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IEM Bachelor's Integration Project

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Intermediate Report

Diftar vs Fixed-rate: An Assessment of Waste Management Proposals in Groningen

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Abstract

The municipality of Groningen aims to harmonise its waste policy. The two proposed policies, pay-per-deposit Diftar and fixed-rate with additional facilities, are not optimal considering the unwanted drawbacks. The study validates the effectiveness of the proposed policies by measuring their performances based upon implementation evidence. The analysis shows that Diftar exceeds in reducing waste and increasing waste awareness, while fixed-rate is more convenient for households and requires lower investments. SWOT analyses were performed to further refine the pros and cons. An improved policy is then constructed based on a framework, setting Diftar as the base and incorporating the measures to ensure convenience and cost-efficiency of the fixed-rate. Proposals to improve Diftar are made based on implementation evidence, case studies and literature. The study has resolved in the an proposition for an improved waste policy for the municipality of Groningen. Future study is required to gauge the success of the implementation of the policy, as adjustments and flaws are inevitable.

Contents

List of Abbreviations

AHP	Analytical Hierarchy Process
Diftar	Differentiated Tariff
KPI	Key Performance Indicators
MSW	Municipal Solid Waste
SMART	Specific, Measurable, Attainable, Relevant, and Time-bound
WAP	Waste Policy

1. Introduction

An overview into the waste management state in Groningen.

The enforcement of three waste policies in the municipality of Groningen has been proven inefficient and impractical. This is due to the different management system and resources required by the municipality, the party responsible for municipal solid waste (MSW) management (Groningen 2019; Rijskwaterstaat 2014). Furthermore, such a situation restricts Groningen's ambition to be a waste-free municipality (Groningen 2015) in 2025 for two of current policies do not promote source separation, hence, higher total waste and non-recyclable waste in the downstream (ibid.).

Policymakers have formulated two proposals; pay-per-deposit Diftar and fixed-rate with additional facilities. Diftar is envisioned to increase waste disposal awareness amongst household, prompting higher source separation and lower non-recyclable (residual) waste (Mutsaers 2020). Nevertheless, tax fraud, illegal dumping and unequal tax burden may arise following Diftar implementation. Such issues have become a major concern for both the municipality and households. As a consequence, the city council is hesitant to opt for Diftar as the new policy (ibid.).

Fixed-rate, on the other hand, retains equal benefits and drawbacks. Moreover, although it requires fewer resources, investment and infrastructure alteration, providing more facilities is not proven to increase the recycling rate. As current insights are still inadequate to delineate the best option (Groningen 2019) and considering the ambition to implement the new policy in 2021, a further investigation of the two options is vital.

This research-design project aims to validate the effectiveness of the proposed policies by measuring their performances based upon implementation evidence. The study is conceptualised in chapter 2. The key concepts and the current waste management in Groningen are elaborated inchapter 3, covering the research aspect of this project. In chapter 4, decision matrix model is formulated to assess the performance of the proposals in chapter 5. Lastly, in chapter 6, a proposition to enhance the policy will be discussed, hence, resulting in an improved waste policy.

2. Report Conceptualisation

Modelling the content of the study

This chapter aims to model the content of the study. Key terms are introduced in section 2.1, where the problems are addressed in section 2.2. The objective of the study is described in section 2.3 and the research questions are formulated in section 2.4. Lastly, risks analysis is covered in section 2.5.

2.1 Key Concepts

Introducing the terms central to this study

This section pinpoints the relevant concepts and terms to provide readers with context into the scope of the project, which are as follows:

1. municipal solid waste;
2. waste management;
3. waste tax;
4. differentiated tariff;
5. fixed-rate per household;
6. key performance indicators.

The complete definitions are addressed later in section 3.1.

2.2 Problem Analysis

The central underlying issue to decipher in this study

The central problem, based on the preliminary problem identification in section A.1, is described as follows:

"The new waste policy development presents two major problems for the municipality; the proposals have worrying drawbacks and the current insights cannot determine which of the proposals are better-suited for Groningen to implement. This has restricted Groningen from enacting the policy in 2021 and reaching the ambition to be a waste-free municipality."

2.3 Project Goal

What can be expected from this study

With the scope, requirements and primary problems defined in previous sections, the goal can thus be formulated using a SMART goal format (Doran 1981) as follows:

"The objective of this project is to redesign the policy proposals for the municipality of Groningen"

The goal will be achieved in three months by validating the effectiveness of the performance of the proposed policies, utilising evaluation criteria and SWOT analysis. Consequently, recommendations to reinforce and/or minimise the drawbacks of the policies will be delineated. Therefore, an improved policy can be designed.

2.4 Research Questions

What must be explored to achieve the goal

A central research question is formulated in aims to fulfil the objective as follows:

"How should the waste policy proposals be improved for Groningen to implement?"

Four sub-questions are devised to aid in answering the main question as follows:

- **Sub-question 1:** *What are the relevant knowledge and theories to assess and improve the policy proposals*?
- **Sub-question 2:** *How is the performance of each proposed policy in light of the evaluation criteria?*
- **Sub-question 3:** *What policy (or policies) should be incorporated into the proposals to minimise the potential undesired drawbacks?*
- **Sub-question 4:** *What can be deciphered by comparing the analysis results in order to improve the proposed policy?*

The first sub-question will be answered in chapter 3 by delving into the system of interests, documents and various literature. The second will be covered in chapter 5, which will be answered utilising the evaluation criteria formulated in chapter 4, as well as analysis of evidences and case studies. These sub-questions constitute the research aspect of this project. Lastly, the third, fourth and thus, the central question will be

solved in chapter 6 by interpreting the results of chapter 5 and exploring literature, case studies and documents; covering the project's design aspect.

2.5 Risks Analysis

Analysing the potential issues that could obstruct the study process

Prior to further delving into the methodology of the study, risk assessment is conducted to identify the possible uncertainties and issues that could jeopardise the study. This process abets in minimising the occurrence of these uncertainties, hence, raising the chance of fruitful project completion.

The risks are assessed utilising risk analysis matrix in Figure 2.1. The possible issues and the connected causes are firstly identified. Consequently, the associated severity and probability of occurrence are identified. Lastly, the effect of the problems are addressed and hence, the scheme to mitigate them.

Severity	Risk Event	Risk Cause	Probability	Effect on Study	Mitigation Plan
A	Biased/irrelevant selected sources	Lack of understanding and planning of search methods	25%	Low validity of methodology and design	Utilise search plan from information literacy workshop
B	Emergence of unforseeable risks	Superficial risks identification	35%	Jeopardise the quality of study	Deducing the possible issues using risk analysis matrix
B	Short time-frame to exectue the study	Fixed deliverable deadline	75%	Unable to provide the optimal solution on time	Meticulous study planning and utilise RDP as guidance
C	Limited access to the required sources (i.e. documents, data, expert)	Untranslatable documents and data; inability to contact expert	40%	Unable to substantiate design decisions; deficient analysis on the proposals; inadequate final recommendation	Prepare backup sources; maximise utilisation of most-important documents; communicate with supervisor and stakeholder
D	Inaccurate modelling of the decision matrix	Neglecting important or incorporating peripheral KPI	50%	Low robustness of the decision matrix and thus, the following policy analysis	Communicate with stakeholders to verify the model
D	Inadequate policy analysis	Inaccurate decision matrix; insufficient data from case studies to project numerical values	50%	Poor overall thesis validity and outcome, thus, its adequacy	Ensure rigorous modelling; adjust the model with the available data (iterative process)

Figure 2.1: Risk Analysis Matrix

The severity of events is denoted alphabetically, where A indicates the least severity while D being the most severe. To conclude, this analysis will only serve as a guideline to advance in conducting this project. Due to the iterative nature of the study, newly emerged, thus, unidentified issues will be tackled using steps that are not elaborated in this section.

3. Body of Knowledge

Understanding the key concepts and waste management in Groningen

The key concepts introduced in chapter 2 will be elaborated in this chapter. Furthermore, the system of interests, Groningen and its waste management system, will be construed and modelled. The findings will also influence the design of the evaluation criteria that will gauge the performance of the two proposed policies. Therefore, sub-question 1 in section 2.4 will be answered.

3.1 Key Concepts Explained

Unravelling the concepts and terms in detail

3.1.1 Municipal Solid Waste

Municipal solid waste (MSW) comprises all the waste generated by the consumption sector, households and the municipality, (Reggiani and Silvestri 2018), which can be classified into six categories, namely, recyclable waste, harmful waste, bulky waste, combustible waste, compostable waste, and other waste (Chen et al. 2017).

3.1.2 MSW management

MSW management encompasses the activities from the upstream (inception) to the downstream (final disposal) which includes waste collection, transport, treatment and disposal (Tchobanoglous 2009). Auxiliary components of the management process include monitoring and regulation. In the Netherlands, municipalities bear the responsibility to determine the overall management configuration, as well as setting the municipal waste tax (Rijskwaterstaat 2014; OECD 2019)

3.1.3 Municipal waste tax

Waste tax is an economic instrument in waste policy, incorporating environmental costs into the households (Morlok et al. 2017). Similarly, this is also known as 'polluter-pays principle', where the costs of pollution are borne by those who cause it (Dahlén and Lagerkvist 2010). The waste tax is currently the main funding for MSW management in the Netherlands (M.A. Allers, Hoeben, and Natris 2010).

3.1.4 Differentiated Tariff

Diftar is a municipal waste tax according to the amount of waste disposed into the bins collected by a municipality (Bilitewski 2004). Diftar in the Netherlands comprises different types, where the most common include pay-per-kilo, -bag and -volume (Rijkswaterstaat 2019a; Van Beukering et al. 2009). Pay-per-kilo depends on the weight of a trash bag or a trash bin, calculated during collection, whereas pay-per-volume is based on the size of waste container (Heijnen and Elhorst 2018).

3.1.5 Fixed-rate per household

It is a municipal waste tax based on the number of households. Throughout the Netherlands, this scheme does not strictly regulate the type of waste that can be disposed of. Furthermore, source separation is not enforced (M.A. Allers, Hoeben, and Natris 2010; Mutsaers 2020). Instead, municipalities heavily rely on separation facilities in the downstream.

3.1.6 Key performance indicators

Key performance indicators (KPI) are a quantifiable measure to evaluate the success of an organisation or program (Fitz-Gibbon 1990). In addition, KPI aids in defining the organisational goals and thus, is crucial to implement (Parmenter 2015).

3.2 System Description

The municipality and the current waste management

This section investigates the current state and performance of the MSW management in Groningen. The prominent elements are then identified and set as a focus for performance juxtaposition between the two proposed policy, which will be covered later in chapter 5. Moreover, the highlighted aspects will aid in composing the evaluation criteria.

3.2.1 Municipality of Groningen

Groningen is the northeastern-most municipality in the Netherlands, with a population of more than 231,000 and total area of 180.5 km^2, making it the sixth most populated municipality in the Netherlands. In 2019, Ten Boer and Haren municipalities merged with Groningen, forming a new single municipality (The Northern Times 2018).

Households, as the main MSW generator, are set as basis for analysis and thus, discussion. Two types of households distributed across 19 regions are distinguished,

namely, single- and multi-persons. Currently, single households have a higher share than the multi-persons in Groningen (53%). Similarly, the number of low-income households, being the target group, retain equal attention. Interestingly, in terms of waste disposal, households can be group based on the designated bin type as seen in Figure 3.1 below.

Bin Type	Region	Total Households	Single-person	Multi-persons	% Low Income
Housefront*	Zuidoost	1,505	53%	47%	9.4
	Hoogkerk	5,115	30%	70%	7.5
	Nieuw-West	8,375	47%	53%	12.6
	Noordoost	7,850	42%	58%	15.3
	Noorddijk	7,570	36%	64%	10.2
	Meerdorpen	440	24%	76%	5.8
	Meerstad	510	15%	85%	5.8
	Ten Boer	2,410	28%	72%	5.1
	Ten Post	585	32%	68%	5.3
	Haren Centrum	8,200	37%	63%	3.5
	Haren Land	750	22%	78%	2.7
Underground *	Centrum	17,820	80%	20%	18.2
	Oud-Zuid	14,765	73%	27%	12.8
	Oud-West	10,180	71%	29%	14.6
	Oud-Noord	12,650	69%	31%	24.0
	Oosterparkwijk	8,175	67%	33%	22.5
	Helpman	10,775	56%	44%	11.0
	Zuidwest	6,030	54%	46%	10.2
	Noordwest	11,350	65%	35%	19.7

* There are mix of bin types in some region. The table provide the majority within the region.

Figure 3.1: Households Statistics Groningen

Underground bins located throughout the heart of Groningen and some surrounding regions, characterised by the many high-rise buildings. In the outskirts, Ten Boer and Haren, MSW are disposed into the house-front mini containers. This type is commonly found in regions with more multi-persons households; low-rise buildings and small villages.

3.2.2 Current State of MSW Management in Groningen

Although currently harmonised, each former municipality is still enforcing its initial waste policy. Enforcing three policies have presented the municipality with different requirements to fulfil, such as different means of waste collection, taxation and administration (Groningen 2015). MSWs in both underground bins and mini-containers are collected every two weeks, whereas other wastes such as plastic, textile and glass are recovered every one to two months (Groningen 2020).

The main distinction between the policies lies in the waste tax collection. Residents in the fixed-rate region pay a constant waste fee based on the number of households, regardless of the frequency or weight. The data from the card used by residents in the city centre to access the underground is utilised by the municipality to track residents

disposal activities. In Ten Boer, the waste fees are determined by the type of container used. Contrarily, waste charges in Haren have two components, a base rate (fixed) and rate per kilogram of MSW disposed into the bins. The average waste charge per households in 2019 (Rijkswaterstaat 2019a) is € 246, where the detail per municipality is as follows:

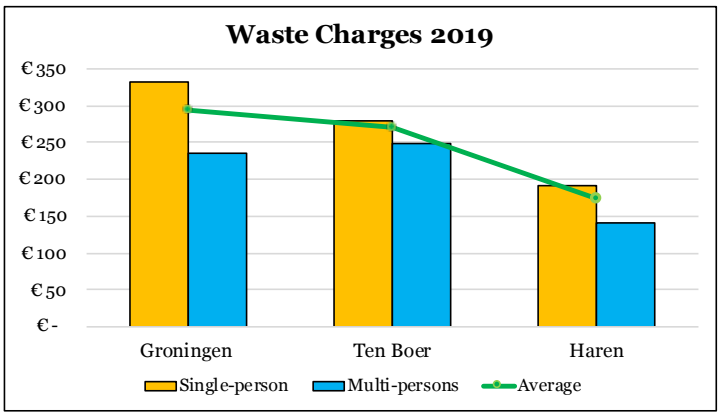

Figure 3.2: Average Waste Fee Per Person

The average waste fee in Haren is significantly lower than the other two cities, which implies that the implementation of pay-per-kilo Diftar in Haren is successful in decreasing the amount of residual waste, as a higher disposal rate leads to a higher average of waste fee paid. Hence, the policy provided better waste disposal awareness. Such a phenomenon is evident in almost all Diftar cases in the Netherlands and other countries (Heijnen and Elhorst 2018; OECD 2019; Rijkswaterstaat 2019a); more will be covered in chapter 5. This has become one of the motivations for Groningen to harmonise Diftar throughout the region (Groningen 2019).

3.2.3 Performance of MSW Management in Groningen

The municipality have set two KPI to measure the performance of the overall waste management (Mutsaers 2020), which are the following:

1. sorting percentage;
2. amount of residual waste per inhabitant per kg.

One of the major aspect of waste management is the rate of waste sorted by households, also known as source separation, as it vastly influences the amount of waste recycled in the collection station. Presently, 59% of waste in Groningen and Ten Boer are sorted, whereas in Haren, it reaches 80% (M.A. Allers, Hoeben, and Natris 2010). This

figure further explains how Haren achieves lower average waste charges paid. The current national goal is to realise a mean sorting percentage of 75%. The municipality has targeted for the recycling rate to be 100% in 2025, with the support of the new policy. Additionally, some of separated waste such as glass, textile and metal are valuable to the municipality as it can be recirculated to the economy.

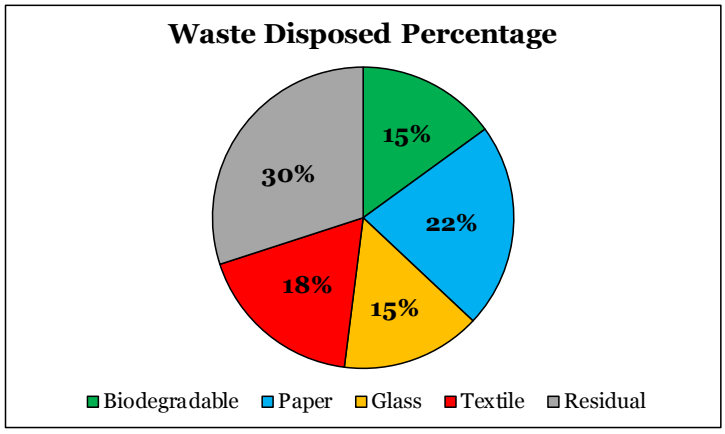

Figure 3.3: Composition of Waste Disposed

On the other hand, each resident throughout the municipality produces, on average, 150 kg of residual waste per year (Groningen 2015). As a comparison, the national goal for 2020 is 100 kg residual waste per year per inhabitant (Mutsaers 2020). The figure above provide the composition of waste in Groningen based on Groningen 2015. From the 30% of residual waste, the municipality is capable of further sorting them in the collection station which will yield more separated and less residual waste. The data of the current performance of downstream separation is given in Table 3.1 below based on (Municipal Services 2019).

Type of Waste	Separated (kg)	Residual (kg)	Total (kg)	% Separated
Biodegradable waste	36	82.40	118.40	30.4%
Glass waste	17.5	9.18	26.68	65.6%
Paper waste	35.9	36.05	71.95	49.9%
Textile waste	4.6	10.08	14.68	31.3%
Total (kg)	94	137.70	231.70	

Table 3.1: Separation Rate of Residual Waste

Nevertheless, the numbers have shown that the separation is not fully efficient, as more than 50% are not recyclable. Therefore, this further emphasise the needs of a policy that could encourage source separation, hence, minimising the non-recyclable residual waste.

3.2.4 Modelling the Waste Management Infrastructure

The waste management in Groningen starts from the upstream, which is the consumption and waste production sector, comprising of households and the municipality. The refuse is collected by the municipal services and then transported to the collection station for recycling. Recyclable waste will be recirculated into the economy and thus, the consumption sector, whereas the residual waste will be incinerated or piled. The model in Figure 3.4 below illustrates the elaboration above, adapted from Van Beukering et al. 2009 WAste Policy (WAP) model and adjusted with the state of MSW management in Groningen.

The three subsystems which would be directly affected by the new policy are confined within the scope of study. This include the waste tax, MSW disposed and the information flow. The new waste management plan will directly influence the waste taxation scheme. The type percentage and amount of MSW disposed will then be affected, which remains as the benchmark for performance indicator.

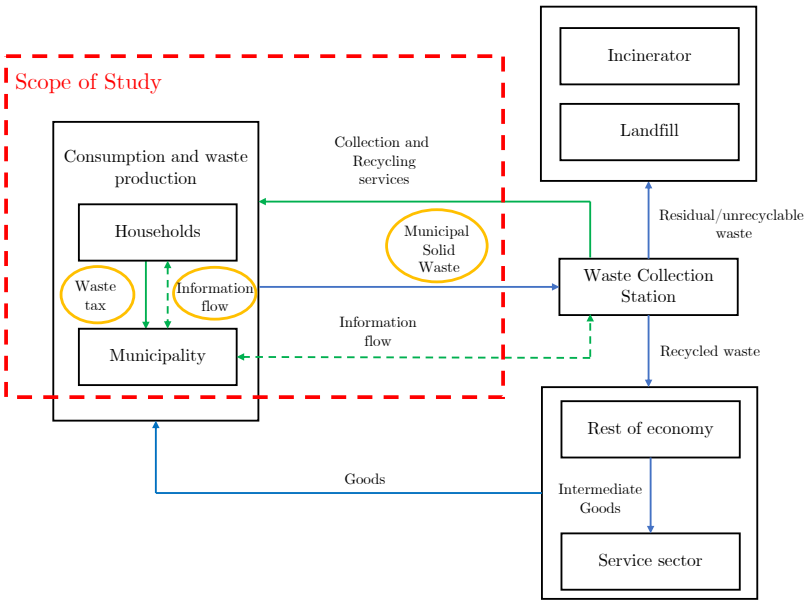

Figure 3.4: The system description adapted from WAP model

Similarly, the information flow, which entails the monitoring, enforcement via regulation and communication between the municipality and residents would also experience changes. Other subsystems are omitted, as they are assumed to be dependent variables in this study (e.g. higher source separation leads to higher recycling rate leads to less waste to incinerator and hence, more supply of recycled-waste to the economy).

4. Decision Matrix Model

Formulating the evaluation criteria to assess the policies

In this chapter, a model to gauge the performance of the proposed policies is formulated by first, pinpointing the reasoning behind the utilisation of evaluation criteria. Subsequently, the criteria or goals for each of the subsystems of focus are identified. Moreover, a cost indicator is included in the model to provide a holistic perspective. Lastly, the weights of the for each criterion are determined.

4.1 Methodology to Assess Policy Effectiveness

The concept of policy effectiveness entails problem-solving and addressing societal problems through a thoughtful process (Mukherjee and Bali 2019; Peters et al. 2018). Moreover, policy effectiveness also includes fulfilment of objectives (Gasper 2005). This implies that the realisation of the municipality waste KPIs, set to accomplish the waste goals, manifest the effectiveness of the overlooking waste policy.

The evaluation of policy effectiveness generally requires empirical observations with a control group in an experimental design, however, stated would be costly and impossible without policy interventions or actual implementation (Jacob et al. 2019). Nevertheless, Sabatier 1986 provide a theoretical approach to evaluate the effectiveness of a policy by a top-down and/or a bottom-up methods. The former starts with the policy and traces the causal chains that are expected from the implementation of the policy, whereas the latter begins from the observed outcomes and uses policy relevant indicators to trace the causalities back to the policy interventions. An adapted framework of these methods is illustrated in section A.2.

Therefore, the reminder of this chapter will focus on formulating a decision matrix model to estimate the performance, thus, the effectiveness, of the policy proposals. The model is used to define attributes, weigh them, and appropriately sum the weighted attributes to give a relative ranking among alternatives (Chang 2015). This methodology will adhere to the bottom-up approach, initiated with the identification of the essential KPIs to monitor the effectiveness of the policy proposal. Subsequently, the model will be designed based on the matrix model in Pahl and Beitz 2013. Several drawbacks of the model that is pivotal to notice will be addressed later in section 5.3.

4.2 Criteria to Assess Waste Tax

The essence of the new waste management plan concerns the the taxation scheme imposed to the residents. There are two criteria to measure the performance of the policies as an economic instrument. First, is the average tax per person as mentioned in section 3.2. As the municipality aims for new waste tax policy to reduce this, incorporating into the model is essential to provide the municipality with insights to accomplish its ambition. This will be evaluated by juxtaposing the estimated average tax of the proposed policies to the current average.

Second, there has been a considerable concern on how the residents with lower income would be negatively affected by the new policy (Groningen 2019). This attention also applies to disabled and chronically ill groups (Mutsaers 2020). An insight into the extent of such an effect should be analysed. However, estimating this aspect quantitatively would be beyond the scope of this study. Therefore, evidence and literature analysis to provide mitigation recommendation will be conducted instead.

4.3 Criteria to Assess Municipality Solid Waste

In order to assess the disposal of MSW, the most common metrics are rate of source separation and yearly amount of waste per inhabitant (Chen et al. 2017; Morlok et al. 2017; Dahlén and Lagerkvist 2010). Providentially, these two metrics are implemented as performance indicators of MSW management in Groningen section 3.2. Both criterion will be measured by comparing the estimated value when a certain policy is implemented to the current (year-to-date) figures.

On the other hand, waste dumping or waste tourism is one of the municipality's major concerns as it may become prevalent following Diftar implementation (Morlok et al. 2017; Linderhof et al. 2001). Waste dumping consists of two types, disposing refuse in other municipality that enforces a different policy (tax fraud - legal) and dumping waste in publicly owned area, which is illegal (Heijnen and Elhorst 2018). Nevertheless, as quantifying this would not be feasible, this study will focus on providing insights into strategies to tackle the issue based on evidences.

4.4 Criteria to Assess Information Flow

The information flow in the context of MSW management between the municipality and households comprises regulation enforcement, monitoring and communicating updates or campaigns (Groningen 2015; Groningen 2019; Mutsaers 2020). These measures are vital due to two reasons; the policy proposals contain several novel regulations and monitoring guidelines, and the success of the new policy is dependent on its social-

isation. Both of which are yet to be examined in terms of effectiveness.

However, this study has opted to omit this from the model, as no preexisting KPI can be found, thus, a possibility of cumbersome knowledge gathering. Furthermore, assessing the effectiveness of a certain regulation and communication flow would require an independent research. Instead, analysis of the information flow will be covered in chapter 5, connected to the recommendation on policy improvements.

4.5 Financial Indicator

Cost efficiency is a criterion that will provide insights into how well the municipality utilises the waste tax stream. The ratio can be obtained by comparing the total projected MSW management costs to the waste tax inflow. This indicator is essential for the municipality, as it highlights the financial effectiveness of the policy development and implementation. Furthermore, the result of this measurement could support costs optimisation in future, hence, reduction of the tax fee. On the other hand, it is also valuable for this study because it incorporates a business aspect into the model.

4.6 Weighting The Criteria

The attribution of weight into each criterion and the corresponding subsystem is vital to accommodate the different interests and importance. Therefore, analytical hierarchy process (AHP) , specifically the pairwise comparison matrix, is utilised to determine the weights. The following steps follow the AHP design guideline by Saaty 2008.

Intensity value	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Moderate importance	Experience and judgement slightly favour one activity over another
3	Strong importance	Experience and judgement strongly favourone activity over another
4	Very strong importance	An activity is favoured very strong over another, demonstrated in practice
5	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above		A reasonable assumption

Table 4.1: Scale for Pairwise Comparison Matrix

First, the fundamental scale of absolute numbers are determined in Table 4.1 above.

Second, the framework, consisting of the determined criteria, can be constructed. Third, documents analysis and interview with Maurie Mutsaers, one of the policymakers in charge of the waste management policy development, have been executed to fill the values for each element of the matrix. Lastly, the values are normalised (refer to Table A.1) with respect to each other. Therefore, the weight for each criterion and thus, the subsystem, are obtained. The final pairwise comparison matrix is depicted in Table 4.2 below.

PAIRWISE COMPARISON MATRIX		Lower amount of tax per household (single and multiple)	Lower residual waste per inhabitant	Higher overall source separation rate	Costs efficiency	Weight	Weight per subsystem
Waste Tax	Lower amount of tax per household	0.14	0.11	0.14	0.17	**0.141**	**0.14**
Disposal of MSW	Lower residual waste per inhabitant	0.29	0.22	0.29	0.17	**0.240**	**0.52**
	Higher overall source separation rate	0.29	0.22	0.29	0.33	**0.282**	
Financial	Costs efficiency	0.29	0.44	0.29	0.33	**0.337**	**0.34**

Table 4.2: Pairwise Comparison Matrix

4.7 Final Design

The final model below is derived based on the steps elaborated earlier. This matrix provides a juxtaposition of three policies, two proposed policies and fixed-rate that represents the currently enforced policy. Therefore, the model displays a direct comparison of the different policies and thus, the overall performances.

Subsystem			Criteria		Objective parameter		Pay-per-deposit Diftar			Fixed-rate with extra facilities			Fixed-rate per households		
No.		Wt.		Wt.		Unit	Magnitude	Value	Wt. Value	Magnitude	Value	Wt. Value	Magnitude	Value	Wt. Value
1	Waste Tax	1.5	Amount of tax per households	1.50	Estimated/YTD	%									
2	Disposal of MSW	5	Residual waste per inhabitant	2.50	Estimated/ YTD	%									
			Overall waste separation rate	2.50	Estimated/ YTD	%									
3	Financial	3.5	Costs efficiency	3.50	Total costs/tax revenue	%									
							Total Sum			**Total Sum**			**Total Sum**		

Figure 4.1: Decision Matrix Model

5. Analysis of The Policy Proposals

Assessing the Effectiveness of Diftar and Fixed-rate

In this chapter, the evaluation criteria will be completed by estimating the magnitudes based on implementation evidences and case studies. Consequently, SWOT analyses will be conducted to further refine the pros and cons of the policy proposals. Thus, this section will answer the second sub-question.

5.1 Waste Management Policy Proposals

The two proposed policies are elaborated below. Moreover, conjunction of the policies, that is the measures the municipality will implement regardless the chosen policy, is discussed.

5.1.1 Pay-per-deposit Diftar

Pay-per-deposit Diftar entails charging two types of rate for waste disposal to the households, namely, a base-rate according to the size of households and variable rate according to waste offered into the bins. In regions with underground bins, the fee is based on the frequency of waste disposal and volume of the underground bin. On the other hand, households with mini containers will be charged based on the kilograms of waste in the bins.

The municipality aims for preventive maintenance of the underground bins as technical failure may occur. Furthermore, effective communication of the changes and what waste to separate, thus, be disposed of has been planned. Policymakers will also formulate the necessary policies to minimise illegal dumpings such as monitoring and enforcement regulations. Lastly, high-rise residences, low-income and chronically ill households will be prioritised as they would have a lower opportunity to maximise Diftar (lower waste separation possibilities).

5.1.2 Fixed-rate with Additional Facilities

This policy has a different approach to reducing waste in the municipality; by increasing the number of underground containers as well as drop-off points for glass, paper and textile wastes. Waste fees will remain the same, based on the size of households. However, to increase efficiency, the municipality will consider the needs of neighbourhood associations, homeowner associations and housing cooperatives.

In addition, the role of the environmental stewards will be expanded (e.g. correcting waste behaviour). The municipality believes that by provisioning these facilities, source separation will increase and thus, decreasing residual waste. This is favourable, as the processing costs of recyclable waste are lower than residual waste. In summary, this policy aims to increase the level of waste management services and lower the related costs while aiming to encourage source separation.

5.1.3 Conjunction of the Policies

There are three planned measures regardless of which policy is chosen. First, the municipality will facilitate the disposal of biodegradable waste in the city centre per households or individual request. This is crucial due to the lower opportunity to separate biodegradable waste in high-rise buildings. Second, the municipality will continue to focus on separating plastics, cans, beverage packaging and metals in the downstream (collection station), as it is more effective than source separation and cheaper for households (less waste equals less fee). However, in the case of Diftar, unsorted plastic waste will be charged as residual waste. Lastly, more locations for disposal of glass, paper, textiles and chemical waste will be added to encourage better source separation, as downstream separation is not yet possible.

5.2 Finding Magnitudes for the Evaluation Criteria

This section will cover the methods and analysis in aims to estimate the values for each criterion which will determine the magnitude and thus, the value column of the criteria. First, the waste disposal criteria will be estimated, followed by projecting the average waste charge. Lastly, the cost-efficiency of both policies will be evaluated.

5.2.1 Separation Rate and Residual Waste

The separation rate and residual waste figures for both scenarios (Diftar and fixed-rate) will be estimated based on case studies and analysis of evidence across the Netherlands. This analysis is integral, as the estimation of the other criteria will be dependent to the findings of this section. Numerous factors affect the waste (recycling) behaviour of individuals which includes demographic characteristics, awareness of consequence, perceived costs and benefits, perceived convenience, and knowledge on waste separation Vassanadumrongdee and Kittipongvises 2018; Briguglio 2016).

For estimating the recycling behaviour, demographics and perceived cost and benefits will be the variables of reference. Other factors will be discussed later in this chapter. Urbanised municipalities have a higher number of single-person households compared to non-urbanised. Recycling behaviour in citified regions shows poor recycling

behaviour, characterised by high waste generation, high residual waste and low separation rate. Such a phenomenon is also caused by the waste policy implemented, dominated by fixed-rate (M.A. Allers, Hoeben, and Natris 2010), which has provided the residents with less awareness of the benefits of recycling. Diftar, on the other hand, serves to heighten the perceived benefits of increasing source separation, thus, recycling, by implying higher waste charges when it is not performed.

Various case studies of Diftar present promising findings which could positively affect the waste disposal behaviour (OECD 2006). Most Diftar regions in the Netherlands have shown on average more than 80% of separation and significantly lower disposal of residual waste (Heijnen and Elhorst 2018). Case studies of four municipalities in Japan showed that implementing pay-per-volume and -bag Diftar reduced the amount of residual waste generated by 20 to 30% (Sakai et al. 2008). In Cork, Ireland, pay-per-kilo leads to 25% decrease of residual waste. Meanwhile, two counties in Germany, Landkreis Schweinfurt and Aschaffenburg manage to achieve a recycling rate of 76% and 86% respectively. Both implement a hybrid of frequency, weight and fixed-rate Diftar, similar to the policy planned for Groningen.

Nevertheless, the findings above are insufficient to determine the expected separation rate and residual waste figures due to the limited and specific evidences. Therefore, an analysis will be conducted on waste statistics of municipalities across the Netherlands. Data from 90 and 172 municipalities are examined for Diftar and fixed-rate respectively (Rijskwaterstaat 2018; StatLine 2019); Rijkswaterstaat 2019a). The data shows the following characteristics:

Reference Point	Diftar	Fixed-rate	Remarks
Urbanity	3	2	1 is highly urbanised and 5 is not urbanised
Single-person	33%	40%	Higher the urbanity, the more single-persons households
Multi-persons	67%	60%	
Avg, Income	€ 25,210	€ 26,040	Lower average income for Diftar municipalities
Avg. Total MSW (kg/person)	490.5	546.6	Diftar municipalities excel in waste recycling performance
Sorting percentage	72.7%	58.8%	
Residual waste (kg/person)	107.9	188.2	

Table 5.1: Summary of Evidence Analysis

Based on the table above, the initial separation percentage for Diftar is 72.7%, whereas

the rate is 58.8% for fixed-rate, with a variance of 0.4% and 1.5% respectively. This implies that the rate throughout the sample has high proximity to the mean, thus, reliable. Nevertheless, there is a standard deviation of 7% for Diftar and 12% for fixed-rate which accounts for influencing factors of recycling mentioned earlier. Considering the higher urbanity and single-households, the separation rate of Diftar is likely to be on the lower boundary (68-70%). In the case of fixed-rate, the extent of source separation consequent to the provisioning of additional facilities is undetermined. Current data is also inadequate to verify this. Considering the current separation rate of 59%, which is well-aligned to the statistical finding, thus, a safe estimation would be an increase of 3% to 4%, setting the figure to be 62%.

Lastly, residual waste will be calculated for both policies. The analysis of evidence in the Netherlands shows a high correlation between the separation rate and the amount of residual waste. Therefore, the matching data set can be utilised. To obtain the estimated figure, the decrease of residual waste consequent to Diftar implementation (first year or first two years) in Dutch municipalities, as well as counties and cities in other countries are investigated. Due to the limited information, the estimation for fixed-rate is based only from Dutch municipalities data.

Reference Point	Diftar	Fixed-rate	Remarks
Residual waste decrease	35%	10%	Average in the first year after implementation

Table 5.2: Rate of Residual Waste Decrease

The analysis showed that by implementing Diftar, Groningen may experience a reduction of residual waste of 35% in the first year (from 150 to 97.5 kg/inhabitant in 2022). In contrast, fixed-rate would only result in a 15% decrease, which is 71.5% less efficient than Diftar. Nevertheless, this evidence analysis did not take into account the provision of additional waste separation facilities, which would increase the figure to around 20% (Groningen 2015). Lastly, the investigation also suggested that the decrease is most-significant in the first two to three years and will reach a plateau in further years (insignificant increase-decrease). This is align with the figures in Japan, Ireland and South Korea (Dunne, Convery, and Gallagher 2008; OECD 2017; Sakai et al. 2008).

5.2.2 Waste Tax per Households

The main variable that determines the waste tax paid for both policies is the household size, with the amount of residual waste disposal added into the equation for Diftar. Ta-

ble 5.3 below summarises the proposed waste charges by the municipality (Groningen 2015). Diftar comprises two rates according to the bin used; weight for mini-container and frequency for underground.

Type of Fee	Single-persons		Multi-persons	
	Base rate	Variable rate	Base rate	Variable rate
Pay-per-deposit Diftar (frequency)	€ 150	€ 1.7 / deposit	€ 174	€ 1.7 / deposit
Pay-per-deposit Diftar (weight)		€ 0.26 / kilo		€ 0.26 / kilo
Fixed-rate	€ 240	-	€ 351	-

Table 5.3: Proposed Waste Charges

Based on the rates above, the average waste fee paid can be estimated. Residual waste estimation in the case of Diftar from the previous section is applied to calculate the frequency of waste disposal. Three assumptions are made; first, plastic, cans and other metal wastes are included in the waste disposal alongside the residual wastes. Second, waste of multi-persons households accounts for 2.5 times the waste of single-persons. Lastly, the mean weight per disposal to underground bins is 6.5 kg. This yields in average 22-23 disposal into the underground bins. Perversely, calculations for weight-based households are more straightforward. The estimation reveals an equal fee paid for the different Diftar fee calculation mechanism, which is desirable for both Groningen and the residents. Interestingly, the variable rate paid for Diftar will continue to decrease as the amount of residual waste declines. Fixed-rate, on the other hand, remains constant.

Waste Policy	Average Waste Fee Paid		
	Single-persons	Multi-persons	Average
Pay-per-deposit Diftar (frequency)	€ 189	€ 269	€ 222.60
Pay-per-deposit Diftar (weight)	€ 188	€ 268	€ 221.60
Fixed-rate	€ 240	€ 351	€ 286.62

Table 5.4: Average Waste Fee Paid per Policy

5.2.3 Costs Efficiency

To obtain insights into the costs efficiency, two variables must be determined, total costs and total revenue. While the latter can be estimated from the calculation of the previous section, the former requires the computation of the total waste management costs and necessary investments costs. Based on the statistical analysis, the average waste fee set by the municipality has a very high correlation to the total waste management costs

(93%). Therefore, this rate will determine the estimated management costs. The total investment costs will be based on the figures reported in Groningen 2015. The table below outlines the costs efficiency calculations.

Waste Policy	Total Revenue	Investments and Structural Expenses	Total Waste Management Costs	Total Costs	Costs Efficiency	Effect on Operations Costs
Pay-per-deposit Diftar	€ 29.8 million	€ 4.5 million	€ 26.8 million	€ 31.4 million	105%	- € 237,000/yr
Fixed-rate with additional facilities	€ 35.6 million	€ 1.6 million	€ 34.3 million	€ 35.9 million	101%	- € 187,000/yr
Fixed-rate	€ 32.5 million	-	€ 30.9 million	€ 30.9 million	95%	- € 63,750/yr

Table 5.5: Cost Efficiency Calculations

The table above also states the effect of operational costs when each policy is implemented based on ibid. Literature reveals that the additional costs of removing any Diftar related waste are much lower than the savings that a Diftar system brings with it (Delft 2004). Furthermore, MA Allers et al. 2006 and Linderhof et al. 2001 states that Diftar may initially lead to higher costs which will be earned back due to the decrease in waste supplied, thus, reducing downstream separation costs. Therefore, the higher return of investment for Diftar is well-justified and can be expected by the municipality.

5.3 Completing the Evaluation Criteria

The final step of the policy proposal analysis is to evaluate each criterion using the decision matrix model based on the findings, summarised in Table 5.6 below. Note that ”Fixed-rate ++” represents the fixed-rate with additional facilities policy. The figures of Diftar and fixed-rate ++ will be confronted to the reference value (fixed-rate) to acquire the magnitude for the model (refer to the ”Magnitude” columns in Figure 5.1). Lower magnitude indicates better result, except for overall source separation rate, as higher estimated value compared to the current value is favourable. On the other hand, although fixed-rate is set as a benchmark, the magnitude of 100% does not apply for the financial aspect. This is due to the higher tax revenue compared to the total costs, suggesting no required investments.

Subsequently, the ”Value” columns will be calculated based on the sum of the difference in magnitude and benchmark value of 1. This method ensures consistency in value-setting, thus, minimising bias and increasing objectivity. Consequently, the value is multiplied by the corresponding criteria weight. In the end, the total sum of the weighted value will resemble the final score for each policy.

Criteria	Unit	Fixed-rate	Fixed-rate ++	Diftar (Deposit)
Amount of Tax Paid per Year	€	294	287	223
Residual waste generated	kg/inhabitant	150	127.5	97.5
Overall separation rate	%	59	62	70
Costs efficiency	%	95%	101%	105%
Annual Costs Saving	€/year	63,750	187,000	237,000

Table 5.6: Summary of Findings from Policy Proposals Analysis

Upon completion, the model shows that Diftar is more effective than the other policies in reducing waste tax paid by households and amplifying waste disposal awareness. Withal, it should be noted that fixed-rate ++ also offer slight improvements in those aspects. This implies that both of the policy proposals are likely to augment the overall waste management in Groningen. Nonetheless, aiming for changes require additional investments, with Diftar being the most taxing and followed by fixed-rate ++.

Finally, although the total sums of the three policies are numerically adjacent, a minor difference may reflect a major change in the weighted value considering the model high sensitivity. For example, a 0.01 change in the magnitude leads to a 0.1 change in the value cell. This prompts a 0.15 change in the weighted magnitude (in case of the waste tax) and therefore, the total sum. A greater chain reaction would be more substantial when a higher weight is applied.

Subsystem			Criteria		Objective parameter		Pay-per-deposit Diftar			Fixed-rate with extra facilities			Fixed-rate per households		
No.		Wt.		Wt.		Unit	Magnitude	Value	Wt. Value	Magnitude	Value	Wt. Value	Magnitude	Value	Wt. Value
1	Waste Tax	1.5	Amount of tax per households	1.5	Estimated/YTD	%	76%	1.24	1.9	98%	1.03	1.6	100%	1	1.5
2	Disposal of MSW	5	Residual waste per inhabitant	2.5	Estimated/ YTD	%	65%	1.35	3.4	85%	1.15	2.9	100%	1	2.5
			Overall waste separation rate	2.5	Estimated/ YTD	%	119%	1.19	3.0	105%	1.05	2.7	100%	1	2.5
3	Financial	3.5	Costs efficiency	3.5	Total costs/tax revenue	%	105%	0.89	3.1	101%	0.94	3.3	95%	1	3.5
							Total Sum		**11.4**	**Total Sum**		**10.5**	**Total Sum**		**10**

Figure 5.1: Completed Decision Matrix Model

The evaluation criteria have established the approximated effectiveness of the proposed policies in contrast to the currently enforced fixed-rate. However, several limitations regarding this model are important to address:

1. none of the policy proposal is optimal from the beginning, thus, a higher total sum

or score does not reflect the overall best policy

2. the model only assess the quantifiable aspects (measurable by statistical analysis and case studies);
3. it does not address the drawbacks of the policies and the unfulfilled goals:
4. the results show the proposed policies will not achieve the national and municipality sorting goals;
5. the model omits the information flow subsystem due to its difficulty to quantify.

Due to the limitations above, a SWOT analysis will be performed in the next section to further refine the pros and cons of the policy proposals. In addition, this analysis will fill the gap of addressing the non-quantifiable aspects and the drawbacks of the policies. On the other hand, the fourth limitation further emphasis the policy proposals inadequacy and thus, the necessity to redesign them.

5.4 SWOT Analysis

SWOT analysis is a tool for strategic planning and management that helps defining the internal and external influencing factors (Thompson, Strickland, and Gamble 2005). In context of policy analysis, the internal factors comprise the policy's strengths and weaknesses, whereas the external factors consist of the opportunities and threats presented by the external environment (municipality and households) (Gürel and Tat 2017).

Strengths	**Weaknesses**
1. Increase waste awareness	1. Requires high investment
2.Motivates source separation	2. Inequality in tax burden
3. Reduces residual waste	3. Less suitable for high-rise residences
4. High adoption	4. Few evidences from urbanised municipalities
Opportunities	**Threats**
1. Achieve waste-free goal	1. Non-Diftar surroundings
2. Reduce management costs	2. Tax fraud
3. Higher perceived fairness	3. Illegal dumping
4. Achieve circular economy	4. Diftar paradox

Figure 5.2: SWOT Analysis of Pay-per-deposit Ditar

Based on the SWOT Analysis, complementing the evaluation criteria, Diftar has an advantage in increasing waste separation and residual waste and overall waste reduction. Moreover, the policy also bestows a greater chance to achieve both municipal and national waste goals. Although Diftar requires high investments, the reduction of operational costs will compensate for this by time. On the other hand, fixed-rate exceeds inconvenience and minimising investment costs. This policy may lead to the attaining the waste goal, however, the required time is undetermined (likely to be longer than Diftar).

In the SWOT analysis, Diftar paradox is listed as a threat to Diftar. In several municipalities, the implementation of Diftar has resulted in a sharp reduction of residual waste. Occasionally, the figures would reach an extreme extent, the revenue from waste tax became insignificant. Therefore, waste management costs are not covered due to the high dependence on residual waste disposal. Such a phenomenon is defined as ”Diftar paradox”; a policy mechanism performs vastly that its affordability is endangered (Van der Wal 2019).

Strengths	**Weaknesses**
1. Requires low investments and alterations	1. Unknown effects on waste separation
2. High suitability for high-rise residents	2. Lower perceived fairness
3. Pre-existing knowledge of the policy	3. High dependence on communication and convenience
4. Suitability with urbanity	4. Poor waste performance
Opportunities	**Threats**
1. Improve waste behaviour	1. Non-conforming to waste goals
2. Reduce management costs	2. Low participation from households
3. More focused steps of extra measures	3. Failure to achieve waste reduction
4. Include the interests of associations	4. High burden for separation facility

Figure 5.3: SWOT Analysis of Fixed-rate with Additional Facilities

In summary, the strength and opportunities of Diftar outweigh fixed-rate’s. The waste performance of fixed-rate with extra facilities cannot match what Diftar has presented. Furthermore, there is a higher plausibility to minimise the unwanted effects of Diftar than expecting the outcome of fixed-rate to be fruitful. Thus, the study will set Diftar as the basis of the improved policy and thus, focus on how to minimise the unwanted side effects. Moreover, the design should strive for the convenience and low investments (or maximising costs saving) offered by fixed-rate.

6. Improving the Waste Policy

Outlining a Redesign of the Policy Proposals

This chapter will discuss the results from chapter 5 to redesign the policy proposals into an enhanced waste policy. First, the scope of waste policy design is defined, followed by describing a design framework. Consequently, recommendations for improvements are elaborated. Therefore, the third and fourth sub-question will be answered, thus, the solving the central question.

6.1 Waste Policy Design

Policy design involves a systematical development of effective policies based on evidence and experience to succeed in attaining the desired goal(s) within a specific context (Howlett 2014). In policy design, policy alternatives or options for how government action can be brought to bear on some identified problem (ibid.), thus, the initial two waste policy proposals. Three elements composed the policy design, goal, tools and calibrations. Policy objectives will be realised through policy measures or instruments – structured activities targeted at altering the public or society towards achieving environmental goals (Jacob et al. 2019).

In context of environmental policies, the increasing awareness of environmental challenges have transformed policy instruments into a policy integration, which would raise the public awareness to policy coherence and systematic approaches (EEA 2018). Waste management policy, in particular, is a subset of environmental policy (Eccleston and March 2011) which aims to nurture desirable behaviours to overcome barriers that obstruct effective waste management (Jacob et al. 2019).

Therefore, waste policy design entails a systematic approach to design a waste policy, based on evidence, in aims to realise the goals of the municipality. The Dutch waste management policy bears four instruments and can be seen as an integration of several policies (Rijkswaterstaat 2019b), as follows:

1. Enforcement of legislation
2. Collection of waste
3. Economic instruments
4. Effective Communication

In this paper, a framework segment to redesign the Diftar policy will stem from the instruments above. The first two items are defined as the regulation of waste disposal, as legislation consists of monitoring and enforcement, whereas waste collection entails the system or infrastructure of waste. The economic instrument implies the financial incentive (taxation scheme of a waste policy) to shift waste disposal behaviour towards higher awareness and recycling. Lastly, the communication aspect covers the means to ensure a sound information flow from the municipality to the households regarding the waste policy (or policy changes).

6.2 Design Framework

The framework to redesign the pay-per-deposit Diftar is as follows:

1. define instruments of focus
2. incorporate other related aspects
3. reflect on the evaluation criteria and swot analysis
4. investigate possible improvements to be incorporated
5. estimate possible results
6. validate the design

The first step is covered in the previous section. In addition to chosen instruments, perceived fairness aspect from Batllevell and Hanf 2008 is incorporated into the design. It comprises three components, where the focus will be in equity. By this, the policy design will assure that all households have the same opportunities to participate in the waste system and bear the fair charges, regardless of the socio-economic condition. The third aspect implies that the policy design should strive on delivering the strengths, maximising the chances to achieve the opportunities, minimise or eliminate weaknesses and curtailing the threats presented by Diftar.

These first three steps will be integrated into the proposition table for improvements on the succeeding section. Subsequently, any quantifiable improvements will be presented in the results section, confronting the improved policy to the previous three policies. An improved waste policy should, therefore, show rigour and robustness. Lastly, the design will be validated to provide a premise that it is reliable and accurate to a certain extent. In addition, design limitations will be elaborated.

6.3 Proposition for Improvements

In this section, several improvements are elaborated to enhance the Diftar policy, separated into two different segments; policy component and reinforcement measures. The former emphasises on the items of the policy, which will be supported by the latter. The findings for policy improvements are outlined per source as follows:

- Miranda et al. 1994: waste managers should consider the impact of fees on low income residents, the need for waste education and enforcement mechanism.
- Dunne, Convery, and Gallagher 2008: waste policy should ensure good monitoring and measuring techniques by co-operation between policy makers, local government and the research community. On the other hand, the author argues that information given in the right social context may alter behaviour more effectively than information without social interaction.
- MA Allers et al. 2006: the chance of waste tourism is reduced when neighbouring municipalities also implement Diftar, restricting the possibility of waste dumping.
- Heijnen and Elhorst 2018: the introduction Diftar can only be successful if laws against waste dumping are enforced.
- OECD 2017: in South Korea, residents who report illegal waste practices to local authorities can be rewarded. About 10% of the cases of illegal dumping are reported by local residents; 90% are detected during inspections by local authorities.
- Fullerton and Kinnaman 1994: empirical evidence suggests that at the individual level the relation between income and waste production, if anything, is decreasing. Therefore, the focus should be in ensuring less waste produced by the target groups.
- Van der Wal 2019: municipalities should set the either or both the base and variable rate based on the expected reduction of residual waste. In addition, the author suggests the cooperation with neighbouring municipalities to prevent waste dumping. Lastly, learning from municipalities or waste management companies with Diftar experiences is highly recommended.

Based on the findings above, propositions for improvements and reinforcements, summarised in Figure 6.1 and Figure 6.2 respectively, are presented below:

Component	Aspect to Improve	What should be incorporated	Possible Advantages	Possible Implications	Source/Remarks
Economic Instrument	Diftar paradox	Setting the base cost to the higher recommended extent	Mitigate Diftar paradox	Tax evasion, higher costs borne by households	Discussed in Van der Wal 2019 and COELO 2019
	Fee equity for target group*	Provide full and partial tax remission	Less tax paid for target groups; increased overall percieved fairness	Increase in expanditures	Planned, however, required concrete realisation (WMP 2015). Special cards for households with underground bins.
Regulation of Waste Disposal	Illegal dumping	Strict policy with considerable penalty	Curtail illegal dumping	-	Strongly advised (Heijnen and Elhorst 2018)
		Increase monitoring by municipality	Rapid identification of possible illegal dumping	Increase in expanditures, required human capital	90% effective in South Korea (OECD 2006)
		Incentive for reporting of dumping by residents	Prevent illegal dumping; increase awareness and participation in waste movements	Increase in costs, possible societal issues	Effective in South Korea to aid monitoring from municipality (OECD 2017)
	Increase separation for other wastes	Provide tax refund for plastis, metals, textile	Increased motivation to separate waste; decreasing sorting costs	Increase in costs for tax refund	The municipality can capitalise circular economy from the influx of separated waste, expanding the revenue stream
Effective communication	Communication of new policy	Focus on communication to target group*	Improve waste awareness, they tend to separate waste less	Increase in expanditures, required human capital	Employ environmental stewards (WMP 2016); also discussed in Miranda 1994
		Extra communication for students and high-rise buildings			-
	Engage more stakeholders to increase the awareness	Cooperate with organisations	Increase active participation, better targeted communications, include the public interests	-	Strongly advised in Dunne 2008
		Personalised online waste disposal data	Provide accurate and timely waste activities, promote better separation	Planning, costs, maintenance	-

* Low income and chronically ill households

Figure 6.1: Proposition for Improvements of Policy Components

Component	Aspect to Improve	Reinforcement Measures or Recommendations	Possible Advantages	Possible Implications	Source/Remarks
Economic Instrument	Diftar Paradox	Discuss rate revision every end of year based on level of waste	Well-adjusted rate per year; mitigate diftar paradox	Increase in costs, bureaucracy issues, time constraints	Van der Wal 2019
	Participation equity for target groups*	Provide bins at concentrated neighbourhoods*	Increased convenience; improved easeness to separate waste	Increased investments, construction and planning time	WMP 2015
Regulation of Waste Disposal	Convenience of waste disposal	Provide more underground bins (strategically)	Increased convenience; improved easeness to separate waste	Increased investments, construction and planning time	Batllevell 2008; Brigulio 2016
	Convenience for waste separation	Provide more locations for disposal of other waste			Batllevell 2008; Brigulio 2016
	Waste tourism	Seek cooperation with neighboring municipalities to implement diftar	Mitigate waste dumping to other municipalites; cretate an overall higher waste awareness surroundings	Bureaucracy issues, requires careful planning and extensive time	Van der Wal 2019; COELO 2017;Heijnen and Elhorst 2018
Effective Communication	Communication of the new policy	Waste campaign or marketing	Boosting communication effort; increase overall waste awareness	Increase in costs, required human capital	Refer to Travaille 2016 for complete analysis and guidelines
		Plan for effective communication of changes	Better execution, clear outline for agents of change (stewards)	-	
	Role of other stakeholders	Education of waste to universities and other educational institutes	Increase the knowledge of waste awareness, joint participation and cooperation	-	Discussed in Miranda 1994
Others	Planning and preparation for Diftar	Use the knowledge and experience of waste companies to import diftar	Better execution, further analysis of the plan, obtain valuable insights and data	-	Discussed in Van der Wal 2019
	Costs optimisation for return of investment	Further analysis of costs components, conduct a business case	Expand revenue stream, maximise circular economy	-	Refer to Dijkgraaf 2004

* Low income and chronically ill households

Figure 6.2: Proposition for Reinforcements of Policy Components

6.4 Estimating the Results of Improvements

This section will provide an overview of the estimated performance or effectiveness of the improved policy, based on the criteria of the decision matrix. Three measures will be discussed, the changes in sorting percentage, average waste paid and annual costs savings. However, an important note that this will be rough estimates, due to the time constraints and limited data for extrapolation. Furthermore, this section will not estimate the outcome of the non-quantifiable aspects such as communication, waste dumping and perceived equity. Instead, the focus will be on how these aspects influence the criteria discussed below.

6.4.1 Sorting/Recycling Percentage

The sorted waste percentage is expected to rise due to the provision of more waste bins and locations for other waste (paper, glass, textile). Furthermore, the effective communication policy, waste dumping prevention measures and reinforcement plan would further increase the awareness of waste disposal. Therefore, amplifying the source separation rate. Based on these assumption and implementation evidences, the recycling rate could reach around 80-85% (OECD 2006; Slavik and Pavel 2013; Puig-Ventosa 2008; Dunne, Convery, and Gallagher 2008). Nevertheless, further analysis is required to better estimate these figures.

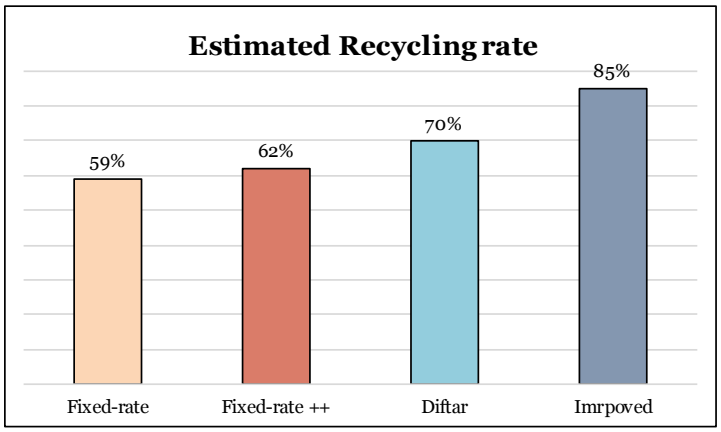

Figure 6.3: Comparison of Recycling Rate

6.4.2 Average Waste Charges Paid

The average waste fee is assumed to increase to mitigate Diftar paradox, which would lead to a higher average waste fee paid. However, if the municipality provides tax remissions to the target group, therefore, such a figure would be slightly reduced. Moreover, a higher fee would further prompt better waste separation by households to avoid in-

curring higher costs. Assuming that all members of the target groups receive a 50% remission, and the municipality increases the fee by 10% (as recommended in Van der Wal 2019), the projection of average waste paid is as follows:

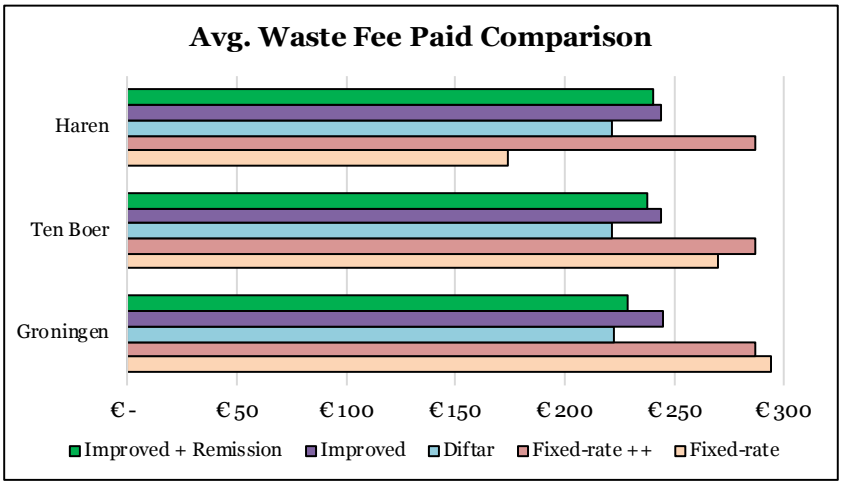

Figure 6.4: Comparison of Average Waste Charges Paid

6.4.3 Annual Costs Saving

The annual costs saving will increase due to the influx of separated waste such as plastics, glass and paper. These secondary materials can be recirculated into the economy, hence, rewarding the municipality with an additional revenue stream. The additional revenue is calculated using the price of recycled materials from Eurostat 2019 and waste data from Groningen 2015. The latter source provides the estimate of plastic, glass and paper wastes collected from each inhabitant per year, following Diftar implementation. The analysis shows that the costs saving may experience a 50% increase. Nevertheless, other factors such as marketability and efficiency of waste sorting may alter this figure. In the end, such an increase would also aid in financing the additional required investments for the improved Diftar policy.

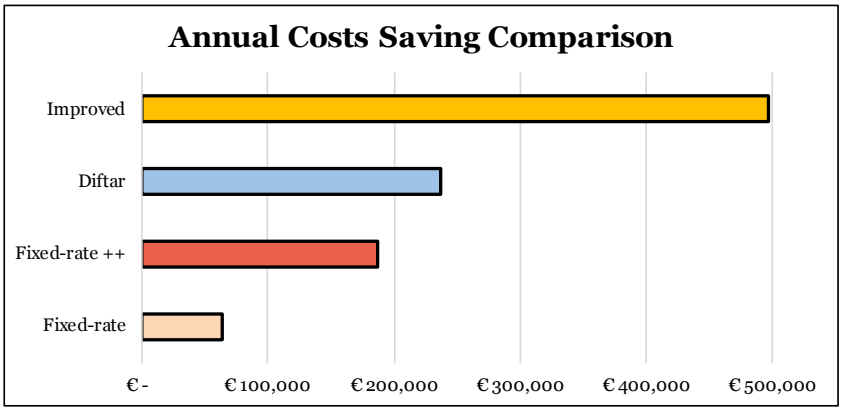

Figure 6.5: Comparison of Annual Costs Saving

6.5 Validating the Design

The final section of this chapter will discuss the design validation; the reliability and accuracy of the improved policy. Furthermore, the limitation of the design will be addressed.

First, the internal and external validity are examined. The former involves how the findings or results match reality whereas the latter concerns the extent of replication possibility (generality) of the findings in other environments (Pellissier 2008). Based on these definitions, the design has a low internal validity, as the outcome, in reality, can only be determined after policy intervention (Jacob et al. 2019). On the other hand, the design has a high external validity due to its applicability for Groningen. The result represents what can be expected from the municipality when the improved policy is enforced. However, this design is not compatible with other municipalities or cities.

Second, the design adheres to the concept of triangulation of methods and sources. Three strategies were chosen to construct the design, namely, case study, evidence analysis and documents analysis. By this, intrinsic biases which commonly a result of single-strategy approach can be diminished, ensuring validity and reliability (Verschuren, Doorewaard, and Mellion 2010). Similarly, the sources were selected to formulate and complete the design, documents, literature, and reality (implementation evidence). Internet, on the other hand, acts as a tool to conduct searches, in particular, necessary literature or articles. These sources establish validity and depth to the design (ibid.).

Finally, the limitation of the design is acknowledged. First, the estimation of the costs is not fully accurate due to the use of a single source instead of delving into the actual spending and financial evidence. Second, the outcome of the design is not simulated to obtain an understanding of performance robustness. Lastly, both the scope of

this study and design framework have limited the aspects of interests incorporated into the final design, which may compromise the holistic aspect (from a broad sense).

7. Conclusion and Recommendations

This project aims to assess the effectiveness and, thus, redesign the waste policy proposals for the municipality of Groningen. Two tools were utilised to measure the performance and effectiveness of the policy proposals, namely, decision matrix model and SWOT analysis. Subsequently, an improved waste policy can be designed, following the established framework, resulting in the proposition tables (Figure 6.1 and Figure 6.2). Finally, it can be concluded that he improved policy increases waste separation and disposal awareness, enables better costs saving and ensure ease of waste disposal

However, there are several limitations to this project. First, the data of implementation evidence are limited to the Netherlands due to the restricted access to other countries' waste data. This has resulted in smaller sample size, thus, reducing the validity. Second, the stakeholder has not been available for discussion due to her maternity leave. Hence, some parts of this project are not discussed and evaluated by the problem owner. Third, this project used numerous assumptions, as well as neglecting real-world examination (due to the study scope) which could jeopardise the robustness of design and results. This real-world inspection could take form in identifying the resources of municipality and the actual condition of the sorting station or interviewing the environmental stewards and manager of the collection station. Lastly, the project does not include an economic model, which is a common research tool for estimating the outcome or effectiveness of a policy.

Further study or research should focus on measuring the actual performance and effectiveness of the implemented policy, obtaining insights from policy intervention and compare that to the estimated results from this project. Moreover, a survey should be conducted to residents about their perception of the policy. This will aid in understanding the factors influencing the recycling/source separation behaviour. As a final note, an essential condition for success in policy design activities rests on the interplay of analytical, managerial, and political capacities (Wu, Howlett, and Ramesh 2017).

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Appendix

A.1 Problem Identification

The problems being or might be faced by the municipality in context of waste tax policy development are pinpointed as follows:

1. The available data and resources cannot verify the optimal waste policy based on the proposed options (Mutsaers 2020). This is an issue for the municipality, for the new policy should be enforced in 2021.
2. The effect of implementing Diftar on the waste management infrastructure, in particular, the elements within the scope of the study, is unknown. This uncertainty, however, is in contrast to fixed-rate, as historical data is available from Groningen and Ten Boer.
3. Diftar may prompt tax fraud and illegal dumping (Groningen 2019; Dahlén and Lagerkvist 2010). Therefore, it can only be successful if the supporting laws are well-enforced (Heijnen and Elhorst 2018).
4. There is a high number of low-income households in Groningen (CBS 2019). These demography groups to pay more waste tax when Diftar is enacted (Groningen 2019), thus, concerns the city council (Mutsaers 2020).
5. Fixed-rate, on the other hand, allows citizen to dispose waste as frequent as possible without them incurring additional costs, hence, hampers the motivation to separate waste from the source.
6. Lastly, the additional facilities that complement the new fixed-rate policy discourages source separation, which would let Groningen to stray further from being a waste-free municipality.

A.2 Methodological Approach for Assessing Policy Effectiveness

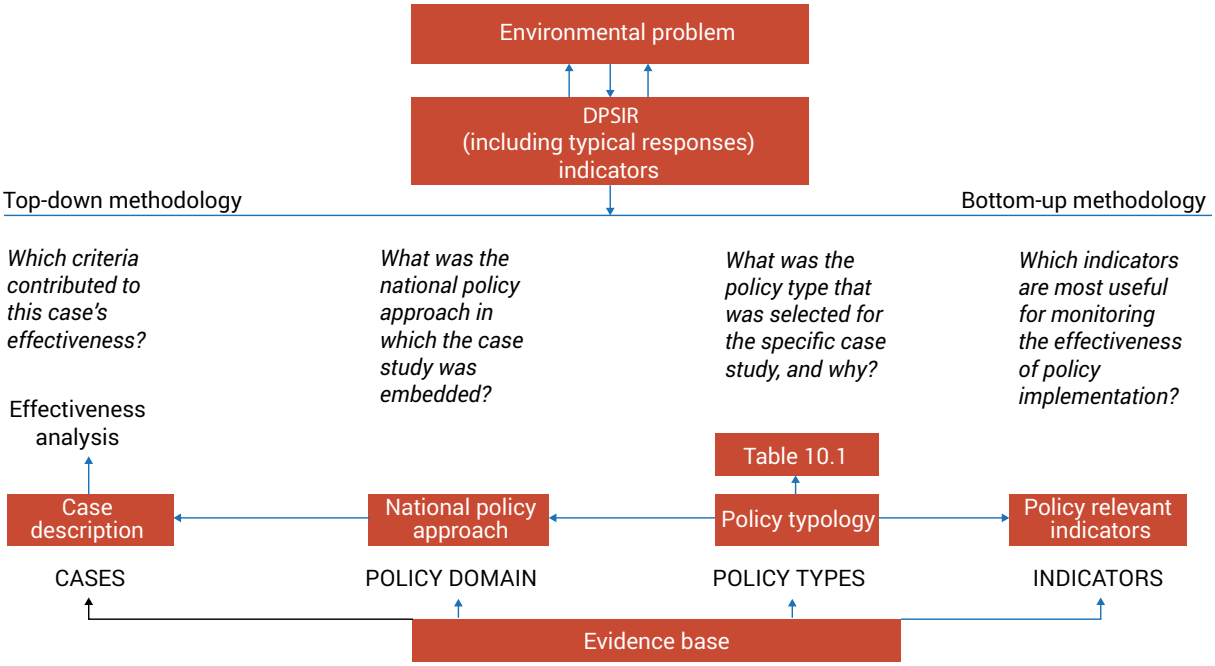

Figure A.1: Top-down and bottom-up approach

A.3 Normalised Pairwise Comparison Matrix

PAIRWISE COMPARISON MATRIX		Lower amount of tax per household (single and multiple)	Lower residual waste per inhabitant	Higher overall source separation rate	Costs efficiency	Weight	Weight per subsystem
Waste Tax	Lower amount of tax per household	0.14	0.11	0.14	0.17	**0.141**	**0.14**
Disposal of MSW	Lower residual waste per inhabitant	0.29	0.22	0.29	0.17	**0.240**	**0.52**
	Higher overall source separation rate	0.29	0.22	0.29	0.33	**0.282**	
Financial	Costs efficiency	0.29	0.44	0.29	0.33	**0.337**	**0.34**

Table A.1: Normalised Pairwise Comparison Matrix