\)](#) found that for climate change policy, a polycentric approach is a necessity. The reason for this is mostly that the negative effects of depreciated commons (like in the case of climate change the earth in its own right) are felt at very concrete, local scales. Despite the idea that sometimes comes up in debate regarding that local policies are a mere drop in the ocean when it comes to world scale problems, it requires concrete action on local levels to reduce pollution and if all local levels of government work on policy reducing the emissions, overall the emissions might drop significantly. Furthermore, when it comes to fine dust and particles in the air on an urban level, local policies have a greater effect on the direct surroundings and improvements would be more noticeable.

All in all, the local policy is of importance in the whole of reducing emissions and pollution. One policy that is localised in the Netherlands is household waste management. The reason this policy is localised to this level is mostly due to the subsidiarity principle of the European Union. All public procurement of household waste management is the responsibility of the municipality. This is delegated by the national law on municipality responsibility. From a European perspective, the law regarding municipal waste does not distinguish between household and business waste. That distinction is one that has been decided upon in the Dutch waste management legislation. The framework for that legislation is national but the responsibility for executing the duty is on municipal level. Hence why it is important to look at waste management in the Netherlands from the local level, however the national government also plays a facilitating and legislative role in the entire field and should also be considered a part in overall waste management policy as an actor.

In short, this polycentric approach to government decision making is important to make effective policy. The polycentricity of the issue at hand plays between national and municipal levels in the Netherlands and should be considered as a condition to formulate and execute policy regarding business waste collection in the Netherlands. Now to formulate which direction to go in, the next section will analyse which direction policy research has found.

Current waste (collection) management research

Waste management as a field focuses on all that has to do with collecting and processing waste. On the collection of waste, much has been discussed about the household waste. One common analysis is one of routing and overall logistics. The paper by [Hannan et. al. \(2018\)](#) takes into account how much capacity one vehicle has and how to route it as efficiently as possible through a flexible algorithm. This paper is one of some to discuss regarding waste management. Policy makers have a certain set of criterion by which they make decisions that are affecting waste management. This waste management is important for environmental reasons, which is the main motivation for this research paper. When digging further into the literature referred to regarding the environmental importance of waste management, it becomes clear that that even there, the problem seems to be a given and the policy recommendations coming from those papers seem to regard just the environmental factor on which policy makers decide for this specific issue ([Manaf, Samah, & Zukki, 2009](#); [Moh & Manaf, 2014](#)).

[Vu et. al. \(2019\)](#) have made a case for GIS based route optimisation using adaptive neural networking. The neural networking in this case consists of a program that can analyse time series and predict certain waste generation from that. The first motivation given for this research is that over 40% of waste management costs is collection. Reduction in emissions is a secondary (externality) improvement. The cost based motivation is well argued through three papers that all describe and analyze the cost aspect of waste management. The first takes the percentage from another source and uses it as a given to further delve into analyzing the components that make up the emissions and costs of waste collection for business and single person and multiple person families ([Jaunich et al., 2016](#)). That paper in turn cites [Chalkias and Lasaridi \(2009\)](#) who in their turn quote two other papers quoting data from the Greek government ([Lasaridi, Rovolis & Abeliotis, 2006](#); [Karadimas, Papatzelou & Loumos, 2007](#)). The second paper Vu et. al. quote has analyzed Canadian public expenditure on waste management ([Richter, Ng, & Pan, 2018](#)) and the third paper is another route optimizing paper mainly concerning the costs of waste collection ([Sanjeevi & Shahabudeen, 2015](#))

To summarize a section of literature that is like the papers mentioned above, a table will suffice to show the general line of motivation across a selection of similar literature.

Table 1: Short literature review of waste management papers

Main motivation	Paper
Environmental concerns	Hannan et. al. (2018) ; Manaf, Samah, & Zukki, (2009) ; Moh & Manaf (2014) ; Son (2014) ; Amal, Son, & Chabchoub (2018) ; Arribas, Blazquez, & Lamas (2009) ;
Cost reduction	Vu et. al. (2019) ; Jaunich et al. (2016) ; Chalkias and Lasaridi (2009) ; Lasaridi, Rovolis & Abeliotis (2006) ; Karadimas, Papatzelou & Loumos (2007) ; Richter, Ng, & Pan (2018) ; Sanjeevi & Shahabudeen (2015) ; Vu, Ng, & Bolingbroke (2018)
Combined issues regarding waste management	Erfani Et. Al. (2018)

This table above represents a mere fraction of the papers regarding waste management and vehicle routing issues. The line that runs through them are mostly consistent of environmental, financial and livability issues regarding the waste collection. Most papers see those issues in relation with each other either as externalities or direct ‘other’ effects of the issue at hand. More papers regarding this have been summarized by [Beliën, De Boeck & Van Ackere \(2014\)](#). Most of these papers cross reference each other and follow the same main line of reasoning among themselves.

The reasons to intervene seem to align among the literature. Mostly environmental or cost related factors are brought up as the main reason to research waste management. This shows that the governing body likely sees that as an important factor to act upon. However, main motivation for that remains vague among the literature. The direct key relation to public decision making regarding waste management is either direct in the form of a question asked by government or indirect citing these articles building on each other. What is lacking in these optimization based papers is a view on public choice regarding waste management. Some factors would be the environmental and economic factors, but there might be more to add to that list based on literature. The addition of this type of research is that it, among the existing literature can further focus the goals and the variables that can measure the achievement of those goals.

Factors weighing on waste collection

To start off, which factors are important when it comes to waste management (collection) policy? [Chung and Poon\(1996\)](#) analysed multiple waste management alternatives according to three

main categories of factors that are at play concerning private choice in regards to waste management (Appendix 1). The list of factors is comprehensive and with the right elaboration could be altered to public choice regarding waste management. The analysis in that paper is also comprehensive and the methodology will serve as a basis for the methodology in this paper as well due to similar complexity and non-monetary nature of the issue discussed. However, for this set of factors, the underlying literature is somewhat lacking. Therefore, it is important to go over these factors and give all of them a renewed validity and possibly add some factors that also influence decision making.

The factors Chung used are based on micro level analysis. In order to use these for this research paper, they do need to be translated into more macro level indices. So, here follows table of factors and their translations

Table 2: Factors from Chung and Poon (1996) translated to macro level factors and applicability to waste collection

Economic	Explanation of Chung	Translation to macro level	Applicability
Internal costs	All costs of waste management operation	All cost to business waste collection for the government	Yes
Transport costs	All waste transport costs	All societal /external transport costs	Yes
Revenue of recovered resources	Self explanatory		No
Socio-political			
Social equity	Change in how different costs and benefit are distributed to different income groups		Yes
Ease of implementation	How long does it take to implement it and how difficult is it to operate this alternative	Addition is the laws regarding consumers/government and market as well as fiscal implications	Yes

Social acceptability	Public perception of the waste management method		Yes
Compatibility with public administration principles	Self explanatory		Yes
Environmental			
Land used	Area of land used for the waste management method		Yes
Material recovered	Excluding incineration recovered materials from recycling		No
Waste coverage	Percentage of the waste that can be dealt with by the tool	Percentage of waste that can be collected with the collection initiative	Yes
Waste elimination	Reduction of waste produced		No
Net energy recovered	Less energy used net		Yes
Local air pollution	Pollution on the local level		Yes
Transportation	Distance driven, mode of transportation	Distance driven and extra congestion pressure	Yes
Global air pollution	Effect on global emissions		Yes
Potential for water pollution	Intensity and area affected		No
Land contamination and future restriction	Self explanatory		No

Disamenity	Visual, odor and nuisance	Visual, odor and nuisance extended to road safety and public safety	Yes
Other health risk	Self explanatory		Yes
Noise	On site and in neighbourhood		Yes

For economic factors, it is important to note that the improvement of hygiene that happened since the invention of sewers is a prime example of why waste management is important to economic structures ([Rosenberger, 1927](#)). The specifics of waste collection in the Chung and Poon paper is basically internal and transport costs. Internal refers to facilities, internal transportation etc, and is largely based on the processing and location side of it all. This is also important to waste collection here, because in some cases, hubs or other logistical centres have a place in this process ([Vang Buitenshuis, 2019](#)). Transportation costs are more of a business insight as far as Ching and Poon describe it, but for the sake of government's perspective, these costs can be seen as the costs related to cause-process direct transport if the government has to step in with subsidies for that matter. Marketability of recovered materials is mostly for the businesses, so that does not require any attention from this perspective. Circularity in process will end up on the side of environmental impact.

Socio-political impacts are more difficult. The first is social equity, and this is where different income groups have different relative costs or benefit. This is not easy to register, because effects like these can really only be shown after implementation. They can be shown through means of qualitative methods such as surveys and interviews ([Sepe, 2010](#)). Social acceptability is a relatively subjective matter, maybe measurable with surveys of inhabitants. Public perception is difficult to grasp for experts, as they can differ in their perception of issues, for example on hazardous waste ([Hadden, 1991](#)). these differences can be caused by biases, misunderstandings and other fallacies in the calculation of a certain aspect of a value like risk in this example. It is, however, still that public perception that for a political figure decides the future of one's position. Being able to show an improvement and thus increasing acceptability is of great importance. However, efficiency and voter pleasing behavior are not always in alignment from a perspective of lobbying and voter persuasion ([Hill, Kelly, Lockhart, & Van Ness, 2013](#)), the macroeconomic effect of this democratic process is debatable ([Drury, Kriekhaus, & Lusztig, 2006](#)). So overall, the social acceptability might be very important on a political level, it is less so on macro economic scale.

Socio-political factors are a definite case where there is a non monetary factor what weighs in on decision making. Furthermore ease of implementation. For this specific factor, there are implications from a few different angles, such as privacy law, authorities on markets and fiscal law.

This is all to be considered for this process. Compatibility with public administration principles can be measured by holding the actions of government against the promises made in policy documents. Coalition agreements versus what has been implemented will show the compatibility of what the actions do versus the agreement between parties on paper, however once again, this is not easily quantifiable.

Environmental impacts consist mostly of quite measurable factors such as fine dust particles, nitrogen deposits and co2 levels. The only downside to the factors in the Chung and Poon paper is that some are heavily based on an all round solution to waste management and this paper only focuses on the collection. Therefore, some measures are left out of the analysis for this research. Furthermore, the transportation factor will be given an extra factor called 'Modality' to differentiate the technical aspect from the measurable impact of the driven distance and (overall) pollution. This is partially based on a paper focused on waste collection using a heterogeneous fleet showing that having multiple types of vehicles improves efficiency of collection ([Rodrigues & Soeiro Ferreira, 2015](#)). This is also tested in some waste collection initiatives in the Netherlands and can thus be interesting to monitor as a factor that might be of influence on decision making. Furthermore, other health risks concern things not encapsulated within the model so far, including factors like road safety and workplace related safety for the employees of the waste collector.

These three main directions of factors are expected to play a role in the decision making process in their own manner. The hypothesis from this is: Economic, socio-political and environmental based factors have effects on the decision making process regarding business waste collection. Overall these factors are to be researched, but in the matter of finding out which of these combinations of factors might weigh in the most on the decision making. Coming from the literature and the line of reasoning in the literature as shown in the table 1, lots of papers show that environmental factors are the main motivation to their paper. That is why the second hypothesis of this research is: Environmental factors have the most weight on public decision making regarding business waste collection.

Methodology

For the finding of the right type of analysis, it is important to first of all consider the available data considering the analysis. When it comes to decision making regarding the specific topic of business waste, there is no quantitative data that can be used to perform an analysis on the subject at hand. That means that it is not possible to perform a descriptive or regression analysis based on the available data for this specific subject. Some literature is available, but most are on routing and more global (macro) regression basis. This specific issue requires specific methodology

First of all, there are many criteria that are to be considered for this issue. The relations are many and are relatively complex to quantify. To analyse decision making at this level, two main

methodologies can be considered. Cost-benefit analysis or multi criteria decision analysis (MCDA). The first being used mostly for the implementation of project costs and discounting revenues and costs, even non-monetary ones. That tool is used often for the goal of financial argumentation. The subject of business waste collection in this analysis does not so much revolve around costs on its own, but forms a more complex, sometime not monetizable nature. For that reason the MCDA will fit this research well ([Department for Communities and Local Government, 2009](#); [Herwijnen, ?](#); [Kiker et. al, 2005](#)).

The MCDA can showcase the framework from where within choices are made and this will be demonstrated by the application in this case on a few different alternatives for business waste collection. Unlike other papers ([Reddy et. al., 2016](#); [Karleuša, Hajdinger, & Tadić, 2019](#)), this research purely focuses on gathering the factors that are inur for the MCDA and producing the MCDA framework as a useful tool to help the decision making process in the end.

The data for this analysis will be mostly from interviews. They will lay the basis for the weights that will be applied to the factors. The questions that have been designed for these interviews can be found in the appendix (3) and have been designed to figure out why the government has decided to intervene in the market for business waste collection. The question set-up is directly chosen as a result from the main direction of factors that are discussed in the Chung and Poon paper and the added factor of multimodality. Furthermore, questions are centered around polycentricity and the role it plays in the decision making.

The interviewees are chosen from the Vang Buitenshuis literature municipalities that have been active in initiating interventions on the market. As an addition to those, on the national government level at the legislative and the executive branch there have also been interviews. For extra perspective on the matter, there are a few interviewees from the business perspective, the education/research perspective and one interviewee from the perspective of an interest group for municipal waste collectors. Regarding transparency, access gained to the interviewees has been gained through numerous ways. For example the people from the ministry, Rijkswaterstaat, the municipality of Rotterdam and Renewi have been through networking within my internship. The people from the other organisations have been found through either calling the main number of the organisation or mailing the general number, or using LinkedIn to get close to the policy makers of a specific area and reach them through asking for them on general numbers.

The interviews have been conducted through Zoom, where full recordings and transcriptions of the interviews have been possible and some have been on the phone where detailed notes have been taken from the interviews but the recordings have not been possible due to technical issues. The transcriptions are kept confidential to have ensured free room to speak on all possible questions from all perceptions. Furthermore, certain chosen quotes can be used to illustrate the choices regarding weights and or values in the MCA. In essence the answers will be coded into the weights ([Flick, 2014](#))

Alternatives that could have possibly fit this MCA type analysis are the MAMCDA, where it is possible to compare multiple actors in a multiple criteria analysis, however, policy documentation and preliminary interviews have shown that there might not be too big a divergence between the objectives of the government on the national scale and the municipal scale. However, in order to control for that, the interviews will contain a question about the relation between national and municipal government and whether or not there are conflicts of interest between those. If there is reason to assume there is, it might be a part of the discussion to suggest future research on this specific conflict of interest.

Another alternative would have been the cost benefit analysis. This analysis however, monetizes every factor and is thus subject to interpretation of the benefit or cost of a certain less quantifiable aspect of the analysis. Despite there being guidelines on how to calculate these, for this research, especially given the amount of uncertainty, the MCDA would fit better given how it is more forgiving and more flexible of uncertainty and non monetizable factors.

The choice within the MCDA spectrum is one that might lead to choice stress. There are many types of MCDA techniques developed and although they have the same objective, they work it out a little differently. The choice made for this research is the Electre method. This has two reasons. The first is its applicability to the data that I have gathered. This is confirmed by using a tool made available on MCDA.it (Wątróbski, Jankowski, Ziemia, Karczmarczyk, & Ziolo, 2019). Filled in answers are: Weights 'has weights', weights type 'quantity' scale 'quantity'. Other alternatives shown in the tool that have been considered are the promethee methods. The original plan was to apply those methods in this research, however due to logistical issues regarding the obtaining of the academic license from the university of brussels which distributes this software, the Electre method had been chosen as the most fitting alternative to this method. The change in method is that Promethee looks at the distance from both positive and negative, where Electre looks at the scores and weights and calculates one score based on most positive scenario. Furthermore, Electre is not easily visually presented, unlike the Promethee software which would have been able to do that on its own. However, keep in mind, this is mostly nuances, these changes do not alter the main motivation and applicability of the MCDA method. For applying the Electre method, the [XLSTAT](#) excel addin will be used.

One advantage of the Electre method is that regarding sensitivity, those tests are included in the software, giving a 10% sensitivity test to both left and right of the analysis.

Results

The interviewees have been very helpful by answering the questions. The results from these interviews can be summarized as the following. The main reasons for governments to intervene in the market of business waste is liveability. That's the catch-all term for that is the perceived safety of citizens, comfort in the public space and pleasure of living in their area. Overall it can be stated that for most of the municipalities, the situation of having multiple collectors for one certain area of

businesses is perceived as unwanted and damaging to the livability of the city. One specific case that sprung out in the interviews was Amsterdam, where the citizens and the business owners in the ‘negen straatjes’ came forward and asked the municipality to take action on the discomfort experienced from the amount of waste collection trucks going through the streets. Furthermore, in some cases it was also a public hygiene affair, where the goal was to decrease the amount of waste bins out on the street. One example was in Gouda, where the Stichting Gouda Schoon project is being supported based on the local regulations regarding waste bins in the streets. Another is in Rotterdam where in the city centre the waste for some businesses is being collected through the municipal household system in order to prevent logistical and pragmatic issues in the area.

Decreasing congestional pressure is also one of the reasons that are repeated a lot, combined with the implementation of a covenant regarding zero emission zones for urban logistics abbreviated as ZES ([RVO, 2014](#)). These combined show that socio-political factors and environmental factors are the most important factors on deciding on this matter. Furthermore, economic factors play a role, but not much. In essence, municipalities show a range of reactions between the Amsterdam approach where they allocate a budget for the Negen Straatjes project, where it does play a role that it does not exceed the cost framed in the program of demands, to the Gouda approach where all is left to the market and there is no financial support for such a project, arguing that it is not their duty by law.

Given that livability issues are the most given answer, from that it can be deduced that social acceptability is a very important factor in the decision for intervening. Furthermore, the other factors like compatibility with public administration principles seems to be important as most of these initiatives sprung forth from ‘Green Deals’ or coalition agreements otherwise if they are initiated or very much supported by government. When it comes to more market initiated projects, the initiation is mostly an efficiency gain.

When it comes to environmental aspects, they are usually seen as something which is very important as well. Given how some of the underlying reasons to act are ‘Green Deals’, it is clear that this aspect is of importance. They specifically come forth from air quality and global pollution issues that are recognised. However, these deals are usually something not directly related to the policy on business waste, thus in this case, they are given a lower score than 1 to showcase that direct livability issues seem to weigh in higher than the environmental issues. This can also be seen in the disamenities, other health risk and noise criteria, which are highly scored. Furthermore, modality could be seen as something that is being left to the market, but it seems to be of great importance that at least the pressure on traffic is reduced, so if alternative modalities like water bound transport can play a role, they do seem to be somewhat preferred. In the Amsterdam case, the preference is encased in the program of demands for the tender they will publicate.

On the topic of authorities on consumers and markets, the Amsterdam case has bypassed that situation by discussing their plans up front and using the crisis and recovery law to bypass parts of the regular market laws that are in place. Furthermore, other more market based initiatives have seen

some issues, but they have been resolved and most current issues are with privacy (of customers and businesses participating in initiatives) which has been taken care of. Fiscally there have been little problems

Regarding the polycentricity, the national and municipal governments have worked together in a facilitating manner from the perspective of the municipality. The initiatives have been followed with interest from the national government and no conflict of interest has been reported. The provinces have played no role in the process whatsoever.

Table 3: Weights for all factors

Factor	Weight
Internal costs	0,50
Transport costs	0,50
Revenu of recovered resources	0,80
Social equity	1,20
Ease of implementation	2,00
Social acceptability	2,00
Compatibility with public administration principles	2,00
Land used	1,20
Waste coverage	1,50
Net energy recovered	0,80
Local air pollution	0,80
Transportation	1,50
Modality	1,20
Global air pollution	0,80

Disamenity	1,20
Other health risk	2,00
Noise	1,70

From this list of weights that have been determined the following can be said about the hypotheses:

Hypothesis 1 can be accepted. The interviewees gave enough reason to assume all specified based factors play a role.

Hypothesis 2 can be rejected, mostly because socio-political factors seem to play a larger role. Environmental factors are important as well, and might be called intertwined with the socio-political factors in regards to social acceptance of a certain policy. However, that is more of a discussion for later researchers.

However, for now this will do. To showcase the MCDA for this purpose, three scenarios will be compared. A 'Null Scenario' with no changes, a white label collection option and a crisis and recovery law option as Amsterdam is implementing, where the government takes more action. The Null scenario is in place as a control on whether or not a change is something that should or should not be chosen. If a certain project is either not too different from the null scenario or if it is too radical, it will be filtered out by the method through pseudo-criteria. If a project has a negative score compared to the null scenario it is also something that will show lower ranked than null. The white label collection is like the Gouda and Haarlem projects. These are market led initiatives that focus on efficiency of collection and do not disturb the market in a very radical way as the collectors and processors individually do not lose their customers, but the municipality benefits from less vehicles on the road. The third, where the crisis and recovery law is used basically tenders the business waste and the household waste in one tender to be collected in that area. This has more consequences in terms of market interference and is more difficult to implement. All these numbers as input for the analysis are pure estimates based on the initiatives description in the Vang Buitenshuis rapport.

Table 4: Input for the showcase MCDA

Factor	White label	CHW + concessie	Nullscenario
Internal costs	-1,00	-2,00	0
Transport costs	1,50	2,00	0
Revenu of recovered resources	0,00	0,00	0
Social equity	0,50	0,25	0
Ease of implementation	2,00	-2,00	0
Social acceptability	2,00	1,00	0
Compatibility with public administration principles	2,00	1,00	0
Land used	0,50	0,75	0
Waste coverage	0,00	0,00	0
Net energy recovered	0,00	0,00	0
Local air pollution	1,00	1,20	0
Transportation	1,00	1,20	0
Modality	1,20	1,40	0
Global air pollution	0,50	0,75	0
Disamenity	0,00	0,00	0
Other health risk	0,00	0,00	0
Noise	0,50	0,75	0

The last input needed for the analysis are the pseudo criterion. The first (in the addon called the concordance threshold) is formally known as q_j . This number is put in place to filter cases where the difference between two cases is too small to decide between the two and when there still is indifference between the options. The threshold for this is placed at 0,25. The other criterion (in the addon called the discordance threshold) is p_j . This number represents the point where the difference between two alternatives is so large that there is no preferential situation anymore ([Figueira, Greco, Roy, & Slowinski, 2010](#)). The input for this criterion in this analysis will be 0,5. The chosen numbers are arbitrary and chosen for showcasing the analysis in a way where all alternatives are considered in the model and thus compared.

Concordance matrix:

a/b	White label	CHW + concessie	Nullscenario
White label	1,000	0,645	0,313
CHW + concessie	0,645	1,000	0,406
Nullscenario	0,977	0,885	1,000

Discordance Matrix:

a/b	White label	CHW + concessie	Nullscenario
White label	0,000	0,125	0,250

CHW + concessie	1,000	0,000	0,500
Nullscenario	0,500	0,500	0,000

Outranking matrix:

a/b	White label	CHW + concessie	Nullscenario
White label	0	0	1
CHW + concessie	1	0	1
Nullscenario	1	1	0

Ranking table:

Action	Rank
White label	1
Nullscenario	2
CHW + concessie	3

The ranking table shows the end result interpretation from the outranking matrix, namely that the white label collection is preferential to no action and to crisis and recovery law intervention.

Ranking tables for the sensitivity analysis applied to the concordance threshold (Left: +10% ; Right: -10%):

Action	Rank
White label	1
Nullscenario	2
CHW + concessie	3

Ranking tables for the sensitivity analysis applied to the discordance threshold (Left: +10% ; Right: -10%):

Action	Rank
White label	1
Nullscenario	2
CHW + concessie	3

Overall the results show that given the input of the alternatives, the white label collection comes out as the most favourable option in this case. The crisis and recovery law scenario (CHW + concessie) shows to be unfavourable even compared to the null scenario. That would mean that for the goals and the factors that are important to governing business waste collection from the municipal and the national level, white label type comes out best from this analysis.

Conclusion and discussion

This research started with a question from a local coalition of governments, municipal to national, in the region of Rotterdam and The Hague. The issue of inefficient collection of business waste collection led to this paper, where in the theoretical framework the story of tragedy of the commons leads to government intervention, theory on externalities and management of those. Furthermore, polycentricity of policy was taken into account. In the literature, there seemed to be an economical and environmental motivation mostly, however, foundation is lacking. This paper intends to fill in the gap in understanding the motivation of government to intervene in the business waste collection market in the Netherlands.

Overall the results of this paper steer towards the conclusion that socio-political aspects are the most important. Namely liveability, through reduction of nuisance, was named as the most important factor to intervene in the market. From there on, the MCDA framework that has been set up can be regarded as a tool for government to use in the decision when it comes to deciding on interventions on the business waste collection market. This model has been set up from, a general point of view, but when substantiated can be dynamic and adjusted to specific wishes of a specific municipality if there is a reason to defy these weights.

The MCDA model can be used to analyse the different options that have been tested in the Vang Buitenshuis literature, but possibly also to analyze new initiatives that would be an option to enter the market. The MCDA model can be used as a dynamic tool to keep on deciding upon if needed. The limitations of the model are mostly in the limits of finding data to put into the model. If that is lacking, the analytical power of the model is lower because of possible estimation bias.

One of the possible shortcomings of this paper is a lack of literature that goes into public choice and waste management. Most papers cited in this research are either very broad or very technical. That leaves a large gap for literature research and possibly a new research topic all together into this field. This paper might even be a start, but it is quite specific in the narrow field it focuses on.

The downside of qualitative methods are the fact that they are difficult to quantify for an analysis like the MCDA. Based on literature regarding coding and using the results from the interviews as a guideline to a scale-based approach to design the weights can always be debated. The MCDA as presented in this paper with its weights has been built with input from different angles which all point in a similar direction confirming these weights overall. Future research might solidify these weights by means of surveying and maybe a more elaborate policy plan literature/data analysis, maybe using software based approaches like a document/transcription analysis using a data science approach and programming language like Python. Furthermore, the lack of concrete data for the showcase is something that is unfortunate to say the least. It is unsure how the numbers really are, however, estimates can be based on the descriptions and given the constraints the current

quantification of the alternatives might eventually be filled out properly when the alternatives have all been well documented and the effects quantified.

On the MCDA technique, as stated in the methodology, Electre was not the first choice. Despite the nuance in the method, it must be noted that the MCDA approach has become very dense in the sheer amount of options it has for analysis. The field of MCDA-methods is very dynamic and very well described. However, the great scale of methods also incurs a form of stress among new researchers in this field and it will always seem as if there is a better or more fitting option. Future researchers should clean up this methodology and come up with a comprehensive list of a more limited amount of options. This might also remove some possible future suspicion of cherry picking methods based on what works best.

Future research in this field has lots of options to delve into. One of the most striking features is that in the specific market of the netherlands, the market dynamics is something that can be taken as a future topic of interest. This because it has implications on many jurisdictions of law and every move that distorts the market might incur action from authorities (either on their own initiative or on the initiative of market players). This might become of greater importance when legislation changes in regard to this specific market.

References

- Amal, L., Son, L. H., & Chabchoub, H. (2018). *SGA: spatial GIS-based genetic algorithm for route optimization of municipal solid waste collection*. *Environmental Science and Pollution Research*, 25(27), 27569–27582. <https://doi.org/10.1007/s11356-018-2826-0>
- Arribas, C. A., Blazquez, C. A., & Lamas, A. (2009). Urban solid waste collection system using mathematical modelling and tools of geographic information systems. *Waste Management & Research*, 28(4), 355–363. <https://doi.org/10.1177/0734242x09353435>
- Beliën, J., De Boeck, L., & Van Ackere, J. (2014). Municipal Solid Waste Collection and Management Problems: A Literature Review. *Transportation Science*, 48(1), 78–102. <https://doi-org.ru.idm.oclc.org/10.1287/trsc.1120.0448>
- Bourguignon, D. (2015). *Understanding waste management. Policy challenges and opportunities*. European Parliamentary Research Service. Retrieved 24-2-2020 from [http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/559493/EPRS_BRI\(2015\)559493_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/559493/EPRS_BRI(2015)559493_EN.pdf)
- Bukszar, E., Jr. (1999), *Strategic Bias: The Impact of Cognitive Biases on Strategy*. *Canadian Journal of Administrative Sciences / Revue Canadienne des Sciences de l'Administration*, 16: 105-117. <https://doi-org.ru.idm.oclc.org/10.1111/j.1936-4490.1999.tb00617.x>
- Chalkias, C., Lasaridi, K., 2009. *Optimizing municipal solid waste collection using GIS*. Athens; AG Loannou Theologu. World Sci. Eng. Acad. Soc., 17–23, 15773. Retrieved 21-5-2020 from <http://www.wseas.us/e-library/conferences/2009/vouliagmeni/EELA/EELA-03.pdf>
- Chung, S. S., & Poon, C. S. (1996). *Evaluating waste management alternatives by the multiple criteria approach*. *Resources, Conservation & Recycling*, 17(3), 189–210. [https://doi-org.ru.idm.oclc.org/10.1016/0921-3449\(96\)01107-X](https://doi-org.ru.idm.oclc.org/10.1016/0921-3449(96)01107-X)
- Coase, R. (1960). *The Problem of Social Cost*. *The Journal of Law & Economics*, 3, 1-44. www.jstor.org/stable/724810
- Das, S., Bhattacharyya, KB. (2015) *Optimization of municipal solid waste collection and transportation routes*. *Waste Management*, 43, P 9-18. <https://doi.org/10.1016/j.wasman.2015.06.033>
- Department for Communities and Local Government (2009) *Multi-criteria analysis: a manual*. Communities and Local Government Publications. Retrieved 4-5-2020 via http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf
- Drury, A. C., Kriekhaus, J., & Lusztig, M. (2006). Corruption, Democracy, and Economic Growth. *International Political Science Review*, 27(2), 121–136. <https://doi.org/10.1177/0192512106061423>
- Erfani, SMH. et. al. (2018) *Using applied operations research and geographical information systems to evaluate effective factors in storage service of municipal solid waste management systems*. *Waste Management*, 79, Pages 346-355. <https://doi.org/10.1016/j.wasman.2018.08.003>

European Commission. (2015) *Closing the loop - An EU action plan for the Circular Economy*. Brussels. European Commission. Retrieved 9-3-2020 from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614>

Figueira, J., Greco, S., Roy, B., & Slowinski, R. (2010). *Electre Methods: Main Features and Recent Developments*. Retrieved from <https://hal.archives-ouvertes.fr/hal-00876980/document>

Flick, U. (2014). *The SAGE handbook of qualitative data analysis*. London, : SAGE Publications Ltd retrieved 10-6-2020 via <http://methods.sagepub.com/book/the-sage-handbook-of-qualitative-data-analysis>

Goodwin, P.B. Empirical evidence on induced traffic. *Transportation* 23, 35–54 (1996). <https://doi-org.ru.idm.oclc.org/10.1007/BF00166218>

Hadden, S. G. (1991). Public Perception of Hazardous Waste I. *Risk Analysis*, 11(1), 47–57. <https://doi.org/10.1111/j.1539-6924.1991.tb00568.x>

Hannan, MA., et. al. (2018) *Capacitated vehicle-routing problem model for scheduled solid waste collection and route optimization using PSO algorithm*. *Waste Management*, 71, P 31-41. <https://doi.org/10.1016/j.wasman.2017.10.019>

Hardin, G. (1968) *The tragedy of the commons*. *Science*, 13 Dec 1968, Vol. 162, Issue 3859, pp. 1243-1248. <https://doi.org/10.1126/science.162.3859.1243>

Hart, O., Shleifer, A., & Vishny, R. W. (2010). *The Proper Scope of Government: Theory and an Application to Prisons*. Retrieved June 9, 2020, from Ssrn.com website: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=75508

Herwijnen, M. van (?) *Multi-Criteria Analysis tools*. VU Amsterdam, retrieved 4-5-2020 via http://www.ivm.vu.nl/en/Images/MCA0_tcm234-161526.pdf

Hill, M. D., Kelly, G. W., Lockhart, G. B., & Van Ness, R. A. (2013). Determinants and Effects of Corporate Lobbying. *Financial Management*, 42(4), 931–957. <https://doi.org/10.1111/fima.12032>

Jaunich, M. K., et. al.. (2016). Characterization of municipal solid waste collection operations. *Resources, Conservation and Recycling*, 114, 92–102. <https://doi.org/10.1016/j.resconrec.2016.07.012>

Karadimas, N. V., Papatzelou, K., & Loumos, V. G. (2007). *Optimal solid waste collection routes identified by the ant colony system algorithm*. *Waste Management & Research*, 25(2), 139–147. <https://doi.org/10.1177/0734242x07071312>

Karleuša, B., Hajdinger, A., & Tadić, L. (2019). The Application of Multi-Criteria Analysis Methods for the Determination of Priorities in the Implementation of Irrigation Plans. *Water*, 11(3), 501. <https://doi.org/10.3390/w11030501>

Kiker, G. A., Bridges, T. S., Varghese, A., Seager, T. P., & Linkov, I. (2005). Application of Multicriteria Decision Analysis in Environmental Decision Making. *Integrated Environmental Assessment and Management*, 1(2), 95. https://doi.org/10.1897/ieam_2004a-015.1

Lasaridi K.E., Rovolis A., Abeliotis K. *Waste management costs in Greece: spatial patterns and causal factors*. In: K. Aravossis, C.A. Brebbia, E. Kakaras and A.G. Kungolos (eds.), *environmental Economics and Investment Assessment*, WIT Press, 2006, pp. 55-64. Retrieved 21-5-2020 from <https://www.witpress.com/Secure/elibrary/papers/EEIA06/EEIA06006FU1.pdf>

Lundberg, S., & Marklund, P.-O. (2018). Green public procurement and multiple environmental objectives. *Economia e Politica Industriale*, 45(1), 37–53. <https://doi.org/10.1007/s40812-017-0085-6>

Macleod, A. M. (2007). Invisible Hand Arguments: Milton Friedman and Adam Smith. *Journal of Scottish Philosophy*, 5(2), 103–117. <https://doi-org.ru.idm.oclc.org/10.3366/jsp.2007.5.2.103>

MarketLine, Datamonitor (2019). *Waste management in netherlands*. <http://search.ebscohost.com.ru.idm.oclc.org/login.aspx?direct=true&db=bth&AN=140472362&site=ehost-live>

McDowall, W., et. al. (2017). *Circular economy policies in china and europe*. *Journal of Industrial Ecology*, 21(3), 651-661. <https://doi.org/10.1111/jiec.12597>

Manaf, L. A., Samah, M. A. A., & Zukki, N. I. M. (2009). *Municipal solid waste management in Malaysia: Practices and challenges*. *Waste Management*, 29(11), 2902–2906. <https://doi.org/10.1016/j.wasman.2008.07.015>

Millard-Ball, A. (2009). Cap-and-Trade. *Transportation Research Record: Journal of the Transportation Research Board*, 2119(1), 20–26. <https://doi.org/10.3141/2119-03>

Moh, Y. C., & Abd Manaf, L. (2014). *Overview of household solid waste recycling policy status and challenges in Malaysia*. *Resources, Conservation and Recycling*, 82, 50–61. <https://doi.org/10.1016/j.resconrec.2013.11.004>

Ostrom, E. (2000), *Reformulating the Commons*. *Swiss Political Science Review*, 6:29-52. <https://doi-org.ru.idm.oclc.org/10.1002/j.1662-6370.2000.tb00285.x>

Ostrom E. (2009) *A polycentric Approach for Coping with Climate Change, Policy research Working Paper*, Washington DC: The World Bank. Retrieved from <http://down.aefweb.net/WorkingPapers/w578.pdf>

Pigou, A. (1932). *The economics of welfare (Fourth ed.)*. London: Macmillan. <https://ru-on-worldcat-org.ru.idm.oclc.org/oclc/302702>

Reddy, P. et. al. (2016). Using MCDA to generate and interpret evidence to inform local government investment in public health. *EURO Journal on Decision Processes*, 4(3–4), 161–181. <https://doi.org/10.1007/s40070-016-0059-3>

Richter, A., Ng, K. T. W., & Pan, C. (2018). *Effects of percent operating expenditure on Canadian non-hazardous waste diversion*. *Sustainable Cities and Society*, 38, 420–428.

<https://doi.org/10.1016/j.scs.2018.01.026>

Rodrigues, A. M., & Soeiro Ferreira, J. (2015). Waste collection routing-limited multiple landfills and heterogeneous fleet. *Networks*, 65(2), 155–165. <https://doi.org/10.1002/net.21597>

Rodrigues, S., Martinho, G., Pires, A. (2016). *Waste collection systems. Part A: a taxonomy*. *Journal of Cleaner Production*. Vol 113, P 374-387. <https://doi.org/10.1016/j.jclepro.2015.09.143>

Rosen, H. S., Gayer, T., & Civan Abdülkadir. (2014). *Public finance (Tenth edition, global, Ser. The mcgraw-hill series in economics)*. McGraw-Hill Education. <https://ru-on-worldcat-org.ru.idm.oclc.org/oclc/886781789>

Rosenberger, R. (1927). *Public Health*. *The Scientific Monthly*, 24(4), 319-324. Retrieved May 4, 2020, from www.jstor.org/stable/7900

RVO (2014) *Green Deal: Zero Emissie Stadslogistiek*. Retrieved 22-5-2020 via <https://www.greendeals.nl/sites/default/files/downloads/GD173-Zero-Emission-Stadslogistiek.pdf>

Sanjeevi, V., & Shahabudeen, P. (2015). *Optimal routing for efficient municipal solid waste transportation by using ArcGIS application in Chennai, India*. *Waste Management & Research*, 34(1), 11–21. <https://doi.org/10.1177/0734242x15607430>

Sepe, M. (2010). Liveability, quality and place identity in the contemporary city. *Journal of Place Management and Development*, 3(3), 221–246. <https://doi.org/10.1108/17538331011083952>

Son, L. H. (2014). *Optimizing Municipal Solid Waste collection using Chaotic Particle Swarm Optimization in GIS based environments: A case study at Danang city, Vietnam*. *Expert Systems with Applications*, 41(18), 8062–8074. <https://doi.org/10.1016/j.eswa.2014.07.020>

Vang Buitenshuis (2019) *Focus op slimme logistiek bedrijfsafval*. Rijkswaterstaat. Retrieved 4-5-2020 via <https://vangbuitenshuis.nl/kennisbibliotheek/@234231/focus-slimme-logistiek-bedrijfsafval/>

Vu, H. L., Ng, K. T. W., & Bolingbroke, D. (2018). *Parameter interrelationships in a dual phase GIS-based municipal solid waste collection model*. *Waste Management*, 78, 258–270.

<https://doi.org/10.1016/j.wasman.2018.05.050>

Vu, HL. et. al. (2019) *Assessment of waste characteristics and their impact on GIS vehicle collection route optimization using ANN waste forecasts*. *Waste Management*, 88, P 118-130.

<https://doi.org/10.1016/j.wasman.2019.03.037>

Wątróbski, J., Jankowski, J., Ziemia, P., Karczmarczyk, A., & Ziolo, M. (2019). Generalised framework for multi-criteria method selection. *Omega*, 86, 107–124.

<https://doi.org/10.1016/j.omega.2018.07.004>

Appendix 1: Input for the MCA

Factor	White label	CHW + concessie	Nullscenario
Internal costs	-1,00	-2,00	0
Transport costs	1,50	2,00	0
Revenu of recovered resources	0,00	0,00	0
Social equity	0,50	0,25	0
Ease of implementation	2,00	-2,00	0
Social acceptability	2,00	1,00	0
Compability wirth public administration principles	2,00	1,00	0
Land used	0,50	0,75	0
Waste coverage	0,00	0,00	0
Net energy recovered	0,00	0,00	0
Local air pollution	1,00	1,20	0
Transportation	1,00	1,20	0
Modality	1,20	1,40	0
Global air pollution	0,50	0,75	0
Disamenity	0,00	0,00	0
Other health risk	0,00	0,00	0

Noise

0,50

0,75

0

Appendix 2: Interviewees

Government	
Municipality of Rotterdam	Jos Streng
Municipality of Haarlem	Alex Jansen
Municipality of Amsterdam	Anita Numan
Municipality of Gouda*	Hans Rijzenga
Ministry of Infrastructure and water management*	Peter Henkens
Rijkswaterstaat*	Marijn Teernstra
Education	
University of applied sciences Amsterdam	Simon de Rijke
Business	
Renewi	Gerard Veldhuijzen
ANVR (representative association of municipal waste collectors)*	Bas Peeters

* These interviews were conducted on the phone, so there is no transcription but there are notes on the conversations which have been taken into account.

Appendix 3: Questions and main direction of answers

1. What was the main reason for the municipality (or government) to intervene in business waste collection?
 - a. Mainly the reasons given relate to liveability. Factors as nuisance and congestion are the main drivers of intervention
2. Were there any economic motives to intervene?
 - a. Most interviewees see no economic motive for intervention
3. Were there social/political aspects to intervene?
 - a. As said, liveability, congestion and visible nuisance of multiple trucks passing a single street for a single purpose
4. Were there environmental reasons to intervene?
 - a. These are highly regarded, but seem secondary to the liveability answers
5. What reason to intervene was the most important of these three: Economic, socio-political or environmental?
 - a. According to most, it's the socio-political.
6. Did the policy (of the government) steer towards the use of different types of vehicles, or is that decision left to the market?
 - a. These are mostly left to the markets
7. Did the intervention meet any problems with the authority on consumers and markets?
 - a. Sometimes yes, but in cooperation these issues have been solved and negated
8. Did the intervention meet any fiscal issues?
 - a. None
9. Was there interaction with (either national or municipal depending on interviewee) level of government?
 - a. Sometimes, mostly in a facilitating manner and usually the national government followed municipal initiatives with interest,.
10. Were there conflicts of interest between the levels of government?
 - a. None were significantly found
11. Did the province play a role in the intervention?
 - a. No

Appendix 4: Other tables from the analysis

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
White label	17	0	17	-1,000	2,000	0,688	0,853
CHW + concessie	17	0	17	-2,000	2,000	0,371	1,068
Nullscenario	17	0	17	0,000	0,000	0,000	0,000
